Transactions of the Wisconsin Academy of Sciences, Arts and Letters. volume XV, Part II 1907

Madison, Wis.: Wisconsin Academy of Sciences, Arts and Letters, 1907

TRANSACTIONS

OF THE

WISCONSIN ACADEMY

OF

SCIENCES, ARTS, AND LETTERS

VOL. XV, PART II

EDITED BY THE SECRETARY

Published by Authority of Law

MADISON:
DEMOCRAT PRINTING COMPANY, STATE PRINTER
1907.

TRANSACTIONS

OF THE

WISCONSIN ACADEMY

OF

SCIENCES, ARTS, AND LETTERS

VOL. XV, PART II

EDITED BY THE SECRETARY

Published by Authority of Law

MADISON, WIS.
DEMOCRAT PRINTING CO., STATE PRINTER
1907

TABLE OF CONTENTS.

THE ST. GEORGE, OR MUMMERS', PLAYS: A STUDY IN THE PROTOLOGY OF THE DRAMA.

ARTHUR BEATTY,

University of Wisconsin.

PREFATORY NOTE.

The scope of this paper is so narrow that only a single aspect of the ceremonies of primitive peoples is noticed. There is no opportunity to discuss the ritual and the bearing of the songs on the question of the origin of poetry and the drama. A volume on this important aspect of folk ceremonies is in preparation by the author.

Perhaps a word is needed in justification of the new term "Protology." The word is used simply because we have no name for the method herein employed. "Comparative Literature" implies a study of the relations between *literatures,* but this essay does not follow this method. It rather goes outside the domain of *literature,* written or spoken, into the world of *belief* and *ceremonial,* where it is conceived the ultimate origin of the Mummers' plays lies. Thus in all such studies as are largely extra-literary, and are yet enquiries into literary origins, a new term seems to be required, and so I venture to launch the word Protology.[1]

INTRODUCTION.

In the study of English literature we come into contact with certain forms which are not amenable to the ordinary literary laws. We are accustomed to associate definite author-

[1] πρῶτος and λόγος.

ship with our novels, plays and poems, but these other forms are all anonymous. We are accustomed to demand a definite written form; but these are fluent, with as many as a score of texts, the one as authoritative as the other. We are accustomed to think of literature as being written; but these anomalous forms are spoken, and are perpetuated, not by being handed down in an authoritative text with the latest additions and corrections, but by means of the memory of the individual who passes it on from his own to the generation following.

These forms are: (1) The Ballad, (2) The Folk-Tale, and (3) The Folk-Drama.

The prevalent method of accounting for these three forms is by connecting them with distinctly literary works, and holding that they are the *débris* of forms which were produced by the ordinary methods. Thus the ballad is a broken down form of the romance and epic; the folk-tale is a folk memory of what was heard in the master's hall, as the minstrel declaimed the deeds of the heroes of old; and the folk-drama is a debased form of the Greek drama filtered down through the church to the unlettered class.[1]

As far as the ballad is concerned, this method of accounting for origins has been triumphantly combated by Professor F. B. Gummere,[2] Professor G. L. Kittredge,[3] and Andrew Lang,[4] who argue for a popular, non-literary origin; but for the folk-tale and drama the popular origin has not been so strenuously asserted.[5]

---

1 Representatives of this method are W. J. Courthope, "History of English Poetry," vol. 1, 1895; T. F. Henderson, "Scottish Vernacular Literature," 1901; J. H. Millar, "Literary History of Scotland," 1903; Gregory Smith, "The Transition Period," 1900 (in "Periods of European Literature").

2 "Beginnings of Poetry," 1901.

3 Introduction to the Cambridge Edition of Child's "English and Scottish Popular Ballads," 1904.

4 Chambers' "Cyclopædia of English Literature," subject "Ballads"; *Folk-Lore*, vol. 14. pp. 147 ff.

5 Professor Joseph Bédier's work, "Les Fabliaux," arrives at a negative result. While it overthrows Benfey's theory that European *folk-*

In the present study, we shall consider only a small portion of the drama—the St. George, or Mummers', Plays—and enquire what the probable origins of these plays are. But necessarily, as we discuss this narrow question, we cannot avoid raising some questions which apply to the whole field of the relations between the "folk" and the "literary" literature.

THE ST. GEORGE PLAY.

At many places in England, even to-day, there is given a play by the village folk, which has to do with the deeds of St. George or a similar hero. To be sure, the plays differ very

tales came from India, it does not establish a popular origin. Professor Wundt, "Völkerpsychologie," Bd. 2, 1905, has some excellent criticisms of the Benfey theory, pp. 326–343. "Nur haben dann freilich diese Märchen jedesmal wieder eine eigenartige Beschaffenheit, und es liegt zudem nicht der geringste Grund vor, anzunehmen, dass die Märchendichtung überhaupt das Privilegium eines besonderen Stammes oder die Schöpfung einer in dieser üppigen Fülle nur einmal in der Welt dagewesenen Phantasietätigkeit sei, sondern die mythische Märchenerzählung wird schliesslich ebensogut als ein allgemeiner und ursprünglicher Besitz der Menschheit gelten müssen, wie das Lied oder der Tanz oder wie die mythologischen Vorstellungen selber, nur dass freilich, wie diese, so auch jene Formen ihres Ausdruckes nach Zeit und Raum überaus wandelbar sind."—p. 343.

"Ueberhaupt ist die da und dort in philologischen Kreisen noch immer spukende Hypothese, dass Fabel und Märchen irgendeinmal an irgendeinem Punkt der Erde zu einer bestimmten Zeit erfunden worden seien und von da aus ihre Wanderung durch die Welt angetreten hätten, eine ebenso voreilige Verallgemeinerung, wie sie psychologisch unmögliche Vorstellungen über diese Art der Volksdichtung voraussetzt. Märchen und Fabeln findet man überall, wo man sie sucht. Dass einzelne ansprechende Fabel- und Märchenstoffe zum Teil weite Strecken durchwandert haben, ist in Anbetracht dieser der Volksphantasie zukommenden Eigenschaft des Fabulierens begrieflich genug und wird eigentlich erst durch sie erklärlich."—p. 357, note 1.

The best *general* treatment of the *drama* is that of Professor Wundt, "Völkerpsychologie," Bd. 2, pp. 463–526. ("Mimus und Drama.")

The folk-origin of English Drama has been upheld by Mr. T. F. Ordish in *Folk-Lore*, vols. 2 and 4, 1891 and 1893, and more especially, in a restricted sense, by Mr. E. K. Chambers in his work, "The Mediæval Stage," 2 vols., 1903.

A volume on the Folk-Drama by Mr. T. F. Ordish is promised by the English Folk-Lore Society.

much in length and in incident: indeed, the difference in incidents is very striking; but there is a family likeness which makes possible a classification under the general head of St. George, or Mummers', Plays.

The most complete study of these plays is that of Chambers,[1] who gives a list of *twenty-nine* texts,[2] and on the basis of these various texts gives an account of the leading features of the plays. From these texts and from Mr. L. Gomme's excellent description of the presentation of these plays,[3] we can say that the following features are common to all, or to the greater part of them:

(1) The drawing of a circle, inside of which the players stand when playing their parts. This seems to have no connection with the familiar "witch's circle." It is rather the mere marking out of the limits of the stage.

(2) A fight between individuals, or a *mêlée.*

(3) The death and revivification of one or more persons. In this incident these plays correspond with the German Shrove-tide and Whitsuntide plays.[4] The revival of the dead is accomplished by a braggadocio Doctor.

(4) The costumes of the players frequently consist of *masks* and *armor* like leaves.

(5) Some of the characters represent animals.

The importance of the third heading, the death and revivification, is so characteristic of the plays that we shall present a few of the different treatments of it. Taking the Lutterworth play[5] as the norm, Prince George fights the Turkish Knight and is mortally wounded. The Doctor comes in and revives

1 "The Mediæval Stage," vol. 1, chap. 10.

2 L. c., vol. 1, pp. 205–206. In Appendix K of his book Mr. Chambers prints the Lutterworth play.

3 In *Nature.* Dec. 23, 1897. Other descriptions are to be found in *Folk-Lore.* Vol. 10, pp. 186 ff., has photographs of a Warwickshire play.

4 Chambers, "The Mediæval Stage," vol. 1, p. 218.

5 Written down by Kelly in 1863, "Notices of Gloucester," pp. 53–56. Reprinted by Billson, "Folk-Lore of Leicestershire and Rutland," 1895, p. 130; by Manly, "Specimens of the Pre-Shaksperean Drama," 1897, vol. 1, pp. 289–292; and by Chambers, "The Mediæval Stage," 1901, vol. 2, Appendix K.

the Prince. In the Warwickshire play,[1] the Turkish Knight fights with St. George and is killed. Father Christmas revives him. Again he is killed, and Dr. Brown revives him. In one Oxford play,[2] the Dragon enters; they all fight, and the Doctor—Old Doctor Ball—revives all but the Dragon, whom he kills. In the other Oxford play,[3] St. George alone is wounded. This is also true of the Middlesex play.[4] In one Dorset play[5] St. Patrick kills Captain Bluster; St. George kills the Gracious King, General Valentine and Colonel Spring; and the Irish Doctor revives all of them. Old Father Christmas kills Old Bet, his wife, and the Doctor revives her. In another Dorset play,[6] the hero is King George, and he performs equally valiant deeds. In a play of uncertain locality,[7] Prince George kills the Dragon and is himself killed by the Turkish Knight, Alexander. Then he is revived, and kills Alexander. In another,[8] the Dragon is killed and revived. In still another[9] King George is killed and revived.

Whence came this play? The most obvious answer is that of Mr. A. W. Pollard[10] that the influence of the old play of St. George is traceable. Unfortunately the old play does not exist, though Warton[11] says that a miracle play of St. George was enacted in a field in 1511. Mr. Chambers shows that a play alleged by Collier[12] to have been given by Henry V. to the Emperor Sigismund was in reality a *sotelte,* or large cake. However, a play on the subject of St. George was written by

1 *Folk-Lore*, vol. 10, pp. 186 ff.

2 5 *Notes and Queries*, vol. 2, p. 503; Manly, "Specimens," vol. 1, pp. 289 ff.

3 6 *Notes and Queries*, vol. 12, p. 489.

4 2 *Notes and Queries*, vol. 10, p. 466.

5 *Folk-Lore Record*, vol. 3, p. 92.

6 *Folk-Lore Record*, vol. 3, p. 102.

7 *Archæologist*, vol. 1, p. 176.

8 *Folk-Lore Record*, vol. 3, part 1, pp. 113–114.

9 *Folk-Lore Journal*, vol. 4, p. 97.

10 "English Miracle Plays," 2d ed., 1895, p. lix, note 2.

11 "History of English Poetry," vol. 3.

12 "Annals of the Stage," vol. 1, p. 29.

William Smith about 1623, which is mentioned by Warburton, and was unfortunately burned with other manuscripts by Warburton's cook. The title was *St. George for England,* and it seems to have followed the story of St. George's life rather closely.[1] This is true of the description of Collier's *cake,* which seems to have represented the chief events in the saint's life.

Ten Brink says:[2] "The play of St. George was widely spread in England, and was usually performed on St. John's Day, when a solemn procession was formed. In many places this drama may have absorbed the remains of native traditions of a very early date."

The processions, or "ridings," spoken of by ten Brink, are well attested by records. For instance, in 1536 we find at Leicester the guild was paid four shillings "for dressing the dragon."[3]

Chambers gives references to others[4]—to Norwich, Coventry (1474, 1498), Stratford, Chester, York and Dublin, as well as to Lydd and Bassingbourne (1577, on St. Margaret's Day).

We know that a play on the subject of St. George was given in the fifteenth century in Germany,[5] and that one on St. George and St. John was presented in 1497—1498.[6] A St. George play was also given in Turin in 1427.[7] A similar play was given in Paris about 1422, and another at Nevers in 1428.[8] In all these instances the play deals with the saint as he is known in the later hagiological writings.

Thus, while we know a good deal regarding the St. George "ridings," our knowledge of the dramas on the subject of St. George is extremely meagre; but it is certain that the life of

1 Fleay, "Chronicle of the English Drama," vol. 2, p. 251.

2 "English Literature," vol. 2, p. 293.

3 Billson, "Leicestershire Folk-Lore," p. 110.

4 "The Mediæval Stage," chap. 10.

5 Keller, "Fastnachtsspiele," nos. 125–126.

6 W. Creiznach, "Geschichte des neueren Dramas," vol. 1, p. 231.

7 Creiznach, vol. 1, p. 231; D'Ancona, "Storia della Litteratura Italiana," p. 104.

8 Petit de Julleville, "Les Mystères," vol. 2, pp. 10, 644.

the saint must have been very well known in England. He appears in the old English Martyrology of the ninth century;[1] and he displaced St. Edward as the patron saint of England in 1349. Moreover, his legend was read in the churches on the Sunday before his day (April 23).

I give a part of this as it actually reached the ears of the people about the middle of the fifteenth century in Gloucestershire.[2] It also has the advantage of briefly putting before us the main incidents in the legend. The most complete form of the later, or "canonical," version is found, of course, in Jacob à Voraigne.[3]

---

[1] E. E. T. S. Ed. Herzfeld, 1900. Only the *martyrdom* appears. The dragon is a later accretion. Professor J. E. Matzke finds that the legend of St. George is mentioned as early as 494, when it was pronounced apocryphal and not worthy of credence, by Pope Gelasius. Professor Matzke shows that the earlier forms of the story contained only the tortures and death of the Saint, and that the Dragon came in after the composition of the "Legenda Aurea" in the thirteenth century—"Contributions to the History of the Legend of St. George," in *Publications of the Modern Language Association*, vol. 17, pp. 464–535, vol. 18, pp. 99–171; "The Legend of St. George; Its Development into a Roman d'Aventure," 1, c., vol. 19, pp. 449–478. See also E. S. Hartland. "The Legend of Perseus," vol. 3, *passim*, with references.

[2] Sidney Hartland, "County Folk-Lore: Gloucestershire." F. L. S., 1895.

[3] "Legenda Aurea," lviii. The story of St. George is epitomized in E. S. Hartland, "The Legend of Perseus," 3 vols., 1894–1896, vol. 3, pp. 38–40. Also S. Baring-Gould, "Curious Myths of the Middle Ages," p. 301; W. A. Clouston, "Popular Tales and Fictions," 2 vols., 1887, vol. 1, pp. 155–157. In connection with Mr. Hartland's statement that he does not find this class of legend below a rather advanced grade of culture, it may be worth while to call attention to the Wollunqua myth of the North Central Australians (Spencer and Gillen, "Northern Tribes of Central Australia," 1904, chap. 7.) This Wollunqua monster is a huge serpent who lives in a certain pool; and the natives live in constant dread of it. There is a tradition that it once came out and destroyed a number of people, but it was driven off. Here are all the elements of the St. George legend, except the hero and his sword. The Australian monster was driven off by being pelted with stones, and he is less systematically voracious. But the courteous hero and system are the inventions of civilization.

.DE FŌ STĪ GEORGIJ [Of the Feast of St. George].

Gode men & wymen suche a day &c. ze shull have the feest of Seynt George the whiche day ze shull come to chyrche ī the worshyp of God & of his hooly martyr Seynt George . that bouzte hys day ful der for we redē ī h[s] lyf th[t] th[r] was an orrybul dragō bysyd' a cyte th[t] was called Syrene of the whych dragō mē of the cyte wer so aferd th[t] by coūsel of th[t] kyng uche day th[y] zyuē hym a sheep & chyld for to ete for he shulde not com īto th[e] cyte to ete hē . thēne whē all the chyldrē of the cyte wer etē . for enchesō th[t] (1) th[e] kyng zaf hē th[t] coūsel th[y] const'ynede hym th[t] had but oon dawzt[r] for to zeve hur to the dragō as th[y] had zevē her chyldrē before thēne the kyng for fere of the pepul wepyng & gret sorow makyng delyv'ed hē hys dowgt[r] in her beste aray . & th[y] settē her in the place thē as they wer woned to sette her chyldrē to abyde the dragō & a sheep w[t] hur . but thene by the ordynāce of God Seynt George coom rydyng that way . & whē he syz the aray of the maydē he thouzte wel th[t] hoe shulde be a wōmō of g[t] worshyp & asked hur why hoe stode th'r w[t] so moornyng chere . thene onswered hoe & sayde . gentul knygt wel may I moorne & be of heve cher th[t] ā akyng dowzt[r] & now am set her to be an orrybul dragon' p'ye th[t] etē all the chyldrē of th[s] cyte . & for all they bē etē now mot I be etē also . for my fad[r] gaf hē that coūsel . & th'fore gentul knyzt go hēn' faste & save thy self lest he lese the as he wol me . Damysel q' George th[t] wer gt[e] shame to me th[t] am a knyzt wel arayed zyf I shulde fle & thu th[t] art a wōmō abyde . thēne w[t] thys word anoō the orybu worme putte up hys hed spyttyng fyr owt of h[s] mowth & p'fered batel to George . thēne made George a c'sse byfore hym & rood at hym w[t] hys spere w[t] suche a mygte th[t] he bar down the dragō to the yrthe . thēne bad he the damysel tye hir girdul abowt h[s] nekke & lede hym aft[r] hur into the cyte . thēne the dragō sued hur forth as h[t] had ben a gētul hownd mekely w[t]out any mysdoyng . but whē the pepul of the cyte syz the dragō come they flowen uche mon īto hujue (2) for ferde . thēne George called the pepul ageyn & bad hē not be aferd . for zyf they wolde beleue ī C[r]st & take C'stēdome he wold slen hym before hem anoō & so

1 Because.
2 Hiding.

delyverē hē of nē enimy . thēne wer they all so glad th' twenty 1000 of mē w^t^owte wymē & chyldrē were fulwed anoō fyrst the kyng & al hys howshold w^t^ hym . And thēne he slowz the dragō & bad hem to tye to hym oxon & drawe hym owt of the cyte th^t^ tee savor of hym shulde not greve hem . & then he bad the kyng bylde church' fast in uche cornel of the lond & be lusty to here godd' servyse & do honor to all mē of hooly chyrche & evermoore have minde & cōpassion of all that wer nedy & pore[1] .

Such is the pious legend, and in this form it appears in more than one place in Europe. Mr. Hartland, in his study of the Legend of Perseus,[2] finds it in Märchen[3] and Saga,[4] and traces a similar rescue story all over Europe, Asia and the North of Africa. I find the story of St. George in a Danish ballad in which the saint is called our Lady's Knight; and the story is told in strict accord with the legend.[5] The story does not occur in any English popular ballad, so far as I know, but in several instances the saint is spoken of familiarly and as our Lady's Knight.[6] I am not aware of any English folk-tale which embodies the legend; but a similar story is told in Ireland, concerning Cuchullain and the Wooing of Emer.

But even though the story of St. George does not appear in England either as popular ballad or folk-tale, there is no manner of doubt that it was very well known. There is, therefore, no need of presupposing a literary play of *St. George* in order to account for a St. George play among the people. It seems more likely that the saint may have stepped directly out of the church story into the popular play.

---

1 Cited in "A New History of Gloucestershire," Cirencester, printed by Samuel Rudder, 1779, p. 461, note.

2 3 vols., 1894–1896.

3 L. c., vol. 1, p. 68.

4 L. c., vol. 3, pp. 38–47.

5 Grundtvig, "Gamle Danske Volkeviser," No. 103, vol. 2, pp. 559 ff.

6 See Child, "English and Scottish Popular Ballads." Illustrations to "Battle of Otterburne," etc.—Index. I am perfectly well aware that the two opening poems of the third book of Percy's "Reliques of Ancient Poetry" are "The Birth of St. George" and "St. George and the Dragon;" but these are late and are not popular in tone.

However, there are some difficulties even in this simple hypothesis. According to the church legend, St. George does not marry the rescued maiden. Instead he gives the would-be father-in-law some sound orthodox advice and leaves. But in the Lutterworth play St. George proclaims:

"I slew the fiery dragon and brought him to the slaughter,
And won the King of Egypt's only daughter."

The daughter here referred to, Sabra by name, herself appears in the Cornish play, but does not speak.

These lines and this incident cannot have been derived from the church legend, but must have come from some other source. The word "won" may mean merely "rescued" or "won from the dragon," but the other meaning seems the more probable one.

In the classical and all the secular forms of the story the marriage of rescuer and rescued is an important feature, and this antimonastic detail appears in the play. It may be merely a change in accordance with the folk-feeling of the appropriate ending, or it may come from a form of the story which the churchly legend displaced. In spite of the difficulties, however, it seems clear that St. George and his Dragon, in the form in which we know them, came from the hagiological story.

The Doctor, too, under his various names, may be traced in part to definite written sources. An important part of his *speech* is his boasting and his hard bargaining. He has traveled far and his powers are great, and he will not sell his experience for nothing. The position of St. George or of the person or persons who are dead is a somewhat awkward one, and so the doctor is in a position to drive a hard bargain.[1]

Almost the very speech that occurs in some of the folk-plays, occurs in an early Latin play on the Resurrection, preserved in a MS. of the twelfth century at Tours. The three Marys are at the tomb and they wish to purchase an unguent (unguentum) for

[1] In some forms of the legend the Magician Anastasius appears and opposes his magic to St. George's supposed magic power. It is difficult to see how Anastasius could be the original of the Doctor. Anastasius does not resuscitate any one. See Matzke, op. cit., vol. 17, pp. 467–475; vol. 18, pp. 481–484, for the part played by Anastasius.

the body of Christ. The *Mercator* praises his wares and holds out for a high price:

"Quo si corpus possetis unguere,
Non amplius posset putrescere,
Neque vermes possent commedere,"

he proclaims; and at last consents to accept "unum auri talentum."[1]

Another case is in a French play, *"Les Trois Maries,"* preserved in a MS. of the end of the thirteenth century at Paris. The merchant asks five gold besants for his ointment and accepts two.[2] In a German play of the twelfth century[3] almost the same words are used, and the medicine dealer says that his salves will bring the dead to life again. The Doctor also appears in another German play and haggles over the price of his wonderful wares.[4] In the most thorough examination of this scene, its sources are traced to Provençal and Italian plays, and in its earliest form it seems always to occur in connection with the three Marys. Those plays which have the Doctor dissociated from the Marys seem to be later.[5] Nevertheless, it

---

1 E. de Coussemaker, "Drames Liturgiques" (1861), pp. 38–39. no. 3.

2 Coussemaker, l. c., pp. 272–273.

3 C. W. M. Grein, "Alsfelder Passionspiel," 1874.

4 F. J. Mone, "Altdeutsche Schauspiele," 1841; R. C. Prutz, "Geschichte des deutschen Theaters," 1847, p. 123. The play is given in W. Wackernagel, "Altdeutsches Lesebuch," 1880, cols. 501–510.

The Benediktbeuer Passion Play is printed in Schmeller, "Carmina Burana" (1847), and in R. Froning, "Das Drama des Mittelalters," vol. 1, pp. 284 ff.

The scene occurs also in "The Play of the Sacrament," *Transactions of the Philological Society*, 1860–61. This play dates from about 1461, according to its editor, "W. S."

5 Richard Heinzel, "Abhandlungen zum altdeutschen Drama," Wien, 1896. For references and sources see the whole chapter, "Ueber das Medicusspiel und die lustige Person in dem altdeutschen Drama," chap. 6.

Wilhelm Wundt, "Völkerpsychologie," 2 Band, 1 Teil, pp. 486–495, has a searching discussion of the Doctor and his allies. Wundt notes that embryonic forms of the clown, or mimus, occur among savages (p. 491).

The most exhaustive treatment of the *mimus* is Hermann Reich, "Der seems not improbable that Creiznach's opinion that the origin of the speech is a popular one, is correct,[1] despite the fact that no *ultimate* source, literary or popular, has so far been discovered. In the pages that follow, there will be found a good deal of evidence that the Doctor and his speech were invented by the people in their communal ceremonies.

"George a Green," and his kind, in the popular ceremonials, with their grotesque costumes and extravagant speeches, seem to be the direct forerunners of the Doctor in the St. George plays. In any case, the Doctor and his speech were in circulation as early as the *twelfth* century at least, and we may grant borrowing on the part of the English plays, without enforcing the possibility that the French and other plays may have borrowed from folk-plays, as Creiznach's opinion suggests.

Let us grant, then, that St. George and his Dragon, and the Doctor's characteristic *speech* all come from the regular liturgical drama, and from church legend, by the plain and simple way of borrowing. There remain still greater difficulties:

(1) In borrowing the St. George legend, the performers of the folk-dramas have altered one of its most essential features. In the St. George story, and in all the related stories,[2] the hero *fights* and *conquers* a dragon, or worm, or monster; in no case is he himself killed.[3] In the plays, on the other hand,

---

Mimus: Ein Literatur-Entwickelungsgeschichtlicher Versuch," 2 vols., 1903.

It is worth while to note that the "Doctor" appears in the all-comprehending comic world of Molière, in "L'Amour Médecin," Act II, Scene 7, under the name of *L'Opérateur*. The cure-all is called *orviétan;* and though worth more than all the gold in the world, is sold for "une pièce de trente sols."

1 W. Creiznach, "Geschichte des neueren Dramas," vol. 1, p. 120.

2 Hartland, "The Legend of Perseus," *passim*.

3 This refers only to the later type of St. George legend. In the earliest form St. George is killed from three to four times and is resuscitated. This type is the apocryphal form of the legend, and one which the church attempted to suppress. It certainly lived on and influenced the Latin forms of the legend in the Middle Ages. The death

St. George is killed as often as he conquers. Moreover, the struggle is sometimes a *mêlée,* and there is a general slaughter. In many of the plays, the *dragon* does not appear at all. Thus there is every evidence that the St. George incident is very roughly laid on over some older story, which evidently did not place any special stress on the death of any particular person or persons.

(2) This brings us to the second important point of difference between legend and play. We admitted that the characteristic *speech* of the Doctor might easily be borrowed from the liturgical plays; but we cannot say the same thing of his characteristic *act.* Here, too, we come to the one constant and central incident of the St. George plays—the *revivification* of all the persons who were killed. In none of the liturgical plays does such an incident appear, nor does there seem to be any idea, even the most remote, of such an outcome in any of the English guild plays. The whole incident is absent from all the liturgical and ecclesiastical plays. Neither the plays in Coussemaker, nor any of the German plays that I have been able to examine, nor any plays in the York, Coventry, Dublin, Digby, Towneley, Chester or Beverley cycles have the elements out of which the constant and most characteristic incident in the Mummers' plays could by any possibility have been developed.

What, then, is the source of the Doctor and his revivifying medicine? To answer this, let us remove from the play the comparatively recent accretion of the St. George element. We have now a play the central act of which is a *death* or *deaths,* with or without a *struggle* or *fight,* and followed by the revivification of all the dead by a *leader,* or a *Doctor.* This play brings us to ground that is very familiar to the student of

---

of St. George in the plays may thus be a memory of this earlier form of the story. But this will not explain many of the details of the play. In the plays the one who habitually resuscitates is not St. George, but the Doctor. Even if one were to grant that the revivification incident passed from the legend to the play, there would still remain to be explained the great popularity of the incident, its frequent dissociation from St. George in the play, its constant association with a combat, and its *ultimate* origin.

European folk-lore and anthropology. It in no way points to *literary* sources, but to purely popular ceremonies which are still to be observed in many parts of Europe, and are to be met with in various forms wherever the savage or the peasant is to be found.[1] In brief, we have in plain sight the ceremonies and practices which have been studied so carefully for Europe by Grimm[2] and Mannhardt,[3] and the European and savage practices, in their world-wide distribution, which have been more recently studied by Mannhardt's disciple, Frazer.[4] This field has drawn to it many students of late, prominent among whom are E. V. Anichkof,[5] who has considered the ritualistic songs of the Slavs and the attendant ceremonies, and, on the basis of a very wide comparative study, has done much to show that the origin of poetry is in the primitive ceremony.[6]

The idea, or ideas, at the basis of all these ritualistic ceremonies is the efficacy of sympathetic and imitative magic. As Frazer says:

"The general explanation which we have been led to adopt of these and many similar ceremonies is that they are, or were in their origin, magical rites intended to ensure the revival of nature in spring. The means by which they were supposed to effect this end were imitation and sympathy. Led astray by his ignorance of the true causes of things, primitive man believed that in order to produce the great phenomena of nature on which his life depended he had only to imitate them, and that immediately by a secret sympathy or mystic influence the little drama which he acted in forest glade or mountain dell,

1 See J. G. Frazer, "The Golden Bough," vol. 2, pp. 190–192; and Yrjö Hirn, "The Origins of Art," 1900, pp. 283 ff.

2 Jakob Grimm, "Deutsche Mythologie." English translation by Stallybrass.

3 W. Mannhardt, "Wald- und Feldkulte," new ed., 1904.

4 "J. G. Frazer, "The Golden Bough," 3 vols., 2d ed., 1901.

5 "Vesennyaya Obryadovaya Pyesnya na Zapadye é u Slavyan" (Spring Ceremonial Songs in the South and Among the Slavs), St. Petersburg, 1903. Part 1, "From Ceremonial to Song," alone is published.

6 His formula is: "From Ceremony to Song," and "From Song to Poetry."

on desert plain or wind-swept shore, would be taken up and repeated by mightier actors on a vaster stage. He fancied that by masquerading in leaves and flowers he helped the bare earth to clothe herself with verdure, and that by playing the death and burial of winter he drove that gloomy season away, and made smooth the path for the returning spring. ... We may smile at his vain endeavors if we please, but it was only by making a long series of experiments, of which some were almost inevitably doomed to failure, that man learned from experience the futility of some of his attempted methods and the fruitfulness of others. After all, magical ceremonies are nothing but experiments which have failed and which continue to be repeated merely because, for reasons which have already been indicated,[1] the operator is unaware of their failure. With the advance of knowledge these ceremonies either cease to be performed altogether or are kept up from force of habit long after the intention with which they were instituted has been forgotten. Thus fallen from their high estate, no longer regarded as solemn rites on the punctual performance of which the welfare and even the life of the community depended, they sink gradually to the level of simple pageants, mummeries, and pastimes, till in the final stage of degeneration they are wholly abandoned by older people, and, from having once been the most serious occupation of the sage, become at last the idle sport of children. It is in this final stage of decay that most of the old magical rites of our European forefathers linger on at the present day, and even from this, their last retreat, they are fast being swept away by the rising tide of those multitudinous forces, moral, intellectual, and social, which are bearing mankind onward to a new and unknown goal."[2]

---

[1] Vol. 1, pp. 78 ff.

[2] "The Golden Bough," vol. 1, pp. 110–112. Of the relations between ceremonial and myth he says:

"We shall probably not err in assuming that many myths, which we now know only as myths, had once their counterpart in magic; in other words, that they used to be acted as a means of producing in fact the events they describe in figurative language. Ceremonies often die out while myths survive, and thus we are left to infer the dead ceremony from the living myth." L. c., vol. 2, pp. 164–165.

Frazer[1] states that in this explanation he is following in the footsteps of Mannhardt, and notes that Mannhardt's conclusions have been not a little confirmed by magical ceremonies which are practiced in Central Australia for the purpose of awakening the dormant energies of nature at the approach of spring. We can say more than this, that not only in Australia, but in America, Africa and Oceania magical ceremonies are employed which point to beliefs similar to those which seem to lie at the basis of the European spring ceremony. The death and resurrection are not associated with the magic spring ceremony alone. They occur in a totally different class, namely, in the initiation rites of various peoples. In these rites, the end is not favorable weather, but a *new person*, and, to meet this end, the novice dies and is revived, receives a new name, and is a new person. To be sure, *death* is not always simulated; but where it is not, some act symbolical of the new birth is performed.

In this paper we shall consider: (1) The European ceremonies; (2) the Australian magic food ceremonies; (3) the Australian and Oceanic initiation ceremonies; (4) the American initiation ceremonies, and (5) the American agricultural and related ceremonies.

I.

EUROPEAN CEREMONIES.

As might be expected, the accounts of ceremonies in Ancient Europe are meagre, but Grimm[2] has gathered many references to them from classical writers, poems, and various other sources. When a people has endured "the drums and trampling of three conquests," and has been exposed to centuries of time,—that "grim wolf," who "with privy paw daily devours apace, and nothing said," it is a marvel that anything like ceremonies and traditions should remain; and the fact that so much does remain is an eloquent testimony to the tenacity of custom and tradition.

---

1 "The Golden Bough," vol. 1, p. 113.

2 "Deutsche Mythologie." Unfortunately, the very suggestive book by Professor Albrecht Dieterich, "Mutter Erde: ein Versuch über Volksreligion," 1905, came to hand too late for adequate mention.

Let us take an example from practices which still live.

"In Little Russia it used to be the custom at Eastertide to celebrate the funeral of a being called Kostrubonko, the deity of the spring. A circle was formed of singers, who moved slowly around a girl who lay on the ground as if dead, and as they went they sang:

> 'Dead, dead is our Kostrubonko!
> Dead, dead is our dear one!'

until the girl suddenly sprang up, on which the chorus joyfully exclaimed:

> 'Come to life, come to life has our Kostrubonko!
> Come to life, come to life has our dear one!'"[1]

In some parts of Swabia some one pretends to be killed and to come to life again. On Shrove Tuesday Dr. Ironbeard professes to bleed a sick man who thereupon falls as dead to the ground, but the doctor at last restores him to life by blowing air into him through a tube.[2]

In Saxony and Thüringen there is a Whitsuntide ceremony, called "chasing the Wild Man out of the bush," or "fetching the Wild Man out of the wood." A young fellow enveloped in leaves or moss is called the Wild Man. He hides in the wood and the other lads of the village go out to seek him. They find him, lead him captive out of the wood, and fire at him with blank muskets. He falls as if dead to the ground, but a lad dressed as a doctor bleeds him, and he comes to life again.[3] In Dauphiné, on the first of May the young people clothe in leaves a youth whose bride or sweetheart has left him. He lies down on the ground and pretends to go to sleep. Then a maiden who likes him, and is willing to marry him, comes, awakes him, raises him up, and offers him her arm and a banner.[4] In some ceremonies the resurrection is represented

---

1 W. R. S. Ralston, "Songs of the Russian People," p. 221; E. V. Anichkov, "Spring Ceremonial Songs," p. 340.

2 F. J. Wiedemann, "Aus dem inneren und äusseren Leben der Ehsten." (In Frazer, vol. 1, p. 82.)

3 Mannhardt, l. c., vol. 1, pp. 335–336.

4 Mannhardt, l. c., vol. 1, p. 434 (Maibraut).

by a procession, as in the Bohemian ceremony. The young girls go out to the woods, cut down a young tree, ornament it, and come marching back to the village singing:

> "Death we carried out of the village,
> Summer we carry into the village."[1]

In still other ceremonies the resurrection is simply announced, but the idea of the revived spring is as strongly in mind as in those in which it is clearly represented.[2]

Thus far we have directed our attention only to the death and resurrection incident. Let us now take some cases which are representative of their class, and which illustrate another incident in the St. George play. We noticed that there is a struggle and sometimes a *mêlée* in the play, and this is illustrated in many of the folk-ceremonies. In the region of the Middle Rhine a representative of summer clad in ivy combats a representative of winter clad in straw or moss and finally gains a victory over him.[3] In Bavaria the same drama used to be acted on the same day. Summer was dressed up in green and carried a blossom or a little tree hung with apples or pears, and Winter was muffled up in furs and carried a snow shovel or a flail. They and their retinues struggled, and Winter was beaten and driven out. In some parts of Bavaria the boys who play Winter and Summer engage in a war of words before they come to blows. The dialogue is in verse and each character vaunts his own season. A few couplets may serve as specimens:

SUMMER.

> "Green, green are the meadows wherever I pass,
> And the mowers are busy among the grass."

WINTER.

> "White, white are the meadows wherever I go,
> And the sledges glide hissing across the snow."

. . . .

---

1 Mannhardt, l. c., vol. 1, p. 156.

2 This class of ceremony is well represented in Frazer, l. c., vol. 1, pp. 70–91. See Mannhardt, l. c., vol. 1, *passim.*

3 Frazer, l. c., vol. 1, p. 99.

SUMMER.

"I am the Summer in white array,
I am chasing the Winter far, far away."

. . . . . .

WINTER.

"I am the Winter in mantle and furs,
I'm chasing the Summer o'er bushes and burs."

SUMMER.

"O Winter, your chatter no more can I stay,
I'll kick and I'll cuff you without delay."

Then follows a scuffle between the characters, in which Summer wins, and turns Winter out of doors. But soon the beaten Winter peeps in at the door and says with a humbled and crestfallen air:

"O Summer, dear Summer, I'm under your ban,
For you are the master and I am your man."

To which Summer replies in a peaceable fashion.[1] In the Isle of Man the Queen of May and the Queen of Winter engage in a mock battle.[2]

The constant use of leaves or green branches has an important bearing on the dress of the actors in some of the St. George plays. The "armor" is made of tissue paper, and this has been supposed by some to represent the scale of the dragon. But the contention of Gomme[3] that the "armor" represents leaves is almost overwhelmingly proven by a consideration of decorations used in the folk ceremonies. In nearly all the ceremonies we have described, green branches form an important part of the dress, and in some they form a very striking feature of the ceremony. On St. George's day in Carinthia the chief figure is "Green George," clad in green branches.

---

[1] In Frazer, l. c., vol. 1, pp. 99–101. Others of a similar nature are cited in these and the following pages.

[2] L. c., vol. 1, p. 103.

[3] *Nature*, Dec. 23, 1897.

At the end of the ceremony the effigy of St. George is thrown into the water.[1] The same figure appears in Transylvania and Roumania. On these costumes of leaves and the attendant ceremonies Mannhardt and Frazer have collected a great deal of evidence.[2] A study of this mass of testimony will convince one that the connection between the leaves of these ceremonies and the tissue paper "scaled armor" is complete.

Even from the comparatively few European folk-ceremonies I have cited, it must seem rather clear that these are very close to the central incidents of the St. George plays. This impression will be strengthened when we consider how widely such ceremonies and beliefs have been spread over Europe in all ages. Again Frazer presents us with a mass of evidence in his study of the death and resurrection of Adonis,[3] of Attis,[4] of Osiris,[5] of Dionysus,[6] of Demeter and Proserpine;[7] and in his study of the Lityrses.[8]

Further, we may say that these beliefs go more deeply into savagery than anything else that can be observed in Europe; and in strangely similar rites among savages we catch a glimpse of what the European ceremonies must have been in past ages, before civilization drove them from among the more progressive classes to the backward and ignorant of our own time. To these ceremonies we shall now direct our attention.

II.

AUSTRALIAN FOOD (OR INTICHIUMA) CEREMONIES.

We shall base our investigations upon the reports of reputable observers, who have lived among the people for a consid-

1 Frazer, l. c., vol. 1, pp. 209 ff.; Mannhardt, "Wald- und Feldkulte," vol. 1, pp. 313 ff.

2 Mannhardt, l. c., vol. 1, pp. 311–341; Frazer, l. c., chap. 1, especially pp. 166–224.

3 L. c., vol. 1, pp. 115–130.

4 L. c., vol. 1, pp. 130–137.

5 L. c., vol. 1, pp. 137–160.

6 L. c., vol. 1, pp. 160–168.

7 L. c., vol. 1, pp. 168–222.

8 L. c., vol. 1, pp. 222–261.

erable time. This is a very important matter, for the casual traveler has no authority to speak. We choose for special consideration the great works of Spencer and Gillen,[1] books which are acknowledged to be the best that have ever been published on a primitive or savage people.[2]

These people the authors describe as very primitive, having no notion of the causes of very simple matters. For this reason the book is valuable, as being the description of one of the most nearly primitive of all peoples.

We shall first consider the first class of magic ceremonies, and then the second, or initiation, class.

The first class is very important among the Australians, because each totem group takes upon itself to procure for the tribe a plentiful supply of its totem, and to this end they perform ceremonies that are based on imitative magic. We shall summarize a part of Spencer and Gillen's account, beginning with the Witchetty Grub ceremony. The witchetty grub is an important article of food among the Arunta tribes. The ceremony has constant reference to the myth of how the first witchetty grubs were produced in the *Alcheringa,* or mythical period. With these explanations the account will be intelligible.

Each totem has its own ceremony, and no two of them are alike; but though they differ to a very great extent so far as the actual performance is concerned, the important point is that one and all have for their sole object the purpose of increasing the number of the animal or plant after which the totem is called; and thus, taking the tribe as a whole, the object of these ceremonies is that of increasing the total food supply.

Every local totemic group has its own *Intichiuma* [sacred ceremony], and each one is held at a time decided upon by the *Alatunja,*[3] under whose direction it is carried out. When the

---

1 "The Native Tribes of Central Australia," 1899. "The Northern Tribes of Central Australia," 1904.

2 See the reviews of the first work by Gummere, "Modern Philology," vol. 1; by J. G. Frazer, *Fortnightly Review*, vol. 71.

3 The head man of a local totemic group.

ceremony is to be performed, the men assemble at the main camp, and those who are to take part in the ceremony go away quietly. Every man leaves all weapons behind him, for all must go quiet, unarmed and without any decoration of any kind. Even the hair girdle, the one constant article of clothing worn by the men, must be left in camp. They all walk in single file except the *Alatunja,* who sometimes takes the lead and at other times walks by the side of the column to see that the line is kept. On no account must any of the men, except the very old ones, eat any kind of food until the whole ceremony is over. Anything that is caught in the way of game has to be handed over to the old men. They usually start for the special camping ground late in the afternoon, and remain there all night. At daylight the party begins to pluck twigs from the green trees at the mouth of Emily Gap, and every man carries a twig in each hand except the *Alatunja,* who carries nothing save a small *pitchi,* or wooden trough, which is called *Apmara.* Walking again in single file, they follow the path taken by the celebrated Intwailiuka, the great leader of the witchetty grubs in the *Alcheringa,*[1] until they come to a shallow cave where a large block of quartzite lies, around which are some small rounded stones. The large block represents the adult witchetty grub and the small ones the young grubs. The *Alatunja* begins singing and taps the stone with his *Apmara,* while all the other men tap it with their twigs, chanting songs as they do so, the burden of which is an invitation to the animal to lay eggs. Then they tap the small stones. Then the *Alatunja* takes up one of the small stones and strikes each man in the stomach with it, saying: "You have eaten much food." Then he strikes each man in the stomach with his forehead. Then they go away to the rock where Intwailiuka used to cook, pulverize and eat the grub. The *Alatunja* strikes the rock with his *Apmara,* and each man does the same with his twigs, while the older men again chant invitations to the animals to come from all directions and lay eggs. At

[1] The fabulous ancestral epoch.

the base of the rock, built deeply in the sand, there is supposed to be a very large *Maegwa*[1] stone.

It was at this spot that Intwailiuka used to stand while he threw up the face of the rock numbers of *Churunja unchinia,* which rolled down again to his feet; accordingly, the *Alatunja* does the same with some of the *Churunja* which have been brought from the storehouse close by. While he is doing this the other members of the party run up and down the face of the rocky ledge, singing all the time.

Once more the line is formed and they go to a pit a mile and a half away. The *Alatunja* goes into the hole, which is four or five feet deep. Soon he lays bare two stones which have been carefully covered up, in the base of the hole; the larger one represents the chrysalis stage from which emerges the adult animal; the smaller one is the egg. While the stones are exposed to view, songs referring to the stones are sung, and the stones are solemnly handled and cleansed with the palm of the hand. One by one the men go into the hole, and the *Alatunja,* lifting up the large stone, strikes the stomach of each man with it, saying again: "You have eaten much food." Finally, dropping the stone, he butts at each man in the abdomen with his forehead.

There are altogether some ten of these pits, and all are visited. When the round of the pits (*Ilthura*) is made, and the same ceremony enacted each time, then a start is made for the home camp. When within a mile or so of the latter, they decorate themselves. A string is tied around their heads, and forehead bands are put on, beneath which twigs of a bush on which the grub feeds (*Udnirringa*) are fixed so that they hang downwards. Nose bones are thrust through the nasal septum, and rats' tails and top-knots of cockatoo feathers are worn in the hair. The *Alatunja* has only the forehead band and the nose bone. He carries the *Apmara* (trough) under his arm and a twig of the *Udnirringa* bush in his hand. The totemic *Ilkinia,* or sacred design, is painted on the body of each man with red ochre and pipe clay, and the latter is used to paint the

1 The adult insect of the witchetty grub.

face, except for the median line of red. A start is again made for the camp with the *Alatunja* at the head.

The old man who has been left in charge of the camp has built a long, narrow wurley, called an *Umbana,* which is intended to represent the chrysalis case from which the *Maegwa,* or fully developed insect, emerges. When the old man sees the party approaching, he steps out and sings:

"Ilkna pung Kwai, Yaalan ni nai, Yu mulk la, Naan tai yaa lai."[1]

The party all enter the *Umbana.* They then begin to sing of the animal in its various stages, of the *Alknalinta* stone and the great *Maegwa* at its base. As soon as the performers enter the wurley, the *Purula* and *Kumara* (i. e. those who belong to the other half of the tribe) men and women lie face downwards, and in this position they must remain until they are given permission to arise. The singing continues for some time, then the *Alatunja* in a squatting position shuffles out of the *Umbana,* gliding slowly along over the space in front, which has been cleared for a distance of some yards. He is followed by all the men, who sing of the emerging of the *Maegwa* from its case, the *Umbana.* Slowly they shuffle out and back again, until all are once more in the wurley, when the singing ceases, and food and water are brought to them by the old man who had remained in camp and built the *Umbana.* When it is dusk they leave the wurley, and go to a fire, singing of the grub. This is kept up until a little before daybreak, and during all that time the women of the right moiety (who had been allowed to rise) must stand peering about in the darkness, to see if the women of the other moiety, over whom they are supposed to keep watch, continue to lie down. They also peer about watching the *Intichiuma* party, just as the women did in the *Alcheringa* (i. e. in the fabulous times to which the myth refers). Suddenly the singing ceases, and the fire is quickly put out by the *Alatunja.* This is the signal for the release of the *Purula* and *Kumara* men and women,

---

[1] The authors do not translate these words. They are probably meaningless.

who run to the main camp. The *Intichiuma* party remain at the wurley until daylight. They then go to the men's quarters in the main camp, give the ornaments to the other moiety of the tribe, rub off their sacred painting, and the ceremony is brought to a close.[1]

I have described this ceremony rather fully, as it is representative of its class. It will be noticed how full of detail it is, and how mimetic each detail is. It is, indeed, a dramatic history of the birth and development of the grub. At the end, and as the climax, of the ceremony is the prostration of the men and women and their final release. In this prostration death is symbolized, and they awake to a new life in the certainty that a supply of witchetty grubs is assured.[2]

In many of these ceremonies the symbolization of renewal is merely a state of silence or quiet; but in all cases there is a definite idea of the magic power which is supposed to come from the ceremony. Thus, in the ceremony of the grass-seed totem in the Kaitish tribe,[3] the headman is supposed to be filled with magic power, and must practice strict continence during the progress of the ceremony, or all would be spoiled. In the rain ceremony of the Kaitish tribe continence and silence are necessary,[4] while in others the removedness of the performers from ordinary life is symbolized by the expulsion from camp of all who have no part in the ceremony.[5] In another, part of the performers go into a wurley and lie face downward where they have to remain until the ceremony is

---

1 L. c., pp. 169–178. See also "The Northern Tribes," pp. 289–294.

2 Other ceremonies are given by Spencer and Gillen, "The Native Tribes": The *Intichiuma* of the emu totem, pp. 179–183; the Hakea flower, pp. 184–185; the manna totem, pp. 185–186; the honey ant totem, pp. 186–189; the important *Undiara*, the *Intichiuma* of the kangaroo totem, pp. 193–201. Two traditions are given in connection with this ceremony on pp. 196–199.

3 "The Northern Tribes," pp. 291–294.

4 L. c., p. 295.

5 For instances, see "The Native Tribes," pp. 179–199; "The Northern Tribes," pp. 283–319.

over.[1] But, however the renewal of life is represented, it is essentially a pantomimic representation of the magical effect of the ceremony. The removedness of the performers from ordinary life is always emphasized by the elaborate paintings and masks which are constant accompaniments of all savage ceremonies.

In several of these ceremonies we find examples of the mimic contest, which is so frequently an element of the St. George plays, and of the European folk ceremonies. For instance, in the ceremony of the grass-seed totem already referred to, part of the men go back to their camp sulky, and seizing their boomerangs throw them at the other men who have received the offering of food. These men guard themselves with shields but make no attempt to retaliate. This quarrel is of course only a pretence.[2] This instance may be paralleled in many of the ceremonies; and seems to occur so frequently that it may be considered as an almost characteristic accompaniment.[3]

III.

INITIATION CEREMONIES OF AUSTRALIA AND OCEANIA.

There is still another class of ceremonies which are paralleled among many primitive and savage peoples,—the initiation ceremonies. This class of ceremony is held when the youth are initiated into the tribe, or, as the Australians say, "are made men." It seems to be a universal idea of primitive man that the child who is born in the tribe is not of the tribe until he is formally admitted, and the ceremony in all instances seems to have reference to the peculiar circumstances attendant upon the forefathers of the tribe, and to be a re-enactment of these circumstances. The ceremony is thus based on the belief in imitative magic; for the neophyte, by assuming the dress and performing the traditional acts of the myth-

[1] In the ceremony of the Water Totem, "The Native Tribes," pp. 189–193.

[2] "The Northern Tribes," p. 292.

[3] See the references to the works of Spencer and Gillen above.

ical ancestor together with the initiated members of his tribe, has the powers and privileges which that mythical ancestor won, or which are characteristic of the tribe. This initiation further is enacted by a pretended death and resurrection to typify the birth of the initiate into the tribe. It is also symbolized by the giving of a new name, and is indicated by the belief that the god takes away the initiate from the camp and re-makes him. Hence, when the death and resurrection are not enacted, the basal idea is expressed by the expulsion and recall of the initiate. These ceremonies often extend to great length and are all of a dramatic nature. The interludes are dramatic as well as the more sacred portions of them. The interludes frequently have representations of mimic quarrels or fights[1] very much like the quarrels in the European folk ceremonies.

The *Burbung* initiation ceremony of the *Wiradthuri* tribes in Australia (as is frequently the case) is an enactment of a legend (or legends) "intimately connected with the ceremony."

The legend is briefly this: A long time ago there was a gigantic and powerful being, something between a black fellow and a spirit, called Dhuramoolan, who was one of Baiami's people. His voice was awe-inspiring and resembled the rumbling of distant thunder. At a certain age the boys of the tribe were handed over to him, that he might instruct them in the laws and observances of the tribe. When he brought them back it was always observed that each boy had lost one of his upper incisor teeth, as a visible sign of his initiation. He pretended that he killed the boys, cut them up and burned them to ashes, and then formed new boys, but each with a tooth missing. But some boys were missing, and the tribe found that Dhuramoolan feasted on some of them. They became angry and destroyed him. Baiami put his voice into all the trees of the forests. He split open a tree and made a bull-roarer from it, and it had Dhuramoolan's voice. Baiami told the tribe that in future they must initiate the youths themselves, using the bull-roarer to reproduce Dhuramoolan's voice.

[1] Spencer and Gillen, "The Native Tribes," pp. 293–294.

Baiami thought it best not to inform the women and uninitiated regarding the change in initiation, but to have them believe that Dhuramoolan still came for the youths.

Dhuramoolan had a wife, Moonibear, and she is represented in the ceremony by a small bull-roarer, which is heard in the camp at night by the women, who know its peculiar sound.

The ceremony is the enacting of the story and other similar ones. The ground is sacred and has Baiami's image on the trees and ground. A new name is given the boys, which is known only to themselves and the initiated men of the tribe.[1]

In another Australian initiation, the ceremony falls into parts:

1. *The procession,* which falls into "stages," and performances accompanying it. They perform pantomimic representations, some to amuse, some to instruct, and some to terrify.

2. *The magic camp* is formed where the knocking out of the tooth is done, where a constant succession of ceremonies of pantomimic representations, magic dances, and "inverted speech" (i. e., speech where the words convey the opposite of the usual meaning) continue until morning.

3. *The ceremonial performances.*—Near the magic fire the youths are placed, each with his feet in a pair of holes. The leader gives a signal and the men who are kneeling by the fire raise each his piece of bark and bring it down with a loud report, and at the same time he and the others surge away from his end of the row, making a rumbling sound, in imitation of the surf breaking upon and rushing up the shore; the other end man now in his turn strikes the ground, and he and all the men surge back with a similar deep sound. This is intended to represent the thunder from the mountains rolling back the sound to the sea. When this has gone on rhythmically for some time, the men begin an excited dance, while the old man whose office it is to knock out the teeth performs that ceremony.

---

1 R. H. Matthews, "The Burbung of the Wiradthuri Tribes." *Journal of the Anthropological Institute*, vol. 25, pp. 295–318.

4. *The pantomimic representations.*—These are of various kinds; some are amusing pieces of buffoonery, others represent the different totems, and others again are what may be truly called moral lessons. One represents the doctoring of a sick child; another a wallaby drive,[1] those hunters in ambush always missing the prey and being punished in a ludicrous manner. A totemic representation is the approach of a pack of dingoes and a dance around the fire. Besides these there are magic dances.

5. *The return.*—There are also certain ceremonies of which the following may serve as an example. "The procession being formed, and on the march from the magic camp, the roaring of the bull-roarer is heard and a halt is made. The old men, having carefully cleared a piece of ground, proceed to mould in earth, in high relief, the life-sized figure of a naked man in the attitude of the dance. He is represented as having his mouth filled with magic substances, and in the full ceremonies is surrounded by an assortment of native weapons. This is Daramulun. The novices are brought and placed in front of this figure and the dances take place—one to the word *Daramulun*, the other to the word *Ngalalbal*. It is now that the novices are finally instructed as to this being and his attributes. I have heard them told by the principal old man, 'This is the Master (Biamban) who can go anywhere and do anything.' They are also cautioned never to reveal this or to make such a representation unless at the ceremonies, under pain of death.

"The figure is now carefully covered up, and the procession proceeds a further stage on its march, when another halt is made and the novices are seated at a distance with their guardians. The old men, meanwhile, disguise several of the others with stringy bark fibre. During this time a grave is dug, and one of the old men, lying in it on his back, after the manner of a corpse, is lightly covered up with sticks and rubbish and earth, and so far as possible the natural appearance of the ground is restored, the excavated earth being carried

[1] These are to be noted in connection with certain animal features of the St. George plays.

away to a distance. The buried wizard holds a small bush in his hand, resting on his chest; the bush appears, therefore, to be growing in the soil, and other bushes are stuck in the soil to heighten the effect. All being ready, the novices are brought to the edge of the grave. The 'singer' is somewhere close at hand, and the performers at perhaps two hundred yards' distance. In the present instance, the singer commenced a well-marked but melancholy chant, the words of which are no more than the class name of the buried man, and the word for the stringy bark fibre used for the disguise. The performers now commenced to move in a kind of slow dance, keeping time with the song. The performers in their advancing line held a small strip of bark in each hand, and by striking these together with a sharp sound they marked the time of the song and of their steps. A little at one side, and advancing with them, are two other disguised men, who represent two very ancient and therefore powerful wizards, by whom the proceedings are directed. Each one, as signifying his great age, assists himself in his tottering dance with a staff in each hand. When the strange procession reached the grave, it wound round it and ranged itself on the side opposite to the novices. The song still continued, and then the bush held by the buried man began to move and to quiver—to move more and more, until suddenly the earth opened, so to say, and the wizard rose, and throwing off his concealment, danced his magic dance in the grave and exhibited his magic substances. . . . The ceremony is most impressive. It is the bringing back to life of the dead wizard by other wizards invoking his class name."[1]

In the *Kurnai* ceremonial the boys are laid asleep and are awakened by the "Doctor." When they awake they are men. This ceremony is described by Howitt in great detail, and is most instructive.[2]

---

[1] A. W. Howitt, "On Some Australian Ceremonies of Initiation." *Journal of the Anthropological Institute*, vol. 13, pp. 432–459. This account has since been reprinted in his "Native Tribes of Southeast Australia," 1905.

[2] A. W. Howitt, "The Native Tribes of Southeast Australia," 1905, pp. 620–626.

Mr. E. S. Parker saw the natives of Laddon perform the dance of separated spirits. This does not seem to be an initiation rite, but its similarity is instructive.

"Holding boughs in each hand, which were waved in unison alternately over each shoulder, and dancing for some time in lines and semicircles, at length they gradually gathered into a compact, circular body; then, slowly sinking to the ground and burying their heads under the boughs, they represented, according to the statement of the old native who was master of the ceremonies, the approach of death, and in the perfectly still and motionless posture they maintained for some time the state of death itself. Then the old man, breaking suddenly into a new dance, and waving furiously his boughs over the prostrate mass, gave them the word, and suddenly springing to their feet, they joined him in his rejoicings. This was explained to me as intended to represent the revival of the soul after death."[1]

A still earlier observer confirms these accounts in his chapter on the ceremonies.[2] Early in the morning the boys are seized from behind and a bandage is fastened over the eyes of each. They are then led half a mile away from the women and children, when they are laid on the ground and covered with a cloak, or skin, so as not to see what is passing among the adults, who proceed with the ceremony. Three of the performers limp and groan, until they arrive opposite one of the boys, upon whom they seize. The individual seized jumps up and runs off at full speed, but he is caught and laid down near the other boys. He is now supposed to be in a state of enchantment from which he is aroused by being lifted up by the ears, at the same time that loud noises are made into them. In another passage[3] the author describes the pretended trance of the initiates, and their "disenchantment."

These Australian ceremonies may be illustrated from Lori-

---

[1] E. S. Parker, "The Aborigines of Australia," 1854. Cited by R. Brough Smyth, "The Aborigines of Victoria," vol. 1, p. 167.

[2] E. J. Eyre, "Discoveries in Central Australia," 2 vols., 1845; vol. 2, pp. 333–334.

[3] L. c., pp. 336–339.

mer Fison's description of an initiation ceremony in Fiji.[1] This instance will also serve as an interesting parallel, not only to the Australian, but also to the American instances which are to follow.

The legend is given in a brief form, which we shall not quote, but we shall proceed at once to the ceremony. There is a general feast for four days, and cloth is given. Then,

"On the morning of the fifth day a huge feast is prepared, and when their culinary labors are over, the young men, with their heads fresh shaven, are swathed in the largest and best rolls of cloth, take in their hands the choicest weapons which have been reserved for this occasion. Following their leader, the old *Vere* (a class-name—the leader) with the graven staff, their eyes fixed upon the ground that they may tread exactly in his footsteps, they proceed to the great *Nanga* as on former occasions. But where are the men who used to be chanting there the voice of the Surf? The great *Nanga* is deserted and empty. The procession stops, and a dead silence prevails. Suddenly, from the forest a harsh scream of many parrots breaks forth, and then a mysterious booming sound which fills the young men's souls with awe. The old *Vere* now moves slowly forward, and leads them for the first time into the *Nanga tambutambu*. Here a dreadful spectacle meets their startled gaze. Near the outer entrance, with his back to the Temple, sits the chief priest regarding them with a fixed stare; and between him and them lie a row of dead men, covered with blood, their bodies apparently cut open, and their entrails protruding. The *Vere* steps over them one by one, and the awe-struck youths follow him until they stand in a row, their 'souls drying up' under his strong glare. Suddenly he blurts out a great yell, whereupon the dead men start to their feet and run down to the river to cleanse themselves from the blood and filth with which they are besmeared. These are the *Vere* and the *Vunilolo matua*, who represent the departed ancestors on the occasion, the blood and entrails being those of

[1] Lorimer Fison, "The Nanga, or Sacred Stone Enclosure, of Wainimala, Fiji." *Journal of the Anthropological Institute*, vol. 14, pp. 14–30.

many pigs which have 'fallen for that night's repast.' The scream of the parrots and the mysterious roaring sound were made by hidden performers, the latter being produced by blowing strongly into a bamboo trumpet, the mouth of which is partially immersed in water.

"The dead men having come to life again, the novices offer their weapons and the bales of native cloth in which they are swathed. These are removed to the storehouse, and the young men are made to sit down in front of it. The chief priest now relaxes the sternness of his demeanor, and becomes a remarkably lively old gentleman. Dancing to and from one side of the *Nanga* to the other, he cries in stridulous tones, '*Ue, a-ue, ao, iwei!* Where are the people of my *longa* (enclosure)? Are they gone to *Tongalevu?* Are they gone to *Tumbalevu* (the deep sea)?' Presently a deep-toned chant is heard, and the revivified dead, cleansed and ornamented, come from the river with a rhythmical movement timed to their solemn chant."

They eat and drink, and are purified ceremonially, when the rite is at an end.[1]

In some of the ceremonies we may notice the incident of the mimic contest, which is much like the incident in the St. George play. In the Australian *Corrobborees* this is a frequent incident, and we shall now illustrate it.

"The first performance was a war-dance, wherein a variety of complicated evolutions and savage antics were gone through, accompanied by a brandishing of clubs, spears, boomerangs and shields. Suddenly the crowd divided into two parties, and after a chorus of deafening yells and fierce exhortations, as if for the purpose of adding to their own and each other's excitement, they rushed together in close fight. One division,

---

1 For an account of the "Malu" ceremonies in the Torres Straits, see A. C. Haddon, "Head Hunters, Black, White and Brown," 1901, chap. 4. For an account of Brazilian ceremonies, see Karl von den Steinen, "Unter den Naturvölkern Zentral-Brasiliens," 1897, chap. 13. Theodor Waitz, "Anthropologie der Naturvölker" (ed. Gerland, 6 vols., 1859–1872), is a storehouse of facts.

shortly giving way, was driven from the field and pursued into the dark void, where roars and groans, and the sound of blows, left but little to be imagined on the score of a bloody massacre."[1]

The aborigines of Victoria also have a *corrobboree* in which the party breaks up into two divisions, one representing the black fellows and the other the whites. After all the appearance of a desperate fight, the whites are driven back, to the great joy of the onlookers.[2]

In another Australian initiation ceremony the boys were pursued by the men, who threw boomerangs at the initiates. The youths reached the *corrobboree* ground, and were safe. They were then freed from the ban of silence.[3] In the Binbinja tribe a boy was sent away from the camp. He was then allowed to return and at sundown he was made to lie down and was covered with paper bark. His elder brothers fixed a row of boomerangs upright in the ground in front of the boy, who still lay quietly down while the performers retired. The brothers sang around the fire, and at midnight the boy was awakened and allowed to see a sacred ceremony.[4] In another ceremony the boy was similarly covered with bark, and was later uncovered, as a sign of his admission into the tribe.[5]

In central Queensland the youth is driven out of the camp and is brought back again as a sign of his final identification

---

1 Lieut.-Col. Mundy, "Our Antipodes," pp. 45–6. In R. Brough Smyth, "The Aborigines of Victoria," 2 vols., 1878; vol. 1, p. 175.

2 R. Brough Smyth, l. c., vol. 1, p. 171.

3 Spencer and Gillen, "Northern Tribes of Central Australia," p. 363.

4 Spencer and Gillen, "Northern Tribes," p. 366.

5 Spencer and Gillen, "Northern Tribes," p. 371. These authors give many examples of these ceremonies. In "The Native Tribes of Central Australia" they give initiation ceremonies and their traditions on pp. 225–226; 282–286; 288; 293–294; 304–305; 312–316; 318–320; 331–332; 334–337; 338–341—"associated with a curious and rather complicated tradition"; 360. A full account of the traditions dealing with the *Alcheringa* ancestors is given in chapters 10 and 11, pp. 387–449.

The following accounts of ceremonies of initiation will be found in the *Journal of the Anthropological Institute:*

A. W. Howitt, "The Jeraeil, or Initiation Ceremonies of the Kurnai with his tribe. In some of the ceremonies of this region the women engage in a mimic contest.[1] In yet another Australian ceremony the faces of the boys are covered up. In this ceremony the novitiates must fight their seniors.[2]

Another, and an earlier, observer describes the sham hunts and fights at some initiation ceremonies[3] in Australia.

In Africa the ceremony of initiation is carried out in almost the same manner and with the same intention as in the case of the Australians. "The boys always take a new name, and are supposed by the initiation process to become new beings in the magic wood, and on their return to their village at the end of their course, they pretend to have entirely forgotten their life before they entered the wood; but this pretence is not kept up beyond the period of festivities given to welcome

---

Tribe," vol. 14, pp. 301–325. The legend and some of the mimetic representations are given, for example, the "opossum game," which is the dramatic presentation of an opossum hunt. The realism is extreme, the tree being represented by a log stood upon end, and the "opossums" climbed up the tree exactly as the real animals do. This is true of nearly all these mimetic plays. They outdo the demands of Bottom and his fellow mechanicals.

A. L. P. Cameron, "Notes on Some Tribes of New South Wales," vol. 14, pp. 344–370. The dramatic representation is brought out very clearly, but the legends are not connected with the ceremonies he describes. Legends are given on pp. 368–370. These are partly etiological, one giving the origin of fire.

Sir H. H. Johnston, "Initiation Rites on the Congo," vol. 13, pp. 472 ff. See also Proceedings of Royal Geog. Soc., N. S., vol. 5, p. 572 ff., 1883. R. H. Mathews, "The Keepaara Ceremony of Initiation," vol. 26, pp. 320–340. Godfrey Dale, "Customs and Habits of the Natives Inhabiting the Bondei Country," vol. 25, p. 189. In this article the dramatic nature of the ceremony is brought out very clearly. It would hardly be suspected that a tribe of the hill country of India could borrow customs from the Australians, and yet they are very much alike. The example is therefore of unimpeachable value.

1 W. E. Roth "Ethnological Studies in the Northwest Central Aborigines," p. 170.

2 John Matthew, "Eaglehawk and Crow," 1899, pp. 118–119.

3 G. Hodgkinson, "Australia from Port Macquarie to Moreton Bay," 1845, pp. 230–235.

them home."[1] North of the Congo the initiates recount marvels of the ceremony, saying that they were roasted, that they entirely change their habits and life, and that they receive a spirit quite different and quite new lights.[2] In the valley of the Congo the young men and women fall down in a fit and are carried away to an enclosed place outside of the town. They are supposed to have died. But parents and friends supply food, and the doctor brings them to life again.[3]

The natives of Bondei cause their boys to pass through a fire in a pit in which they are supposed to be burned to death. They are "killed" with a bamboo sword, and the bloody entrails of a fowl are laid on the initiate to frighten the boys who are looking on.[4]

IV.

AMERICAN INITIATION CEREMONIES.

We shall now examine the ceremonies of the North American Indians, a people on a higher plane of culture than the Australians or the Central Africans. Some of the tribes of these peoples have been studied with great thoroughness, and a good example of such study is the monograph by Professor Franz Boas on the Kwakiutl Indians of British Columbia.[5]

This excellent work may be supplemented by articles on the Navahos and Zuñis and other Indian tribes in the *Journal of American Folk-Lore* and in the *American Anthropologist*, as well as by other monographs issued under the enlightened superintendence of the late director of the United States Bureau of Ethnology, Major J. W. Powell. To these must be added the work done by the British Association for the Advancement of Science on the Indian tribes of northwestern Canada, and

1 Mary A. Kingsley, "Travels in West Africa," p. 531.

2 J. G. Frazer, "The Golden Bough," vol. 3, p. 428.

3 J. G. Frazer, l. c., vol. 3, pp. 425–426.

4 Godfrey Dale, "The Natives of Bondei," *Journal of the Anthropological Institute*, vol. 25, p. 189.

5 Report of the Smithsonian Institution, 1895.

many separate works by various authors. To a few of these I shall refer in the course of the discussion. For our purposes the most useful works are those of Dr. Washington Matthews,[1] J. Walter Fewkes,[2] Frank Hamilton Cushing,[3] J. O. Dorsey,[4] and the work of Boas, previously referred to.

In all these works the mimetic nature of the ceremonies of these tribes is brought out very clearly, and the magic nature of their origin is almost as clear as in the case of those of the Australian. For instance, one of the best observers says:

"When a man is dressed in his godly costume he does not speak, he only makes motions and utters a peculiar cry,—each god has his own special cry,—and he may perform acts on the patient with his special weapon or talisman. The masquerader, they say, is, for the time being, no longer a Navaho—but a god, and a prayer to him is a prayer to a god."[5]

The same statement regarding the Zuñi is made by Cushing, who says that when the costume connected with the god is put on with the proper ceremonial, the actor in the drama-dance is the deity he presents, and is possessed of his powers:[6] "The *Kâkâ*, or sacred drama dance, is represented by a great variety of masks and costumes worn by Zuñi dancers during the performance of this remarkable dramatic ceremony. Undoubtedly many of the traditional characters of the sacred drama thus represented are conventionalizations of the mythic conceptions or personifications of animal attributes. Therefore many of these characters partake of the characteristics, in appearance as well as in other ways, of animals and men. . . It is believed that through the power of breath communicated by these ancient gods to men, from one man to another man, and thus from generation to generation, an actual connection has been kept up between initiated members of the *Kâkâ*

1 "Navaho Legends," 1897.

2 "The Snake Ceremonials at Walpi."

3 "Zuñi Folk-Tales," and articles in the *Journal of American Folk-Lore.*

4 In the publications of the Field Columbian Museum.

5 Washington Matthews, "Navaho Legends," p. 47, § 106.

6 F. H. Cushing, "Zuñi Folk-Tales," pp. 229–230.

drama and these original demi-god characters which it represents; so that when a member is properly dressed in the costume of any one of these characters, a ceremony (the description of which is too long for insertion here) accompanying the putting on of the mask is supposed not only to place him *en rapport* spiritually with the character he represents, but even to possess him with the spirit of that character or demi-god. He is, therefore, so long as he remains disguised as one of these demi-gods, treated as if he were actually that being which he personates."

These authorities are confirmed by Boas in the before-mentioned study. In speaking of the legends which have to do with the gifts which the spirits impart to the Kwakiutl youth, he says:

"The principal gifts in these tales are the magic harpoon which insures success in sea-otter hunting; the death bringer, which, when pointed against enemies, kills them; the water of life which resuscitates the dead; the burning fire which, when pointed against an object, burns it; and a dance, a song and cries which are peculiar to the spirit. The gift of this dance means that the *protégé* of the spirit is to perform the same dances which have been shown him. In these dances he personates the spirit. He wears his mask and his ornaments. Thus the dance may be considered a dramatic performance of the myth relating to the acquisition of the spirit, and shows to the people that the performer by his visit to the spirit has obtained his powers and desires. When nowadays a spirit appears to a young Indian, he gives him the same dance, and the youth also returns from the initiation filled with the powers and desires of the spirit. He authenticates his initiation by his dance in the same way as his mythical ancestor did."[1]

This corresponds with what is said by J. G. Frazer regarding such a ceremony as that at the sanctuary of the goddess Astarte in Zela, when her myth "was translated into action." "The story of her love and death and that of her divine lover was performed year by year as a sort of mystery-play by men

[1] Report of the Smithsonian Institution, 1895, p. 396.

and women who lived for a season and sometimes died in the character of the visionary beings whom they personated. The intention of these sacred dramas, we may be sure, was neither to amuse nor to instruct an idle audience, and as little were they designed to gratify the actors, to whose baser passions they gave the reins for a time. They were solemn rites which mimicked the doings of divine beings, because man fancied that by such mimicry he was able to arrogate to himself the divine functions and to exercise them for the good of his fellows. The operations of nature, to his thinking, were carried on by mythical personages very like himself; and if he could only assimilate himself to them completely, he would be able to wield all their powers. This is probably the original motive of most religious dramas, or mysteries among rude peoples."[1]

The legends and the ceremonies in connection with these "gifts" given to the Kwakiutl youth are one and the same thing, and we cannot understand the one without the other. They "relate entirely to spirits that are still in constant contact with the Indians, whom they endow with supernatural powers."[2]

One of the spirits who thus helps is Baxbakualanu Xsi-wae (= the first one to eat at the mouth of the river, i. e. in the north, because the ocean is considered a stream running northward). He is a cannibal living in the mountains who is always in pursuit of man. One who meets his cannibal grizzly bear, Hai'alik'ilal, may become a *hamats'a*, or any of eight other orders.[3]

There are several versions of the legend dealing with the origin of the *hamats'a*, one of which Boas gives,[4] with a variant ending.[5] The substance is as follows:

Nanwaqawe, the chief of the Awikenox, had four sons who were mountain goat hunters. At one time members of his tribe were disappearing one after the other and he did not

1 "The Golden Bough," vol. 3, p. 164.

2 Boas, p. 393.

3 L. c., pp. 394–395.

4 L. c., pp. 396–400.

5 L. c., pp. 400–401.

know what became of them. The chief wanted to eat mountain goat meat, and his sons offered to go hunting. Their father advised them not to go into the house the smoke of which looks like blood, else they would never return home. This was the house of Baxbakualanu Xsi-wae. He told them also to avoid the house the smoke of which was gray on one side, for that was the house of the grizzly bear. The young men set off early in the morning and about noon discovered the grey smoke. They went to the house, met the bear and finally overcame him. Next day they saw the bloody smoke and went to the house. An old woman who was rooted to the floor told them whose house they were in, and instructed them to dig a pit in the corner of the house and to put hot stones into it. This they did and covered it with boards. This was a trap for the cannibal god. He returned, and, crying *"hap,"* danced about the place with his crow and fell in. Then when he died the elder brother took the ornaments of red cedar bark off the singers who had fainted. He took also the masks, the *hamats'a* pole and the whistles. The old woman then taught him the song of the cannibal god.

Then the elder brother told his father, who went to the house. The old woman gave him the *hamats'a* mask, the raven mask and the *ho-xhoku* mask, the cannibal god's mask, and all the different kinds of red cedar bark. Then she taught the father and sons the songs. She sang the song of the head mask:

"The *hamats'a* mask for the forehead.
The *ho-xhoku* mask of the forehead.
The raven mask of the forehead.
The cannibal mask of the forehead."

Then she sang the song of the *q'o'minoqa*, who always goes to get food for the cannibal god. (Given, p. 398.)

Then she taught them regarding the initiation of a *hamats'a*.

Then she told the chief that she was his daughter and that he could not dig her up. Then she sang the song of the *no'nltsistalal*. (P. 399.)

Then she instructed him to have the eldest son made a *hamats'a* and gave them a ritual. This the chief did, and he was the first to celebrate the winter ceremonial.[1]

The dramatization of this myth and the myths allied to it, is very elaborate in the masks, dress and ritual, many of which can be explained by a reference to the myth.[2] An important part, too, is played by the dances and songs.

As the myth implies, "the object of the whole winter ceremonial is, first, to bring back the youth who is supposed to stay with the supernatural being who is the protector of his society, and then, when he has returned in a state of ecstasy, to exorcise the spirit which possesses him and to restore him from his holy madness. These objects are attained by songs and dances. In order to bring the youth back, members of all the secret societies perform their dances. It is believed that they will attract the attention of the absent novice, until finally one of the dances may excite him to such a degree that he will approach flying through the air. As soon as he appears, his friends endeavor to capture him. Then begins the second part of the ceremony, the exorcising of the spirit, or, as the Kwakiutl call it, the taming of the novice. This is accomplished by means of songs sung in his honor, by dances performed by women in his honor, and by the endeavors of the *Shaman*.[3] The songs are made up mostly of four verses. "Each novice, viz., member of a society, has his own songs. They open with a burden which varies according to the society to which they belong. This burden is sung in order to indicate the tune. Then follow the words, which, however, are interspersed with repetitions of the burden. The words are called 'the walk of the song' (or, as we should say, the words

---

[1] A similar legend is given on pages 403–405. This illustrates what Boas says (p. 663), that there are several legends to explain the same ceremony. This fact is so significant that it should be noted. It seems to point to the probability that the ceremony is of earlier date than the legends.

[2] E. g., the raven mask, pp. 448–449; the cross-pieces and head rings, etc., pp. 449–454. See the illustrations—an important feature of Boas' work.

[3] L. c., p. 431.

go this way). Each song is accompanied by beating of time with batons, and by a drum. The beating is sometimes so loud that it almost drowns the song. The rhythm of the tune, as well as of the beating, is exceedingly complex; but the most striking characteristic is the fact that the beating is always syncopated. The arm is raised when the tone is uttered and falls quickly afterwards. In all songs of the winter ceremonial the beating begins several bars before the singing. It is the reverse in profane songs. The beating is an intrinsic part of the song and cannot be separated from it."[1] The dances f the various societies differ in character, but they have certain features in common,[2] while the paraphernalia, costumes, masks and so on, are prescribed by the myth. The painting of the face in the dances is prescribed in the same way and has a reference to the legend with which the ceremony is connected. As in the case of the Australian dances, the story is acted out with some skill and with remarkable realism.[3] Boas gives many of these dramatic dances, with their legends.[4]

In the ghost dance, for example, in accordance with the legend, the dancer gives a mimic representation of a visit to the lower world. He wears the head ring and neck rings which are associated with this dance.[5] Elaborate preparations are made. A ditch is dug in the dancing house behind the fire, and speaking tubes of kelp are laid under the floor of the house so as to terminate in the fire. The ghost dancer appears, led by one attendant. He goes around the fire four times, summoning the ghost. After he has made the fourth circuit he slowly disappears in the ditch near the fire. The people try to hold him by the rope, but apparently he sinks out of reach. Then many voices are heard coming from out of the fire—actually the voices of people hidden in the bedrooms who speak through the kelp tubes. It is announced

---

1 L. c., p. 432.

2 L. c., pp. 432–445. The *Hamats'a* dance is described on page 443.

3 See pp. 436–447, with the illustrations.

4 The ghost dance, pp. 482–3, with its legend, p. 408; the *Mātem* dance, p. 483, with its legends, p. 411.

5 Illustrated on p. 497.

that the ghosts have taken the dancer away, who will return after a certain number of days. When the time of his return is at hand, another dance is held. A carving representing a ghost is seen to rise out of the ground carrying the dancer.[1]

As Boas says, the object of the whole winter ceremonial is to call back the novice and to cure him.

There is a master of ceremonies, who has general supervision of the rite, and there is much dialogue and many long improvised speeches at first. Songs are sung also.

"The whole ceremonial of bringing back the novice is, according to the Kwakiutl, a repetition of the same ceremonial performed by the wolves who attempted to bring back their novices; and the following tradition, which, however, is not complete in its details, is made to account for its origin:[2]

"Mink made a salmon trap. The tribes had a winter ceremonial, and the chief of the wolves had disappeared in the woods. There they spoiled Mink's trap. For three days they did so. Then Mink became angry. He watched and saw them take a salmon from his trap. He crawled up and killed them with his club. He cut off their heads and carried them home.

"Now the wolves were going to bring back their novices. Mink went and watched his trap and caught a *sisiul*. He took it home. In vain the wolves waited for the novices to appear.

"Mink came with the heads under his blanket, then went out and came back wearing them on his head. Then the wolves saw what he had done and tried to kill him. But he came with the *sisiul* mark and all the people died. He resuscitated whom he liked. That is the end."

---

1 The song of the ghost dancer is as follows:

1. I went down to the under world with the chief of the ghosts. Therefore I have supernatural power.

2. The chief of the ghosts made me dance. Therefore I have supernatural power.

3. He put a beautiful ornament on to my forehead. Therefore I have supernatural power.

2 L. c., pp. 538–539.

When the novices are purified, they act as if they had forgotten everything, and have to learn all anew.[1]

In another Kwakiutl ceremony, Namaqua is supposed to throw disease into people. Blood flows from the performer's mouth and he vomits forth a worm. Then he throws a rope, which finally falls among the people. They rush towards the fire and fall down lifeless. They are then carried away dead, and are brought to life again by Namaqua.[2]

In an initiation ceremony of the Musquakie Indians the initiates die and "awake men."[3]

One of the most complete studies of initiation ceremonies of our savage people is the elaborate paper by Mr. W. J. Hoffman,[4] on the *Midé win*, or "Grand Medicine Society," of the Ojibwa Indians. In this society there are four degrees, each with an elaborate ritual. In each the death and revival of the candidate is an essential. A brief description of one ceremony will suffice for all. After a long series of ritualistic dances and songs, the first priest grasps his medicine sack as if holding a gun, and aims it at the candidate's left breast, uttering a song. This he does three times. This is all repeated by a second priest and then by a third. Now a fourth priest, who is the leader of the ceremony, aims the sack at the candidate's head, who falls forward upon the ground, apparently lifeless. Then the four priests lay their sacks on the candidate's back, and a shell drops from his mouth. He begins to revive, but the priest puts the shell back into his mouth and he falls upon the ground as before. They then pass around the candidate's body, and this causes him to revive. The chief priest then says to him, "Get up," which he does. Then to the drum the priest sings a song.[5]

---

1 J. G. Frazer, l. c., vol. 3, pp. 425–426.

2 L. c., pp. 485 ff.

3 Mrs. M. A. Owen, "Folk-Lore of the Musquakie Indians," 1904, pp. 68–69. A partial account of what was probably an initiation ceremony on the Pacific coast is given by J. B. Jewett in his "Narrative . . . Among the Savages of Nootka Sound," Middletown, 1815, p. 98.

4 7th Annual Report of the Bureau of Ethnology (1891), pp. 143–300.

5 Hoffman, l. c., pp. 210–220. For the ceremonies connected with the other degrees see pp. 231–236; 243–251; and 258–274.

Dr. Hoffman has also studied the ceremonies of the Menomonie Indians, and has given the accounts of other authors. In several of these ceremonies the death and resurrection is an important part.[1]

V.

AMERICAN AGRICULTURAL AND KINDRED CEREMONIES.

When discussing the folk ceremory in which the Manx May Queen and her "court" fight the representative of winter and his retinue, Frazer appositely quotes an Eskimo ceremony which is clearly magical in intent. On the approach of winter, the Eskimo divide themselves into those born in winter and those born in summer and engage in a tug-of-war. In order to have a fine winter, those who were born in summer are victorious.[2]

Of course, the Eskimo are not an agricultural people, and so the ceremony might not appear appropriate to the beginning of a chapter on agricultural ceremonies. But the Eskimo depend much on the weather and so resort to methods of producing a favorable season by means of the mimic contest. The underlying motive thus seems to be exactly the same as that of the corresponding European rites. The Tusayan Indians have ceremonies called the *Katcinas,* which are performed for the purpose of influencing the season, in which the actors divide themselves into two irregular groups. All break out into song, and the shield-bearer makes eccentric dashes among his associates, first on one side and then on the other. While the song lasts the shield-bearer continues these rushes, and the assembled groups crouch down and meet his dashes by rising and driving him back. He madly oscillates from right

---

1 Hoffman, 14th Annual Report of the Bureau of Ethnology, vol. 2, p. 295. See esp. pp. 101, 110–111; 112–113. The initiation ceremony not infrequently takes on the form of the real death and supposed revival of the totem of the clan. This class of ceremony we cannot discuss, as it seems to be connected with sacrifice. See J. G. Frazer, "Totemism," 1887, pp. 48 ff.

2 Frazer, l. c., vol. 1, p. 104. Cited from Franz Boas, 6th Annual Report of the Bureau of Ethnology (1888), p. 605.

to left, that is from the north to the south side of the room, and swings his shield in rhythm, while those near him beat their feet in time. The shield is dashed from face to face, and the groups make many motions as if to seize it, but no one does more than touch it with outstretched hands. The movements on both sides are highly suggestive of attack and defense. This represents the struggle between the bad spirits and the beneficent Sun, who is able to resist all attacks upon him.[1]

In these ceremonies, masks play an important part. The wearing of the mask of a deity indicates that the wearer is endowed with the god's power and will retain much of this power. While the mask is on, therefore, the wearer is "out of the body," and his "return" to earthly things and earthly powers is indicated by the doffing of the mask.[2]

But the death and return are shown more plainly in another Tusayan *Katcina,* which is plainly intended to consecrate the corn-seed. The performers made a pile of cones, and a reward was offered to anyone who could lift the pile and set it back without disturbing the cones; but all failed. The cones were then placed in two piles, and a youth succeeded. Then all the performers fell down "dead." They were rubbed with ashes, and so revived. At the close of the ceremony, corn which was placed beside the cones was distributed in small handfuls to the women, and another handful was planted in the *kivas.*[3] Among the Navahos the Mountain Chant is used for various purposes—the curing of disease, and at the same time of "invoking the unseen powers in behalf of the people at large for various purposes, particularly for good crops and abundant rains."[4] The ceremony is given by one who wishes to be restored to health, and incidentally to confer benefits upon the community. Part of the ceremony is as follows:

---

1 J. W. Fewkes, "The Tusayan Katcinas." 15th Report, Bureau of Ethnology (1897), pp. 251–313 (p. 269).

2 Fewkes, l. c., p. 276.

3 Fewkes, l. c., pp. 278–279.

4 Washington Matthews, "The Mountain Chant." 5th Annual Report, Bureau of Ethnology, 1887, pp. 385–467 (p. 386).

"A blanket was spread on the ground on the north of the fire, near where the man in evergreens was concealed. [This man was previously described.] At the last appearance of the man in evergreens the woman fell back apparently paralyzed and suffering from a difficulty of breathing, all of which was probably feigned, but was supposed to be a sign that the right remedy for her ailment had been found and that none other need be tried. The medicine man now proceeded to restore her to consciousness by drawing zig-zag lines from her body east and west and straight lines north and south, like their symbols for the chain and sheet lightnings, by stepping over her in different directions, and by rattling."[1] She then "recovered consciousness."

A hunting ceremony with similar import is celebrated by the Eskimo. They kill the evil spirit of the deer, which would prevent good hunting. The main performer is the medicine man. "He goes through a number of gyrations and contortions, constantly hallooing and calling, till suddenly the imaginary deer is among them. Now begins a lively time. Every one is screaming, running, jumping, spearing and stabbing at the imaginary deer, till one would think a whole madhouse was let loose. Often this deer proves very agile, and must be hard to kill, for I have known them to keep this performance up for days, in fact till they were completely exhausted.

"During one of these performances, an old man speared the deer, another knocked out an eye, a third stabbed him, and so on till he was dead. One who is able or fortunate enough to inflict some injury on this bad deer, especially he who inflicts the death blow, is considered extremely lucky, as he will have no difficulty in procuring as many deer as he wants, for there is no longer an evil spirit to turn his bullets or arrows from their course."[2]

Somewhat the same result is aimed at among the Zuñi Indians in one of their ceremonies, by means of a mimic contest.

1 Matthews, l. c., pp. 423–424.

2 Franz Boas, "The Central Eskimo." 5th Report, Bureau of Ethnology (1888), pp. 399–669 (p. 607, cited from Kumlien).

A representative of the god carries an effigy of a deer and is pursued by the young men. When the representative is caught, he throws down the effigy, amid great excitement. The one who catches the effigy exclaims: "I have killed the deer." He sprinkles it with meal, praying that he may be successful in the hunt. The catching of the effigy is indicative of success in the coming hunt, and great efforts are made to get ahead of one another in capturing the so-called "deer." This and the rest of the attendant ceremony is to bring rains to fructify the earth.[1] This deer-effigy, and similar effigies, so common in Indian ceremonial, are very similar to those of Europe, which have been so fully described by Mannhardt. The Zuñi bury little bunches of plumes, and deposit ashes and sweepings in the fields, with the firm assurance that the corn will increase.[2] To be sure, this is not a resurrection acted out dramatically, but this method of procedure is very common among the American Indians. The spirit of the corn is in the effigy or puppet instead of a person, and the ceremony is modified accordingly. Another depository of the corn spirit is in the sand and pollen paintings so common among the Indians of the Southwest.[3] These ritualistic paintings, which seem to be without a parallel in Europe, have been carried to a very high state of development. For these reasons the dramatic representation of the death and revival by means of a person, and the presentation of the mock combat, are both somewhat meagre among the North American Indians. But in the cases we have found, we have testimony that it is far from unknown in this kind of ceremony, and this suffices to establish a connection of common intention between these ceremonies and those of Europe.

In concluding this division, it may be instructive to cite an instance from a people on the same cultural level, but widely

---

1 Matilda Coxe Stevenson, "The Zuñi Indians," 23rd Annual Report, Bureau of Ethnology (1904), pp. 1–634 (p. 260).

2 Stevenson, l. c., pp. 108–141, with excellent illustrations.

3 Stevenson, l. c., pp. 108–141; and "The Sia," 11th Annual Report of the Bureau of Ethnology, pp. 1–165. Washington Matthews, "The Mountain Chant," 5th Annual Report of the Bureau of Ethnology (1887), pp. 385 ff.

separated geographically. In the *paddy* feasts of the natives of Sarawak, in the Island of Borneo, a ceremony is celebrated, in which all the people are "doctored" by a medicine man, and "die." The pretended corpses are laid in a row and after a time they are revived. This ceremony is a preparation for the year's labors.[1]

CONCLUSION.

The immediate result of our enquiries seems to be that the part of the St. George or Mummers' Play which could not be explained by reference to literary sources may be explained by a reference to the people—the *folk*—themselves. We have seen that the central incident of the play is widely spread all over Europe in ceremonies practiced by the folk themselves. Further than this, we have seen that among the lowly Australians, the Africans, the North American Indians, the incident is common; and this, by all the methods of anthropological reasoning, points to the certainty that in the earlier stages of culture these ceremonies flourished in Europe, and that their object and aim was magical. They were attempts on the part of man to force the powers of nature to his will, to produce for him abundant harvests and rich vintages, as it is the object of the Australian and North American Indian today. As the magic idea passed out of the European ceremony with advancing civilization, the peasant still continued to keep it up, because of that vague feeling of probable efficiency in traditional customs, and partly because a small portion of the magic efficiency still remained. Here we have the original form of the St. George play, in which there is the mock struggle or the mock death and revival, now scarcely magic, and almost entirely entertaining. To this village mumming came Christian influence, and the mock struggle attracted to itself, and made an integral part of itself, the champion of Christendom and the patron of England—St. George. But the late Christian influence was not strong enough to transform the tradi-

---

1 H. Ling Roth, "The Natives of Sarawak and British North Borneo," 2 vols. Vol. 1, pp. 412–415.

tional drama; and St. George, as we have seen, is killed as frequently as he kills.

To the death and revival and the mock struggle as direct contributions from the folk, may be most probably added the Doctor, as we have seen. We see him appearing in Australia,[1] Sarawak,[2] America,[3] as well as in various parts of Europe,[4] and this gives great strength to the opinion of Creiznach that he was developed outside of the liturgical drama.[5] If our reasoning is just, he must have been in Europe as early as the earliest agricultural magic rites. At least he has representatives even among the very primitive rites of the Australians.

We have already noted the costumes of the players in the St. George mumming.[6] We need only to mention again that green boughs and green leaves are habitually associated with most of these ceremonies, in Europe[7] and out of it.[8]

In our description of the plays, we said that some of the actors represented animals. The ceremonies we have examined are very largely associated with animals, and in initiation and other ceremonies there are many animal presentations. The testimony on this point is so overwhelmingly abundant that I have not made any special note of it. Moreover, it is not important for an understanding of the plays as read, as animal costumes are noticeable only when the plays are presented. It is to be noted, however, that many of the plays have no animals whatever.[9] Examples of the mimic contest we have found in plenty.[10]

As a direct result, then, of our examination, we can say that we have accounted for the St. George plays, first, in assigning to them an original motive, and, secondly, in giving a derivation of

1 Pp. 299, 300, 302, 303, 308.

2 P. 321.

3 Pp. 315, 316, 317, 318.

4 P. 289.

5 P. 284.

6 Pp. 276, 291, 292.

7 Pp. 289, 290, 291, 292, note 2.

8 Pp. 294, 300, 302, 303, 304, 307, 319, 320.

9 In his forthcoming book on the Folk Drama, Mr. T. F. Ordish may clear up this and other points.

10 Pp. 290, 291, 298, 299, 301, 305, 306, 307, 317, 318, 319, 320.

the various parts. But, as I have said, the St. George plays bring up the whole question of the drama. If the intent of all these ceremonies is the bringing about of a desired result by means of mimetic action, or mimetic magic, we may perhaps see what was in Aristotle's mind when he made the statement that poetry arose from the instinct of imitation, and from the instinct for harmony and rhythm.[1] Is it not probable that Aristotle had here in mind initiative or mimetic ceremony? Curtius attempts to connect the verb μιμέομαι through μῖμος with the Sanskrit *mâ-yâ, phantom*, or *juggling*. This connection is frowned upon by Leo Meyer, but it is most interesting and is highly probable from the evidence of folk-lore. Such a connection would exactly correspond with the known facts of savage and peasant life, and it is certain that the Bacchanalian and other Greek festivals were in part mimetic in the magic sense.[2]

In nearly all the savage ceremonies we see a very close connection between ceremony and myth, and there seems to be little doubt that the ceremony is not the derived form. In other words, the myth or legend is a late invention to explain the ceremony. In all cases where both survive, the ceremony has all the marks of being the original.[3] Thus the legends, epics and ritual songs have as their ancestor the pantomimic ceremony, and therefore we are not making an impossible or even

---

1 "Poetics," iv, 2–6.

2 On the origin of Drama, and its *mimetic* character, see Wundt, "*Völkerpsychologie*," vol. 2, chap. 1, pp. 463–526 ("Mimus und Drama").

3 See W. Robertson Smith, "Religion of the Semites," sect. 1; Washington Matthews, "Navaho Legends," Introduction. Stevenson, ll. cc. Matthews expresses the general facts excellently, l. c., p. 52:

"Whenever an opportunity has occurred of studying a rite with its associated myth, it has been found that the myth never explains all the symbolism of the rite, although it may account for all the more important acts. A primitive and underlying symbolism, which probably existed previous to the establishment of the rite, remains unexplained by the myth, as though its existence were taken as a matter of course and required no explanation. Some explanation of this foundation symbolism may be found in the Origin Legend, or in other early legends of the tribe; but something remains which even these do not explain."

an improbable assumption when we trace our mummers' play back to a mimetic ceremony.[1]

Finally, we may note that the central theme of the St. George plays is similar to the central doctrine of the Christian Church. If our reasoning is sound, we cannot suppose that this is derived from the Church; moreover, according to the best evidence, the incident was present in ceremonies long before the appearance of the Christian Church. It was, therefore, an independent possession, and this consideration might lead to a modification of Chambers' opinion that the folk-drama contributed to the mighty stream of European drama only the tiniest rill.[2] Mr. Frazer has given as a reason for the rapid spread of Christianity in Western Asia the fact that the death and resurrection of a god had been yearly celebrated for generations before the crucifixion of Christ.[3] Somewhat the same reason may be given for the *dramatization of the resurrection* in the Church liturgy—a question which Mr. Chambers nowhere answers. A remembrance of the fact that the people among whom the Church came were familiar with this incident, may show us why this part of the church service developed so rapidly, was the first to become dramatic, and was the first to develop the trope and liturgical play.[4] The liturgical plays did not deal with other events of the life of Christ until later. Even the passion plays were a later development.[5] From this standpoint, a study of the whole matter would be most useful, as indicating the progress of liturgy and early drama, in their inter-connection.

---

1 On this whole matter, see Wundt, "Völkerpsychologie," vol. 2, chap. 1, pp. 307–394 ("Das Lied and erzählende Dichtung"). Wundt makes the assumption a most natural one and traces the process of development in an admirable, though brief, manner.

2 "Mediæval Stage," vol. 1, p. 82. He is criticising Grimm's statement that these ceremonies are the probable source of modern drama. (In Grimm's "Kleinere Schriften," vol. 5, p. 281.)

3 L. c., vol. 3, pp. 195 ff. I quote Frazer in this connection in spite of Mr. Andrew Lang's criticism of "The Golden Bough," in "Magic and Religion," 1901.

4 Léon Gautier, "Histoire de la Poésie Liturgique au Moyen Age," vol. 1, "Les Tropes," 1886. (The second volume is not yet published.)

5 Chambers, l. c., vol. 2, p. 39.

THE SETTLEMENT OF OKLAHOMA.

SOLON J. BUCK, A. M.,

Assistant in American History in the University of Wisconsin.

(With Plates IX-XIV.)

PHYSIOGRAPHY.

The story of the Indian has been virtually the same from the settlement of Jamestown in 1607 to the present time. Slowly but gradually his territory has diminished before the advance of the white man, hungry for land, until in the year 1889 the domain of the American Indian, which once included our whole country, had come to comprise merely the so-called Indian Territory, a district slightly smaller than the state of Kansas and immediately south of it, together with a number of smaller reservations scattered through the western states. It is this Indian Territory which will probably constitute the future state of Oklahoma, and the western half of which, together with the former Public Land Strip or "No Man's Land" north of the Texan panhandle, constitutes the present territory of Oklahoma.

The territory of Oklahoma lies between the parallels of thirty-four and thirty-seven degrees north latitude, and between ninety-six and one hundred degrees west longitude, excepting Beaver county, which, thirty-five miles wide and one hundred and sixty miles long, stretches to the one hundred and third parallel west longitude. In latitude it corresponds with Tennessee and in longitude with central Kansas and Texas.

Its area is about thirty-nine thousand square miles, or twenty-five million acres, corresponding roughly to that of the state of Ohio. The land, like that in most of the prairie states, slopes gradually upward from an altitude of seven hundred and fifty feet in the east, to one of four thousand in the west, the lowest parts being along the Cimarron in Pawnee county, and the highest in the extreme west of Beaver county.[1]

A range of hills extending in a wide curve from the east central to the southwestern border and culminating in the Wichita mountains, whose highest peak has an altitude of twenty-three hundred feet, breaks up the monotony of the prairie. The territory is crossed from northwest to southeast by three large rivers, the Arkansas, Canadian and Red, and their branches, the Cimarron, North Canadian and Washita.[2] The valleys of these rivers are generally well wooded, and in the eastern part of the territory there are considerable areas covered with timber, chiefly the different varieties of oak and mesquite.[3]

All of Beaver county and the neighboring district are west of the line of sufficient rainfall and consequently, without irrigation, suited to stock raising only. The area of sufficient rainfall extends farther west in Oklahoma than in the states to the north, and the farmer has pushed his way well into the western tier of counties, and in the river valleys many successful farms are found well beyond the danger line. The soil of central and northeastern Oklahoma has proven its excellence by the abundant crops of the last ten years. It is well described by Governor C. M. Barnes in his report for 1900. He says: "The surface is mostly of a rich, red clay or sandstone decomposition mixed, in the valleys, with black alluvial deposits, and is highly productive, as shown by the rich results to the husbandman during the past three years. The soil is of sufficient depth and character to render it almost inexhaustible, and it will stand many successive crops before needing fertilization."[4] In this region the crops of the North and South meet.

1 Interior Department, Miscellaneous Reports, 1901, pt. 2, p. 414.

2 Ibid., 1900, pt. 2, p. 632.

3 Ibid., 1898, p. 681.

4 Ibid., 1900, pt. 2, p. 632.

Side by side can be seen the wheat or corn fields of Kansas and the cotton fields of Texas and the lower South. A great diversity of crops exists, each farmer planting the staple of the locality from which he came.[1] This section is especially suited to fruit raising, peaches and grapes being very abundant. Melons are a staple crop in some of the eastern counties, and hundreds of carloads are shipped east every year.[2]

The southern part of Oklahoma comprises Greer county, long disputed with Texas, and what was formerly the Kiowa, Comanche and Apache Indian reservation. The former is exceptionally productive, considering its western location. In the Kiowa, Comanche and Apache tracts there are fertile lands, along the Washita and other valleys, with undulating plains stretching away to the Red river on the south. Much of the land in this area is suitable only for grazing, and thousands of acres in the mountains are absolutely worthless except for minerals. The Washita mountains in the northeastern part of the reservation consist of gigantic piles of rock pushed up through the prairie and covering an area of twelve by thirty miles. They are interspersed with fertile valleys and mountain parks. Hundred of large mountain springs give rise to streams which flow in every direction to join the large rivers. The mountains also give promise of considerable wealth in minerals, oil and natural gas.[3]

Indian Territory Before the Opening.

The idea of removing the troublesome Indians of the southern states to the great unsettled plains west of the Mississippi appeared immediately after the acquisition of Louisiana in 1803. In the very next year Congress passed an act authorizing the President to make such removals, the Indians to exchange their lands east of the Mississippi for other lands to be granted them in the West. In 1809 a delegation from the Cherokee Indians in Georgia, the Carolinas, Alabama and

1 Int. Dept., Misc. Repts., 1900, pt. 2, p. 633.

2 Ibid., 1902, pt. 2, pp. 438, 440.

3 Ibid., 1900, pt. 2, pp. 684–686.

Tennessee visited Washington and in an interview with Jefferson represented to him that a part of their tribe was anxious to move to lands west of the Mississippi in order to continue their hunting life. The President gave them permission to send a party to explore the territory and afterwards to move to the lands of their choice, and by 1817 one-third of the Cherokees had crossed the river.[1] By two treaties in 1817 and 1819 (7 Stats., 156, 195) the United States conveyed to the Cherokees a large tract of land between the Arkansas and White rivers, mostly in the present state of Arkansas.[2]

In order to make room for the advancing settlement, a new treaty was entered into with the Cherokees in 1829 (9 Stats., 311), by which they gave up all claim to the lands in Arkansas granted to them in 1817 and 1819, and the United States agreed to guarantee to them forever seven million acres and a perpetual outlet west with free and unmolested use of all that country west of the western boundary of the seven million acres as far as the United States extended.[3] By treaties of 1833 and 1835 (7 Stats., 414, 478), this Cherokee land was defined so as to include Tract 1, Plate IX, together with other land in what is now the state of Kansas, and in 1838 a single patent was issued to the Cherokees conveying all of this land.[4] Meanwhile the Indian Territory, as such, had been created by an act of Congress of 1834, setting it apart for the permanent occupation of all the five tribes from the southern states.[5] The discovery of gold in Georgia and Alabama had led to trouble with the Indians remaining there and to a demand for their removal, so that the Cherokees east of the Mississippi were by the treaty of 1835, mentioned above, forced to cede all their inherited lands and to join their tribesmen in Indian Territory.[6]

The first steps toward the removal of the Creek Indians were taken in 1824, in which year a treaty was made (7 Stats.,

1 *Congressional Record*, vol. 18, p. 334.

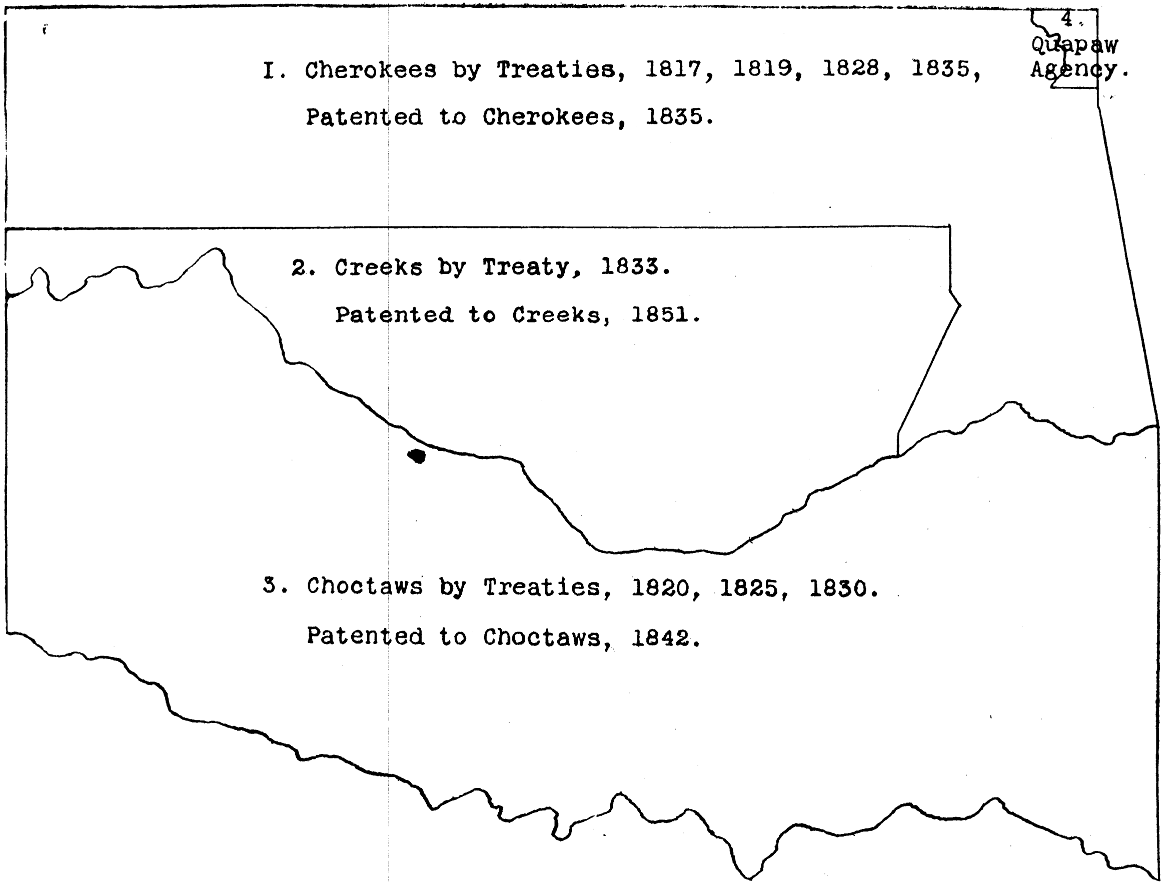
2 Senate Executive Doc., 78, 51 Cong., 1 Sess., p. 3.

3 Ibid.

4 Ibid., p. 4.

5 United States Census, 1900, Indians, p. 529.

6 *Congressional Record*, vol. 18, p. 334.



INDIAN TERRITORY; THE ORIGINAL CESSIONS.

278) giving them permission to examine the country. The removal took place in the years 1832–33, and in 1833 a treaty (7 Stats., 417) conveyed to them the tract numbered 2 on Plate IX. By this treaty the Seminoles, with whom a treaty of removal had been made in 1832 (7 Stats., 369), were to be incorporated into the Creek nation and to enjoy a part of their lands. A patent was issued to the Creeks for this land in 1851.[1]

The first session of land west of the Mississippi to the Choctaws was made by a treaty of 1820 (7 Stats., 210), by which they were given the tract of land between the Arkansas river with its branch, the Canadian, and the Red river. By the treaties of 1825 and 1830 (7 Stats., 333), this tract was restricted on the east to the western Arkansas boundary, making it coincide with Tract 3, Plate IX. The patent was not issued to the Choctaws for this land, however, until 1842, at which time the Chickasaws, who gave up their lands east of the Mississippi in 1832 (7 Stats., 381), had been settled there also.[2] Thus the whole of Indian Territory, excepting the small Quapaw agency (Tract 4, Plate IX), was covered by these three letters patent of 1838, 1842 and 1851 to the Cherokees, Choctaws and Creeks respectively.

In 1837 an agreement was entered into between the Choctaw and Chickasaw Indians by which the Choctaws formed the western part of their domain into the Chickasaw district as a permanent home for that tribe, but never to be alienated without the consent of both tribes. By a second convention in 1854 this district was defined as is indicated by Tracts 4 and 5, Plate X. The next year the United States made a treaty (11 Stats., 611) with the two tribes, by which the Chickasaw district was confined to Tract 4, Plate X, and the territory west of this—Tract 5—was leased to the United States for a permanent home for the Wichitas and such other Indian tribes, with certain exceptions, as the United States might see fit to locate there.[3]

---

1 Sen. Ex. Doc., 78, 51 Cong., 1 Sess., pp. 15–16.

2 Ibid., pp. 24–25.

3 Ibid., pp. 25–27.

The first division of the Creek territory was made in the year 1855. As before mentioned, the Seminoles had been incorporated into the Creek nation by the treaty of 1833, but the two tribes did not get along well together, and the dissensions finally became so violent that the United States government intervened and made the treaty of 1856 (11 Stats., 699), by which the Creeks ceded to the Seminoles the land between the Canadian river and its North Fork, designated as Tract 6, on Plate X.[1]

Many of the Indians in the territory were slaveholders, and for this reason and others, when the Civil war broke out in 1860, all of the tribes made treaties with the southern confederacy and thus severed their relations with the United States. Some of the tribes repudiated this action early in the war, while others remained allies of the confederates throughout. At the close of the war, it was necessary to make some new arrangement with these Indians, and so a series of four treaties was made in the year 1866 with the several tribes. By these treaties the Choctaws and Chickasaws converted the lease of Tract 5, Plate X, into an absolute conveyance, the Seminoles ceded their entire domain, Tract 6, and the Creeks the entire western half of their domain, Tract 7, to the United States "in compliance with a desire of the United States to locate other Indians and freedmen thereon."[2]

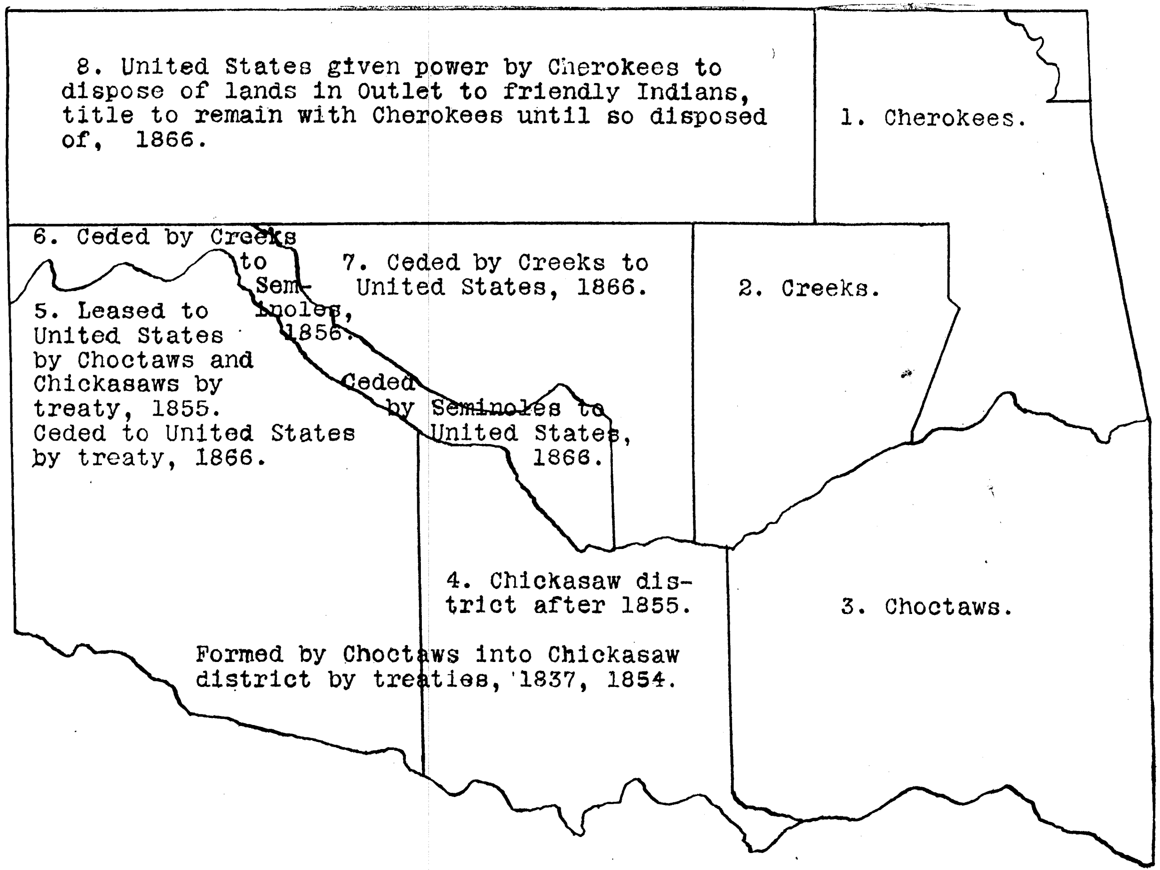
The Cherokees gave up what land they possessed in Kansas and also agreed with the United States that all of their land west of ninety-six degrees west longitude, which is Tract 8, Plate X, should be held in reserve as it were, the United States to have power to settle thereon, under certain conditions, friendly Indians to whom the Cherokees would convey the land in fee simple and at a price to be agreed upon, but the title and jurisdiction of the Cherokees in this land was to remain unimpaired until so conveyed.[3] Plate XI represents the situation

---

[1] Sen. Ex. Doc., 78, 51 Cong., 1 Sess., p. 16.

[2] *Congressional Record*, vol. 18, pp. 335–36; Sen. Ex. Doc., 50, 48 Cong., 2 Sess., p. 18.

[3] Sen. Ex. Doc., 109, 48 Cong., 1 Sess., p. 2.



INDIAN TERRITORY; DIVISIONS TO 1866.

in Indian Territory after the treaties of 1866. Tract 1 is what remained of the original three cessions shown on Plate IX; Tract 2 represents the territory in the possession of the United States for the purpose of settling Indians and freedmen thereon; and Tract 3 is the Cherokee Outlet, the disposal of which was in the control of the United States.

To take up the disposal of the two latter areas by the United States: Tract 1, Plate XII, was sold to the Seminoles by the same treaty of 1866 by which they gave up their entire domain. The rest of their present territory was purchased from the Creeks in 1882.[1] By the treaty of 1867 (15 Stats., 496), Tract 2, Plate XII, was given to the Sacs and Foxes,[2] and by another treaty in the same year (15 Stats., 581), Tract 3 was ceded to the Kiowas, Comanches and Apaches.[3] The Cheyennes and Arapahoes were located on Tracts 4 and 8 by executive order in 1869.[4] The first disposition of Cherokee land was made by an order of the Secretary of the Interior in 1871 locating the Osages on Tracts 5 and 6. An act of Congress of the next year (17 Stats., 228) gave the Osages Tract 5 and the Kansas Indians Tract 6.[5] The Pottawatomies and Absentee Shawnees were located on Tract 7 by act of Congress in 1872 (17 Stats., 159),[6] and in the same year the Wichitas were located on Tract 8, an agreement to that effect being made with the Cheyennes and Arapahoes, but this was never ratified by Congress.[7] In 1876 the Pawnee Indians were located by act of Congress (19 Stats., 28) on Tract 9, partly within the Cherokee Outlet and partly in the Creek cession.[8] Then Tracts 10 and 11 were given to the Nez Percés and Poncas respectively by acts of Congress in 1878 (20 Stats., 74, 76) and Tract 12 to the Otoes and Missourias in 1881 (21 Stats.,

1 Sen. Ex. Doc., 50, 48 Cong., 2 Sess., p. 18.

2 Ibid.

3 Ibid., 109, 48 Cong., 1 Sess., p. 6.

4 Ibid., and Sen. Ex. Doc., 50, 48 Cong., 2 Sess., p. 19.

5 Ibid., 109, 48 Cong., 1 Sess., p. 3.

6 Ibid., 50, 48 Cong., 2 Sess., p. 18.

7 Ibid., 78, 51 Cong., 1 Sess., p. 29.

8 Ibid., 50, 48 Cong., 2 Sess., p. 18; Sec. Int. Rept., 1883, vol. 2, p. 42.

318).[1] The last disposals were made in August 1883, when the Iowas and Kickapoos were located by executive order on Tracts 13 and 14 respectively.[2]

Of the remaining territory, the title of the United States to Tract 15 was disputed by Texas owing to a disagreement as to what constituted the Red river of the treaties of 1819 with Spain and 1828 with Mexico. The portion of the Cherokee Outlet which was still unassigned, and consequently still under the jurisdiction of the Cherokees, is represented by Tracts 17 and 18, including about six million acres. Tract 15, including 1,887,800.47 acres[3] in the very center of Indian Territory, and embracing parts of both the Creek and Seminole cessions, was still unassigned. This was the region known to the Indians and afterwards to the "boomers" and the world at large as Oklahoma, "the beautiful land."

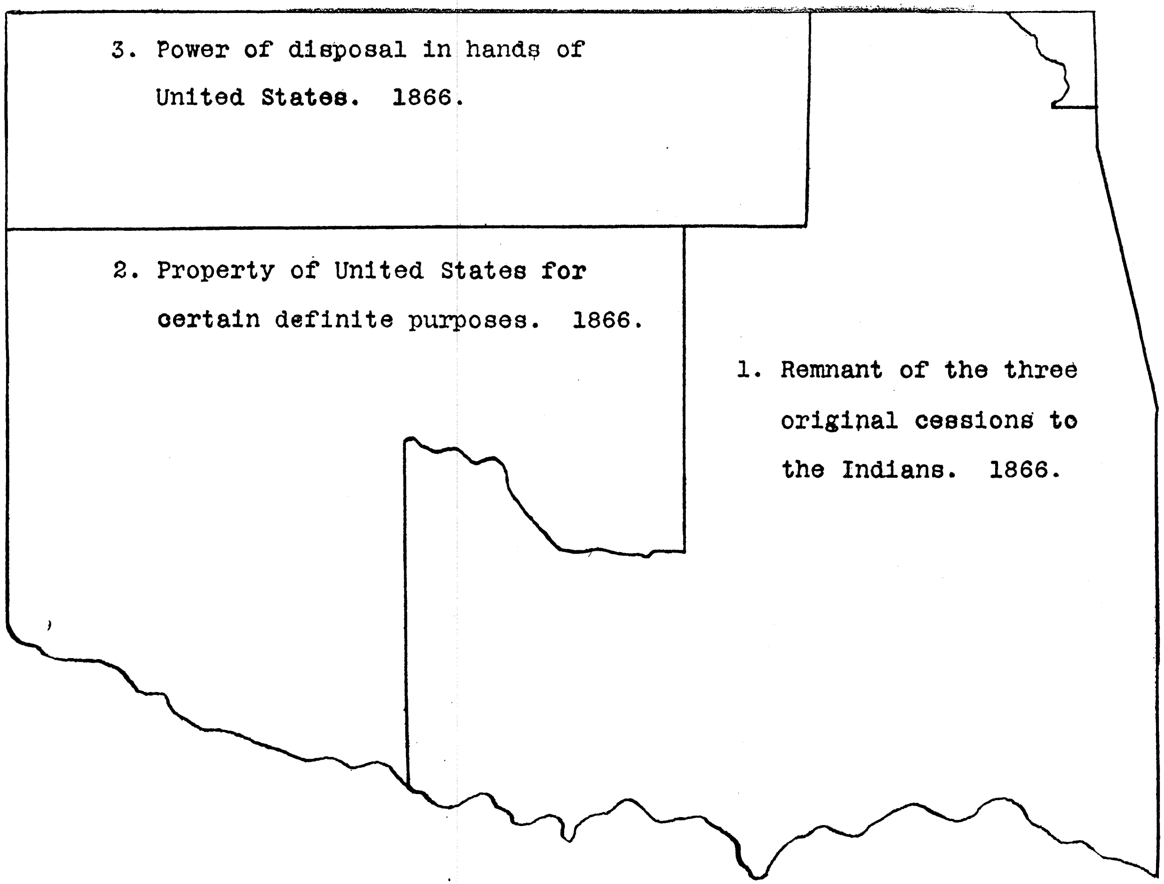
Such was the status of the land in the western part of Indian Territory, later the territory of Oklahoma, in the decade from 1879 to 1889, the period of the Oklahoma "boomers." And now perhaps some statistics regarding the density and condition of the Indian population will be of value in understanding the situation. To take first the Indians settled on the Cherokee strip in Tracts 5, 6, 9, 10, 11 and 12, Plate XII; we find in 1884 a population all told of four thousand, three hundred and eight Indians possessing an extremely fertile tract of two million, one hundred and twenty-two thousand acres, or nearly five hundred acres for every man, woman and child.[4] When we consider that the white farmers who afterwards settled Oklahoma thought a farm of one hundred and sixty acres ample for a family, an average of about thirty-two acres per individual, we can comprehend the fact that the poor down-trodden American Indian had become a wealthy landlord. These Indians on the Cherokee strip were mostly semi-civilized and cultivated the soil to some extent. The Indians on what was some-

1 Sec. Int. Rept., 1883, vol. 2, p. 42.

2 Sen. Ex. Doc., 50, 48 Cong., 2 Sess., p. 18.

3 Ibid., p. 19.

4 Sec. Int. Rept., 1883, vol. 2, pp. 131–33.



INDIAN TERRITORY; 1866.

times considered part of the original Oklahoma, Tracts 2, 7, 13 and 14, numbered about two thousand, one hundred and sixty souls, and their territory included roughly about one million, six hundred and fifty thousand acres of the best land in the territory, an average of about seven hundred and seventy acres for each individual.[1] Some of these Indians were partly civilized and some were still in the blanket stage. Tracts 3, 4 and 8 contain in round numbers about eight million acres and were held by ten thousand, three hundred blanket Indians, making an average of seven hundred and fifty acres apiece,[2] but these Indians were not so well off comparatively as the others, because their land was located farther west and much of it was of little value.

There remained about six million acres of the Cherokee strip, one million, eight hundred and eighty-eight thousand acres in Oklahoma proper, and Greer county with a million and a half acres,[3] in which there were no Indians. In the latter there was already some white settlement under the jurisdiction of Texas. Outside of the Indian Territory, but afterwards a part of Oklahoma, was the Public Land Strip, or "No Man's Land," consisting of three million, six hundred and eighty-one thousand acres.[4] This strip of land, which had accrued to the United States from Texas, had never been organized or placed under the jurisdiction of any state or territory. It was, however, a part of the public domain, and as such was open to settlement under the homestead laws. There were already quite a number of settlers in this land along the edges of the streams where settlement was possible, and as they were entirely without law they had organized a provisional government, and on March 4, 1886, resolved themselves into a territory to be called Cimarron and elected a certain Dr. Chase as delegate to Congress to demand recognition. Nothing came of this organization, however,

1 Sec. Int. Rept., 1883, vol. 2, p. 142.

2 Ibid., pp. 118, 128; *Congressional Record*, vol. 17, Appendix, pp. 175–76.

3 Int. Dept., Misc. Repts., 1902, pt. 2, p. 493.

4 Ibid., p. 492.

but it served as a means of protecting property rights among the settlers.[1]

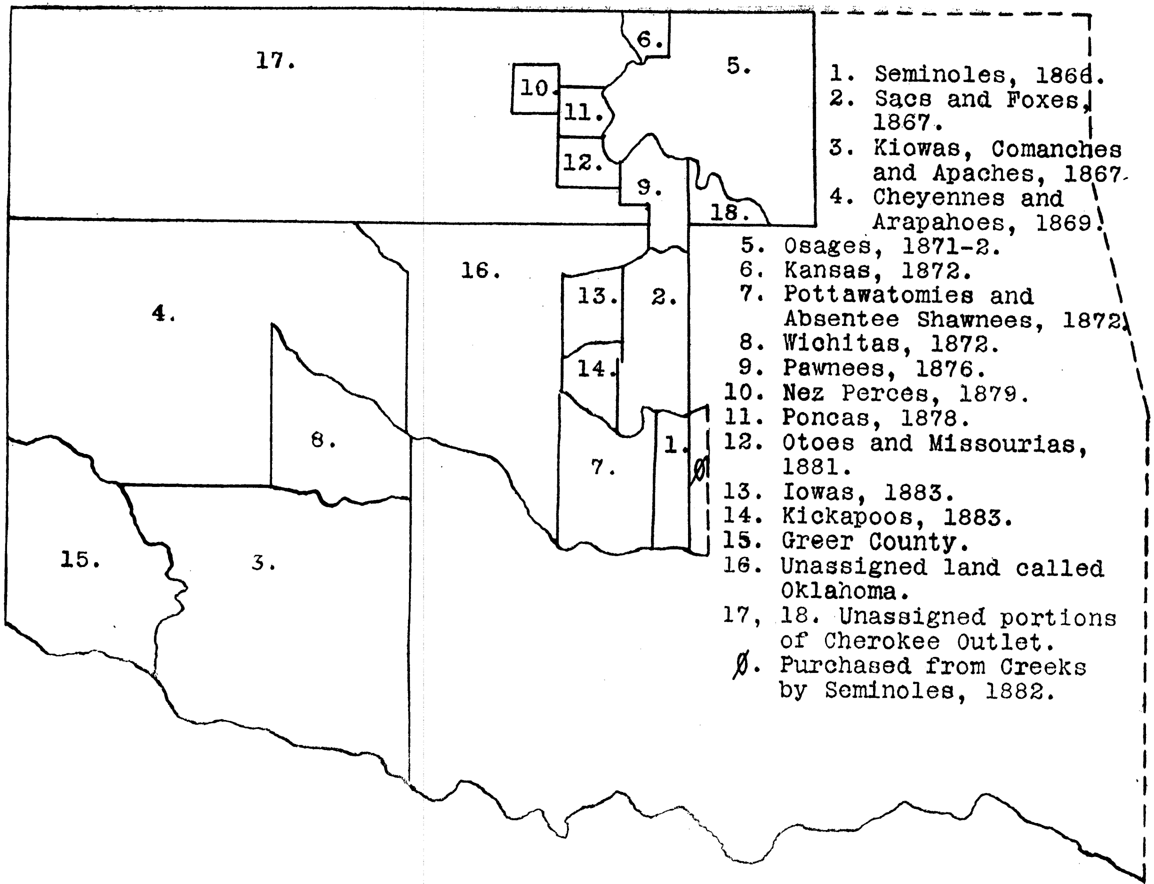
Here, then, are twenty-four million, seven hundred and seventy-four thousand, four hundred acres in all, occupied by less than seventeen thousand Indians, who can at best make use of but a very small part of it. It could not be expected that all the rest of the land would lie idle when surrounded by settled states in which land was at a premium. Consequently the natural thing happened, and this vacant land was taken possession of by stock raisers with their vast herds of cattle. At first they simply drove on their herds and asked no question as to the ownership of the land. But the Indians soon saw that here was an opportunity to turn their vast unused acres to account, and they began to make leases to the cattlemen, which, although at absurdly low rates per acre, netted them large sums of money because of the great extent of the area leased.

An investigation of these leases made in 1885[2] shows that the Cherokees had leased the six million acres in the Outlet to the Cherokee Strip Live Stock Association for one hundred thousand dollars per annum, or less than two cents an acre. The Cheyennes and Arapahoes had leased the whole western part of their domain, about three million, eight hundred thousand acres, in eight different leases at two cents per acre. The Osages had leased three hundred and eighty thousand acres in six leases at six cents per acre, and the Kansas Indians, fifty-two thousand acres at four cents and three hundred acres at fifty cents, the latter being under cultivation. Each of the other small tribes, the Nez Percés, Poncas, Pawnees, Otoes and Missourias, Sacs and Foxes and the Iowas, had leased about half of its reservation at an average rate of three cents per acre. The Oklahoma district, being thus surrounded on nearly all sides by leased grazing lands, was of course overrun with cattle for which no payment was made to anyone.[3] Some of these Indians, as the Cherokees, who held their land in fee simple, seem to

1 Int. Rept., Misc. Repts., 1900, pt. 2, p. 671.

2 Sen. Ex. Doc., 17, 48 Cong., 2 Sess., pp. 12–15.

3 Ibid., pp. 90, 91.



INDIAN TERRITORY; DIVISIONS AND CESSIONS, 1866-1883.

have had the right to make these leases, but those who had possession merely under executive order had no authority to do so. It was, however, understood that the Department of the Interior would not interfere. In spite of all the landed possessions of these Indians in the territory and of the money flowing into their coffers from these cattle leases, they were still paupers of the government, unable to take care of themselves, and it was costing the United States a quarter of a million dollars every year to support them.[1]

Another aspect of this region, surrounded as it was with settled states, was the fact that it furnished an unusually safe harbor for criminals and outlaws from all the surrounding region. A fugitive from justice had but to make his way into Indian Territory and be adopted into some of the tribes or join some of the cattle ranches, and he was practically safe from the arm of the law.[2] That Indian Territory was the home of the law breaker is shown by the fact that the United States District Court for western Arkansas, which had jurisdiction over Indian Territory, had five hundred and fifty-two criminal prosecutions in the fiscal year ending June 30, 1885, a number double that of fifty-seven of the other sixty-eight districts in the United States.[3] Such, then, was the situation in Indian Territory in the eighties, and everything was indeed ripe for the work of the "Oklahoma boomers."

THE AGITATION FOR THE OPENING OF OKLAHOMA.

There are many facts which tend to show that the plan of settling Oklahoma with white men was in the beginning the work of the railroad interests involved.[4] In July 1866, shortly after the Indian treaties of cession, a bill was rushed through Congress granting to the Atlantic and Pacific railroad each alternate section for forty miles on both sides of the proposed

---

1 *Congressional Record*, vol. 17, Appendix, p. 177.

2 Ibid., p. 5214.

3 Ibid., Appendix, p. 178.

4 *New York Tribune Extras*, vol. 1, no. 7, p. 23; Sen. Ex. Doc., 50, 48 Cong., 2 Sess., pp. 49, 55.

line of location through Indian Territory, title to be made good when the Indian title should be extinguished.[1] Although this grant had been forfeited through failure to complete the road in the specified time, the company, or its successor, still felt it had some claim to the grant, which would be strengthened by opening the territory to white settlement. Moreover, it was evident that the earning capacity of all the different roads through the territory would be vastly increased by the additional traffic which would come with its settlement.[2]

The movement seems to have been started by two men, Col. E. C. Boudinot, a Cherokee Indian and a talented lawyer and lobbyist in Washington, holding the position of clerk of the House committee on private claims,[3] and C. C. Carpenter, a man of unsavory reputation in connection with a similar enterprise for opening the Black Hills to settlement.[4] In the *Chicago Times* of February 17, 1879, Col. Boudinot published an article calling attention to certain lands in Oklahoma which he asserted were open to settlement, and, in answer to numerous inquiries, he prepared a map and a letter declaring all western Indian Territory below the Cherokee Strip, excepting the Sac and Fox, Pottawatomie and Wichita reservations, to be property of the United States and open to settlement under the homestead laws. This map and letter were widely circulated throughout the country and attracted the attention of many homeseekers.[5]

Early in 1879, C. C. Carpenter, presumably in the pay of the railroads, issued a circular and spread notices through the newspapers of Kansas to the effect that Oklahoma was open to settlement, and inviting people to take possession of it.[6] Many worthy people were attracted by these notices and began to move toward Oklahoma. The attention of President Hayes having been called to this state of affairs, he issued a

1 *Congressional Record*, vol. 17, Appendix, p. 181.

2 *Chautauquan*, June 1889, p. 533.

3 Ibid.

4 Sen. Ex. Doc., 50, 48 Cong., 2 Sess., p. 49.

5 Ibid., p. 51.

6 Ibid., pp. 8, 52.

proclamation on the twentieth of February, 1879, warning all persons against attempting to invade or settle on any land in the Indian Territory and advising them that they would be removed by military force if necessary.[1] At the same time, the army was given instructions to enforce the proclamation and the proposed invasion was checked with little difficulty, the people readily turning back when informed of the true conditions.[2]

From this time on, attention centers in Captain D. L. Payne, the most noted of the "Oklahoma boomers." He was of a frontier type, a skilful hunter, soldier and politician. In 1878 he was doorkeeper of the House of Representatives.[3] Payne was probably in the pay of the railroads at the start, but his fertile brain soon evolved a scheme of organization whereby "booming Oklahoma" became an extremely profitable occupation in itself, and no incentive was needed to keep the leaders at it. Payne and his associates organized what they called the "Oklahoma Colony." Every one who joined the colony had to pay a fee of at least one dollar, and in addition, the leaders organized themselves into a town-site company and sold claims to lots at from two to twenty-five dollars each, according to whether "booming" was dull or brisk. It is estimated that one hundred thousand dollars must have been received in this way before the death of Payne.[4]

In order to get around the President's proclamation of 1879 and to delude the people into believing that they still had the right to settle in Oklahoma, the leaders of the "colony" represented that the President had changed his mind as to the state of these lands since the issuance of the proclamation, and had admitted in his last message to Congress that they were open to settlement.[5] To correct this statement the President issued a second proclamation on February 12, 1880, declaring such representations wholly without foundation, and reiterating the

1 Sec. Int. Rept., 1879, vol. 1, p. 294.

2 Ibid., pp. 14, 103; Sen. Ex. Doc., 50, 48 Cong., 2 Sess., p. 9.

3 *Chautauquan*, June 1889, p. 534.

4 Ibid.; Sen. Ex. Doc., 50, 48 Cong., 2 Sess., p. 5.

5 Sec. Int. Rept., 1880, vol. 1, p. 96.

declarations of the former proclamation.[1] In spite of this, the first organized raid on Oklahoma took place in April 1880. A party of about twenty-five men, led by Captain Payne and "Oklahoma Harry" (Harry L. Hill, a wealthy resident of Wichita), left Arkansas City April 13th and advanced into Oklahoma over what is known as the Hog's Back trail. On April 22nd, they selected a town-site about forty miles east of Fort Reno and a mile and a half south of the North Fork of the Canadian river.[2]

Meanwhile the military officers in charge of the Missouri district had been instructed to remove the intruders, and if any returned, to turn them over to the United States marshal at Fort Smith.[3] In pursuance of this, the outfit led by Payne was corralled on May 12th by Lieutenant Pardee and twelve soldiers, and Payne and thirteen of his followers were arrested. These were held until the third of June awaiting instructions and then conducted outside of the territory and warned not to return.[4] Not at all deterred by this treatment, Payne was soon at work again, and on the fifteenth of July was again discovered in the Indian Territory and captured with twenty-two followers. This time they were held until August 7th, when Payne and the other old offenders were turned over to the United States marshal for the western district of Arkansas, and the others released. The prisoners were soon released on bail to appear at the November term of court, and at the subsequent May term a civil suit in the nature of an action for debt, the only action possible under the law, was brought against Payne in the name of the United States to recover the statutory penalty of one thousand dollars for invasion of Indian reservations. Judgment was of course rendered against him, but nothing could be collected, as he was entirely impecunious.[5]

Even while awaiting trial Payne had not been quiet, and in December 1880 had assembled about two hundred men be-

---

1 Sec. Int. Rept., 1880, vol. 1, p. 323.

2 Ibid., pp. 96–97; *Chautauquan*, June 1889, p. 534.

3 Sen. Ex. Doc., 50, 48 Cong., 2 Sess., pp. 3–4.

4 Ibid., p. 4.

5 Sec. Int. Rept., 1881, vol. 2, p. 54.

tween Caldwell and Arkansas City, and would have entered the territory but for the presence of the troops. They encamped near Caldwell December 11th, determined to wait until the troops were removed, but were forced to disperse about January 6th by the extreme cold.[1] In the year 1882 Payne was twice captured in Indian Territory, once in May with twenty-nine men, when the party was merely conducted across the border and released, and again in August with seven men and two women, when Payne and six of the men were taken to Fort Reno as prisoners and, in the latter part of September, turned over again to the civil authorities at Fort Smith, where the previous performance was repeated.[2]

There is no need of going into the details of the subsequent raids, for they are but variations of these. About twice each year Payne and a party of "boomers" would be arrested in the territory by the military, the old offenders turned over to the marshal at Fort Smith, and then released to repeat the farce. It was evident that the United States laws were entirely inadequate to deal with the situation, and the Secretary of the Interior and Commissioner of Indian Affairs were continually urging upon Congress, but without success, the advisability of passing a more stringent law to cover the offence.[3] The military officers also soon tired of the farce they were compelled to play in periodically ejecting the intruders. The commanding general of the Missouri district reported in 1882 that these raids were entailing a heavy expense upon the government and subjecting the troops to long and severe marches to no purpose. He suggested that Payne be shut up in the guardhouse and made to work for his living until some remedy for the situation be found. Such action, of course, could not be countenanced by the Secretary of War, and so the continuous vaudeville performance went on.[4]

The most noteworthy of all raids was that which in 1884 effected a settlement at Rock Falls and at other places a few

---

1 Sen. Ex. Doc., 50, 48 Cong., 2 Sess., pp. 4, 10.

2 Ibid., p. 4; Sec. Int. Rept., 1881, vol. 2, p. 54.

3 Sec. Int. Rept., 1882, vol. 2, p. 13.

4 Sen. Ex. Doc., 50, 48 Cong., 2 Sess., pp. 4, 11.

miles south of the Kansas border in the Cherokee Strip. The raiding parties had been gradually growing in strength up to this time, and this one was made up of about six hundred men, women and children. On July 1, 1884, President Arthur issued a proclamation which was substantially the same as those of his predecessor, but the settlement at Rock Falls continued to prosper and developed into a well settled town with its stores and its newspaper. Finally, on August 6, 1884, Col. Hatch appeared at Rock Falls, after the little settlement had prospered quietly for several months, and, explaining his mission to the leaders and the people, read the President's proclamation and ordered them to withdraw. The next day the removals began, the improvements at Rock Falls were burned, Payne and others arrested and taken to Fort Smith, and the rest of the colonists driven across the border into Kansas, but Cherokee lands were not entirely cleared of intruders until the middle of September.[1]

The reported presence and active assistance of a cowboy in the removals at Rock Falls[2] indicates one of the principal grievances of the "Oklahoma boomers." They knew that not only Oklahoma proper, but the whole western part of Indian Territory was in reality in possession of the cattlemen, and they could not understand why their right to make use of this land was not as good as that of the stock-raising companies nor why they should be ejected by the military forces while the cowboys and their herds were protected. In 1884 it was called to the attention of the Secretary of the Interior that Oklahoma was covered with wire cattle fences, and in June their removal by the military was ordered. This was carried out in September, but it did not mean a removal of the cattle themselves.[3]

Payne died suddenly in November 1884 under suspicious circumstances, and a report was circulated to the effect that he had been poisoned by the cattlemen. He was succeeded by Capt. W. L. Couch, who had been one of his associates. Couch

---

1 Sec. Int. Rept., 1884, vol. 1, pp. 31–32; *Chautauquan*, June 1889, p. 534.

2 Ibid., pp. 534–35.

3 Sen. Ex. Doc., 50, 48 Cong., 2 Sess., pp. 5–6.

made such representations to Secretary Lamar of the Interior Department, concerning the injustice of excluding settlers and allowing cattlemen to remain, that an order was issued in March 1885 for the removal of the cattle in Oklahoma. The carrying out of this order was long delayed by the plea of the cattlemen that their herds had been crowded for range and were too poor to stand the journey, and it is probable that it was never strictly enforced.[1]

Two raids occurred under the leadership of Couch in 1885. In January he was found at Stillwater with several hundred armed men and a few women and children, living in small excavations in the sand hills on the left bank of the Cimarron river. When Lieutenant Day with a troop of thirty men ordered them to remove, he was met by two hundred men armed with shotguns and Winchesters. Not wishing to precipitate a collision, the Lieutenant sent for reinforcements and arranged his troops so as to cut off supplies and new arrivals who were constantly pouring in. Finally the provisions gave out, and on January 27th the troops closed in and effected a removal.[2]

During the summer a camp of "boomers" was formed near Arkansas City numbering from six to eight hundred, with the avowed intention of crossing the border at the first opportunity. In October and November they entered, headed by Couch, and encamped near Council Grove on the Canadian, but were soon removed by the military with little difficulty.[3] The Gulf, Colorado and Santa Fé railroad having by this time succeeded in getting from Congress a right of way through the territory, Couch now ceased "booming" to take contracts for grading the new line, and although a few people entered Oklahoma every year from 1885 to 1889, there were no more organized raids.[4]

Although a great many petitions for the opening of Oklahoma were received by Congress at each session from the western states, and although several bills concerning it had been in-

1 *Cosmopolitan*, vol. 7, p. 461.

2 Sec. Int. Rept., 1885, vol. 2, pp. 58–60; Sen. Ex. Doc., 50, 48 Cong., 2 Sess., p. 7.

3 Sec. Int. Rept., 1885, vol. 2, pp. 58–60.

4 *Chautauquan*, June 1889, p. 535.

troduced, Congress did not take any real notice of the situation until 1885, when a resolution was passed authorizing the President "to open negotiations with the Creeks, Seminoles and Cherokees for the purpose of opening to settlement under the homestead laws, the unassigned land in Indian Territory." (23 Stats., 384.) President Cleveland did not consider this resolution as obligatory, and believing that such action would not be advisable in the state of affairs then existing, he paid no attention to it.[1] But the demand for opening Oklahoma was not to be stifled in this way. The agitation increased in the western states, floods of petitions poured in upon Congress, and one by one the states passed resolutions in favor of the opening.

As a result of this agitation, a bill was introduced into the House in 1886 to provide a territorial government for Indian Territory and to create a commission to treat with the Indians for opening the vacant land to settlement. A strong opposition to this bill was immediately developed which based its arguments on the idea that the interests of the Indians were not receiving sufficient consideration, and that it would be a violation of their solemn treaties. The influence of the powerful cattle corporations was also exerted against the bill, and it failed of passage after having given occasion to a long debate.[2]

Congressman Springer, chairman of the committee on territories, introduced another bill in Congress in 1888, from which he had endeavored to eliminate the objectionable features of the previous bill. This bill provided for the organization of the territory of Oklahoma out of Indian Territory, excepting the land of the five civilized tribes and including the Public Land Strip. No lands patented to the Indians were to be included nor any Indian rights disparaged. Nevertheless the opposition maintained that to organize Oklahoma into a territory before the clear title had been procured from the Indians, was practically to force them to sell, and in spite of the demands of the western people and the arguments advanced to support the bill, its promoters were unable to push it through.[3]

---

1 *Congressional Record*, vol. 19, p. 6744.
2 Ibid., vol. 17, p. 4064.
3 Ibid., vol. 19, p. 6741.

It having now become evident that Congress would take no step toward opening Oklahoma until arrangements had been made with the Indians, the President, acting under the authorization of 1885, made a treaty with the Creeks on January 19, 1889, by which they agreed to convey to the United States a complete title to the land ceded by the treaty of 1866 in consideration of a little over two million dollars. This arrangement was ratified by act of Congress March 1, 1889 (25 Stats., 735), and was followed by a section tacked on to the Indian appropriation bill of March 2nd (25 Stats., 1004), which appropriated a slightly smaller sum to pay the Seminoles for the lands ceded to them in 1866, and provided for opening to settlement the land thus acquired by proclamation of the President. All of this land was in the possession and occupancy of various Indian tribes, except the one million, eight hundred and eighty-eight thousand acres of Oklahoma proper, and so a proclamation was issued March 23, 1889, defining this area (Tract 16, Plate XII), and declaring it open to homestead settlement after twelve o'clock noon, the twenty-second of April, 1889.[1] At last the dream of the "boomer" was to be realized and he was to be permitted to make a home for himself on government land in the fertile Oklahoma district.

OKLAHOMA OPENED TO SETTLEMENT.

The law under which Oklahoma was opened (25 Stats., 1004) made no provision whatever for the government of the territory. It merely provided that it should become a part of the public domain and be disposed of in accordance with the homestead laws to qualified persons, in areas not to exceed one hundred and sixty acres for each settler. Sections 16 and 36 of each township were reserved for the benefit of the public schools, and it was further provided that anyone who should enter prior to the opening should forfeit the right to homestead any lands thereon. The only jurisdiction of any sort over the district was that of the courts of Texas, Kansas and Arkansas,

[1] Sec. Int. Rept., 1889, vol. 1, pp. 95–103.

in criminal cases punishable by death or hard labor, and of the newly established United States court of Indian Territory with jurisdiction in other offences and civil cases where the amount involved was one hundred dollars or more. Under the act of March 1, 1889 (25 Stats., 784), which created this court, an attorney and United States marshal had been appointed for it, and the latter had been given power to appoint deputies. Under this very defective system there was no law and no one with executive power but a marshal of a distant United States court.[1] In spite of all this, the President and the Secretary of the Interior felt that it would be far better to open up the territory as it was and trust to the innate sense of justice in the American people, than to postpone the opening until proper government could be provided by the next session of Congress and thus disappoint and entail great hardships upon the thousands of people already gathered on the borders of the promised land.

The President's proclamation of March 23rd[2] provided for the establishment of two land offices for Oklahoma, one at Guthrie and one at Kingfisher Stage Station, and registers and receivers for these were immediately appointed. Inspector Pickler was detailed from the General Land Office and proceeded to make arrangements for establishing the Oklahoma offices. The buildings for these offices were made in sections, conveyed into the territory on wagons, and there put together, and on the stated day the land officers were in their places and the offices opened ready for business.[3] The United States marshals appointed a large number of deputies in anticipation of the crowds to come and made arrangements for preserving order among the settlers, and a military force was also detailed by the Secretary of War to keep out the people on the border until the stated time and to assist in preserving order during the opening.

Word had gone forth throughout the United States that Oklahoma was at last to be opened to the homeseeker, and long before the opening day her future population began to

1 Sec. Int. Rept., 1889, vol. 1, pp. iv–v.

2 Ibid., pp. 95–103.

3 Ibid., p. v.

gather on the borders. Those on the north stopped at Arkansas City or Caldwell or camped along the border. Each of these places had its population increased many fold by this great influx of transients, while on the southern border a veritable metropolis sprang up where before was nothing but a railroad station and a water tank. This was at Purcell in the Chickasaw district, just across the Canadian river from Oklahoma.[1] A week before the opening, there were about fifteen hundred prospective settlers at each of the northern cities, and the number grew at a rapidly increasing rate as the time drew near. Together with those at smaller camps and on the southern line, there were on the twenty-second of April at least twenty thousand people waiting for the sound of the bugle which should let them into the coveted territory.

As those on the north would otherwise have been at a serious disadvantage compared to their southern rivals, the authorities decided to permit them to cross the Cherokee Strip after the eighteenth. Consequently most of the outfits moved down from the cities to the line on the seventeenth to get an early start the next day. At a signal blast from a bugle in the morning, the procession started across the strip. Before noon five hundred wagons had crossed the border of the extemporized road near Arkansas City, and more were on the way, and still the city was overflowing.[2] Trains came rolling in every hour filled with prospective settlers from all parts of the Union, and on the morning of the twenty-second most of these gathered around the depot and the five trains drawn up on adjacent tracks ready to make the run, and speculated as to which train would start first. But so great was the crowd that those were lucky who got a place on any of the trains. The platforms were overflowing, some clambered up on top of the coaches, and a few even rode on the car trucks in their anxiety to get there in good season. As the trains moved slowly across the strip, the passengers could see the endless procession of wagons still winding on toward the goal. When the Oklahoma border was reached, the "boomers" were found drawn up in a

1 *Tribune Extras*, vol. 1, no. 7, pp. 21–9.
2 Ibid., pp. 29–30.

line awaiting the sound of the bugle which would give them permission to cross the imaginary line protected by the troops. In the front rank were the best riders of each outfit mounted on their fleetest steeds, and behind were the "prairie schooners" and mule teams with the families and outfits driven by the "boomers'" wives.[1]

At exactly twelve the blast from the bugle rent the air, an exultant shout came forth from the throats of the waiting "boomers," the quivering steeds sprang over the line, and the race for homes was on. One by one the reckless riders disappeared over the crest of a hill, closely followed by buggies and buckboards with the rear brought up by the heavy wagons and outfits, so that the spot where thousands had been camped during the forenoon was practically deserted within half an hour after the first man crossed the line.[2] The land had been surveyed and laid out in mile-square sections with the corners marked by stones or blazed trees, and each settler was to be allowed to "squat" on a quarter of one of these sections. Frequently it would happen that several would locate on different parts of the same quarter-section. Each would claim priority, and each would make improvements, and thus the way was prepared for much litigation and bad feeling, often leading to family feuds and twilight shootings.[3]

Meanwhile, the first train from the north which had also crossed the border at the blast of the bugle had pushed on to Guthrie, the spot where one of the land offices was located. When this train arrived, at half-past one, all there was of the future capital of Oklahoma was the railroad water-tank, a small station house, a shanty for the express company, and the government land office, a building about twenty by forty feet and located five hundred feet from the depot on the brow of a gentle rise stretching eastward from the tract. A town-site company had already been organized[4] by a few enterprising

---

1 *Cosmopolitan*, vol. 7, p. 461.

2 Ibid., vol. 7, p. 461.

3 *Atlantic Monthly*, vol. 86, p. 329.

4 Under the homestead laws a town-site company is permitted to survey and lay out in lots a district not larger than half a section,

deputy-marshals, railroad men and their friends, several hundred acres of town-site had been staked out, and a few tents erected near the land office to hold the claim. But the people from the train soon grasped the situation, and no attention was paid to the rights and privileges of the deputy marshals and their friends. The passengers made their exit from the cars through the windows or any other convenient openings and scrambled pell-mell up the hillside in the wild race for town lots. Everything was in confusion, no one seemed to know where the streets were going to run or where he wanted to drive his stakes. The race was not over when a lot was staked out, for improvements had to be made in the shape of a little tent or wooden shanty. Many hired an enterprising man with a plow, who appeared on the scene, to mark out their lots with a furrow, but as eternal vigilance is the price of liberty, so was it the price of a town-lot in Guthrie that day, and the surest way to prevent a claim from being jumped was to guard it with a loaded revolver.[1]

At the close of the first day Guthrie was a city of nearly a thousand tents and several thousand inhabitants, but in a short time many of these tents were superseded by small frame structures and the city began to assume a more permanent aspect. The first few days were largely spent in wrangling over lots and in contentions between the different town-site companies. The representatives of the various companies finally got together and appointed a committee to adjust matters, and this committee went around from lot to lot taking evidence and pronouncing judgment as to the rightful possessor of the lot. Although their decisions were not always accepted, it quieted matters somewhat, and before the city was a week old the savage and ferocious "boomer" with knives and pistols sticking out all over him had quietly tucked his revolver away in his satchel and appeared as a plain, ordinary, everyday grocer, butcher, or real estate man.[2] The organization of a

and these lots, with certain reservations excepted, are then open to homestead settlement.

1 *Cosmopolitan*, vol. 7, p. 461.

2 Ibid.

municipal government began on the very first night, when the roll of the states was called and a representative governing committee appointed. The next day this committee was endorsed by *viva voce* vote of the people, and they proceeded to the election of a mayor. Two candidates were put up, and the adherents of each formed in line four abreast and marched past a definite point to be counted; but it was soon discovered that an ingenious system of repeating was being used, and the election nearly broke up in a row. Finally the two candidates picked out a committee of six who added a seventh to their number, constituted themselves a nominating board and presented the name of Col. D. B. Dyer to the people for mayor. He was unanimously elected and at once turned all his energies to the organization of the young municipality.[1]

Among the other disagreeable features of Guthrie life during the first few days was the scarcity of food and water. The one eating tent was continually overflowing, although the rate was five dollars per meal. The water in the Cimarron river was brackish and practically unfit to drink, and crowds hung around the railroad tank which was guarded by soldiers. To add to the unpleasantness, a sand storm arose on the third day and covered everything with the fine sand of the prairie. Many became disgusted with the situation and decided to pull out at the first opportunity; but they found nearly as much difficulty in doing so as they had in getting in. At one time it seemed as if the city would be depopulated, and lots which had previously changed hands at fancy prices went begging at five dollars. But this lasted only for a few days. The places of those who left were rapidly filled by newcomers, provisions soon became more plentiful, and the town settled down to a steady growth and development.[2]

One hundred days after its settlement Guthrie presented the appearance of an ordinary western metropolis, with its streets and alleys, stores, parks, boulevards and fine iron bridges. An excellent electric light system was in operation and the contract

1 *Tribune Extras*, vol. 1, no. 7, p. 43; *Cosmopolitan*, vol. 7, p. 468.

2 *Tribune Extras*, vol. 1, no. 7, pp. 39–42.

let for a street railway. It had a population of about fifteen thousand, most of whom were men who had not yet brought their families. There were about four thousand houses in the course of construction and several hundred tents still scattered through the suburbs. The city boasted five banks, fifteen hotels, three music halls, fifty grocery stores and six printing offices with three daily papers. The price of lots had risen from five hundred dollars a few weeks before the opening, to between two and five thousand dollars, and Guthrie was well started on the fair road to prosperity.[1]

The other metropolis of Oklahoma, and the rival of Guthrie, was Oklahoma City, located about thirty miles further south on the north fork of the Canadian. This place was settled largely by the "boomers" from the south who had occupied Purcell and Beaver City, and who seem to have had a larger proportion of speculators, confidence men and other lawless characters in their ranks than those from the north.[2] Therefore the events attending the settlement of this site, though much the same as those at Guthrie, were somewhat more disorderly, and but for the presence of the United States troops, serious collisions might have taken place. The troops, which were under the command of Brigadier-General Merrit, and later of Captain Styles, were stationed at Oklahoma City to preserve the peace and assist the marshals in carrying out their orders, but the situation was such that the military took entire charge of the city until the sixth of May and practically controlled the situation all summer.

On April 21st, Brigadier-General Merrit issued a proclamation announcing that the presence of the troops was to protect the United States government property and mails, and to guard the people from lawlessness and disorder.[3] Soon after noon on the twenty-second the scramble for town lots began. The military officials were constantly forced to interfere to prevent the honest settlers from being bulldozed out of their rights and to settle rows and street fights, and it was not always possible to

1 *Cosmopolitan*, vol. 7, p. 468.

2 *Tribune Extras*, vol. 1, no. 7, pp. 23–29.

3 Sen. Ex. Doc., 72, 51 Cong., 2 Sess., p. 22.

get a marshal from whom proper authority could be obtained. In fact, many of the marshals sympathized with the worst elements in the crowd. On the twenty-third of April, the only pump in town was taken possession of by a Chicago gambler named Cole, who demanded five cents for every drink and enforced his demands with a revolver. He was soon removed by the military authorities. They were also continually called upon to protect a settler who had homesteaded the claim just west of the city on which the crowd was determined to lay out a town-site.[1]

On the twenty-sixth of April a call was issued signed by a dozen citizens of Oklahoma City for a mass-meeting on the next day to organize a municipal government. At this meeting it was decided to elect a temporary mayor who should make arrangements for a regular election on the first of May. W. L. Couch was unanimously elected. On May 1st, a regular ballot election was held and Couch was again elected, according to the books of the city recorder. At the time the election was accepted in good faith as the expression of the will of the people, but later it was questioned by many. The new government was installed on the sixth of May and the military officials resigned their control to it, but it was absolutely powerless without their aid in enforcing its orders, and until August 5th a guard of from five to fourteen men was sent to town from the camp every day. After that until October 21st, from two to four men were sent. During this period several attempts were made to displace the city officials by holding new unauthorized elections, but as the established government was always supported by the military authorities, these were all failures. The action of the military officials throughout seems to have been approved by all the better and more solid citizens of the new community, who desired a stable government, but it was late in the fall before the disturbing elements were finally quelled and the city settled down to a regular life.[2]

Several other cities were laid out and settled in Oklahoma on

1 Sen. Ex. Doc., 72, 51 Cong., 2 Sess., pp. 30–38.

2 Ibid., pp. 22–30.

that memorable opening day, the principal ones being Kingfisher, where the other land office was located, and Norman, which later became the site of the territorial university. At each of these places the scenes and events of the first few days at Guthrie and Oklahoma City were reproduced on a smaller scale. Outside of the cities, practically all of the available land was taken up by would-be farmers during the course of a few days.[1] The opening was too late in the spring for the farmers to do much in the way of crops the first year, and so most of them proceeded to build rude houses and make themselves comfortable in their new home when not putting in their time quarreling over the title to their quarter-sections. Although a great many of those who took up homesteads were farmers who wished to better their conditions, there was also a large proportion of people from the other walks of life, who, having won a quarter-section in the rush, were forced to live on it and turn farmers in order to prove up their claims. The demand for land was so great that the sections reserved for the benefit of the schools were readily rented during the year.

Perhaps the most noticeable thing about the first opening in Oklahoma was the imbecile policy or lack of policy of the government in regard to it, which led to so much confusion, illegality, corruption and future litigation. Although the Interior department can not be blamed for the failure of Congress to provide suitable legislation, it still would seem that more care should have been exercised in providing men of integrity for marshals and for receivers and registers at the land offices. The district was supposed to have been cleared of every intruder the day before the opening, and the law provided that "sooners" should not be allowed to homestead claims; nevertheless when the first honest settlers who crossed the line at noon reached the interior, they found many of the best claims all staked out and in possession of men who had spent the night hidden in the cracks of the earth or among the bushes along the rivers.[2]

The greatest amount of corruption seems to have been at

---

1 Sec. Int. Rept., 1891, vol. 3, p. 450.

2 *Atlantic Monthly*, vol. 86, p. 329.

Guthrie, where a veritable conspiracy was planned by the marshals and their friends. Some of the marshals used their appointive power to make deputies of all their friends and relatives, and each one of these registered a choice claim when the land office was opened at noon. Many of the most valuable claims around the site of Guthrie were filed on by relatives and friends of the register at the Guthrie office, who afterward admitted that he knew they were in the territory before the opening and had thereby sacrificed their rights to make entry.[1] The attempted looting of the town-site of Guthrie by the "sooners" and their official friends has already been referred to, and the way in which their plans were in a measure defeated by the rush of honest homeseekers. A great deal of confusion in regard to town-sites was due to a defect in the law. The act of March 2, 1889, provided that town-site entries might be permitted after the opening, in accordance with sections 2387 and 2388 of the revised statutes; but these sections provide that application should be made through certain town or county officers, and there were no such in Oklahoma nor any power to create them. So nothing could be settled without further legislation, and the land officers were instructed simply to receive all applications for town-sites and report them to the general office without taking any action.[2]

As soon as the Interior department became aware of the situation in Oklahoma a commission was sent out to investigate, and it reported in June 1890 that a great number of town lots and other claims were in the possession of "sooners" who had been in the territory previous to the opening. These had secured their certificates and in some cases had sold them to others who were now claiming the lots. The department was kept busy for a long time settling contested claims, and although justice in every case was not to be expected, an effort seems to have been made to get at the true situation and deprive the "sooners" of their unjust possessions. A ruling of the department to the effect that the provision in regard to homesteading by those

---

1 House Ex. Doc., 209, 51 Cong., 1 Sess.

2 Sec. Int. Rept., 1889, vol. 1, p. vii.

who were in the territory prior to the opening applied as well to those who were legally there as to intruders, deprived many of the deputy marshals and railroad employes of their easily gotten claims.[1]

The people who settled Oklahoma were for over a year entirely without any law or organized government excepting that established by common consent. Finally, in May 1890, an act was passed by Congress (26 Stats., 80) organizing them into a territory. This act provided that "all that portion of the United States now known as the Indian Territory, except so much as is actually occupied by the five civilized tribes, and the Indian tribes within the Quapaw Agency, and except the unoccupied part of the Cherokee Outlet, together with that portion of the United States known as the Public Land Strip, is hereby erected into a temporary government by the name of the Territory of Oklahoma." It was further provided that the Cherokee Outlet should become a portion of the territory without further legislation as soon as the Indian title should be extinguished, and also that any other lands in Indian Territory might thereafter become a part of Oklahoma whenever the Indian tribes owning such lands should signify their assent.

The act established seven counties in the territory, numbered from one to six in Oklahoma proper, the seventh being Beaver county in the Public Land Strip, and county seats were designated for each. The laws of Nebraska, such as were not locally inapplicable, were extended over Oklahoma until the legislature should have an opportunity to frame a new code. All lands in the Public Land Strip were declared open to settlement and a land office was established at Beaver, but preference was to be given to "all actual and bona fide settlers upon and occupants of the land" at the time of the passage of the act. Another act of the fourteenth of May (26 Stats., 109) relieved the town-site situation by providing for the establishment of a commission to take the place of the regular officers as trustees for the town-site.

On the fifteenth of May 1890, George W. Steele was ap-

---

[1] Sec. Int. Rept., 1890, vol. 1, p. xix.

pointed first governor of the territory of Oklahoma, and on the twenty-second he assumed the duties of his office. These consisted at first in defining the boundaries of the counties, organizing county governments and appointing officers to carry out the provisions of the laws of Nebraska. A census enumeration was immediately taken which disclosed a population of over sixty thousand. On the basis of this, the territory was apportioned into districts for legislative purposes, and on the fifth of August 1890 an election was held for members of the first legislative assembly. This assembly met August 27th, and after spending the greater part of the session of a hundred days in quarreling over the location of the capital, finally enacted a fair code of laws to take the place of the Nebraska code. The organization of the government in this youthful territory was now fairly complete, and it continued to run with very little friction.[1]

Many things combined to make the first two years in Oklahoma especially hard ones for the farmers on their new claims. Large numbers of them had already failed in western Kansas or northwestern Texas on account of drought or had been waiting on the borders of the country until their resources had been exhausted. When we add to all this the fact that the opening was too late for any crops to be raised in 1889, it can readily be seen how dependent the farming population must have been on the results of the harvest of 1890. But through some strange freak of fate an unexampled drought occurred in that year which was almost fatal to the first crops throughout the new territory. Under such circumstances it was but to be expected that destitution and suffering would be prevalent among Oklahoma's ill-fated citizens, and urgent measures of relief were necessary. The governor made an appeal to Congress, and on the first of September a resolution was passed (26 Stats., 679) appropriating a generous sum for relieving the destitute in the new territory. The Atchison, Topeka and Santa Fé, and the Chicago and Rock Island railroads did their share toward relieving the situation

1 Sec. Int. Rept., 1891, vol. 3, pp. 449–450.

by furnishing seed wheat to the farmers at actual cost without transportation charge, to be paid for out of the crop without interest. With this help and that of favorable weather conditions, abundant crops were produced in all lines in 1891, and the farmers were well started on the road to prosperity.[1]

THE CHEROKEE STRIP AND OTHER OPENINGS.

The act of March 2, 1889 (25 Stats., 1004), by which Oklahoma proper was opened to settlement, also established a commission of three members to be appointed by the President to negotiate with the Cherokees and all other Indians owning or claiming land west of the ninety-sixth parallel in Indian Territory, for the cession of all title in such lands to the United States. This body, known as the Cherokee commission, proceeded at once to negotiate treaties or agreements with the Iowas, May 20, the Sacs and Foxes, June 12, the Pottawatomies and Absentee Shawnees, June 25 and 26, and the Cheyennes and Arapahoes, October 18, 1890. By these treaties the several tribes agreed to take up land in severalty and to relinquish to the United States the remainder of their reservations, Tracts 2, 4, 7 and 13, Plate XII.

By an act of Congress of February 13, 1891 (26 Stats., 749), the Iowa and Sac and Fox agreements were ratified and the President was authorized to open the land to settlement. Another act of March 3rd (26 Stats., 1016) ratified the agreements with the Pottawatomies and Shawnees, and the Cheyennes and Arapahoes, and appropriated nearly three million dollars to pay the Chickasaws and Choctaws, who also had a claim over part of the Cheyenne and Arapahoe reservation, for all interest in the lands ceded by them in trust to the United States in 1866.

The allotments to the Indians having been completed in all these reservations except the Cheyenne and Arapahoe, the President issued a proclamation September 18, 1891, opening the remaining nine hundred and forty-one thousand acres of the

1 Sec. Int. Rept., 1891, vol. 3, pp. 450–451.

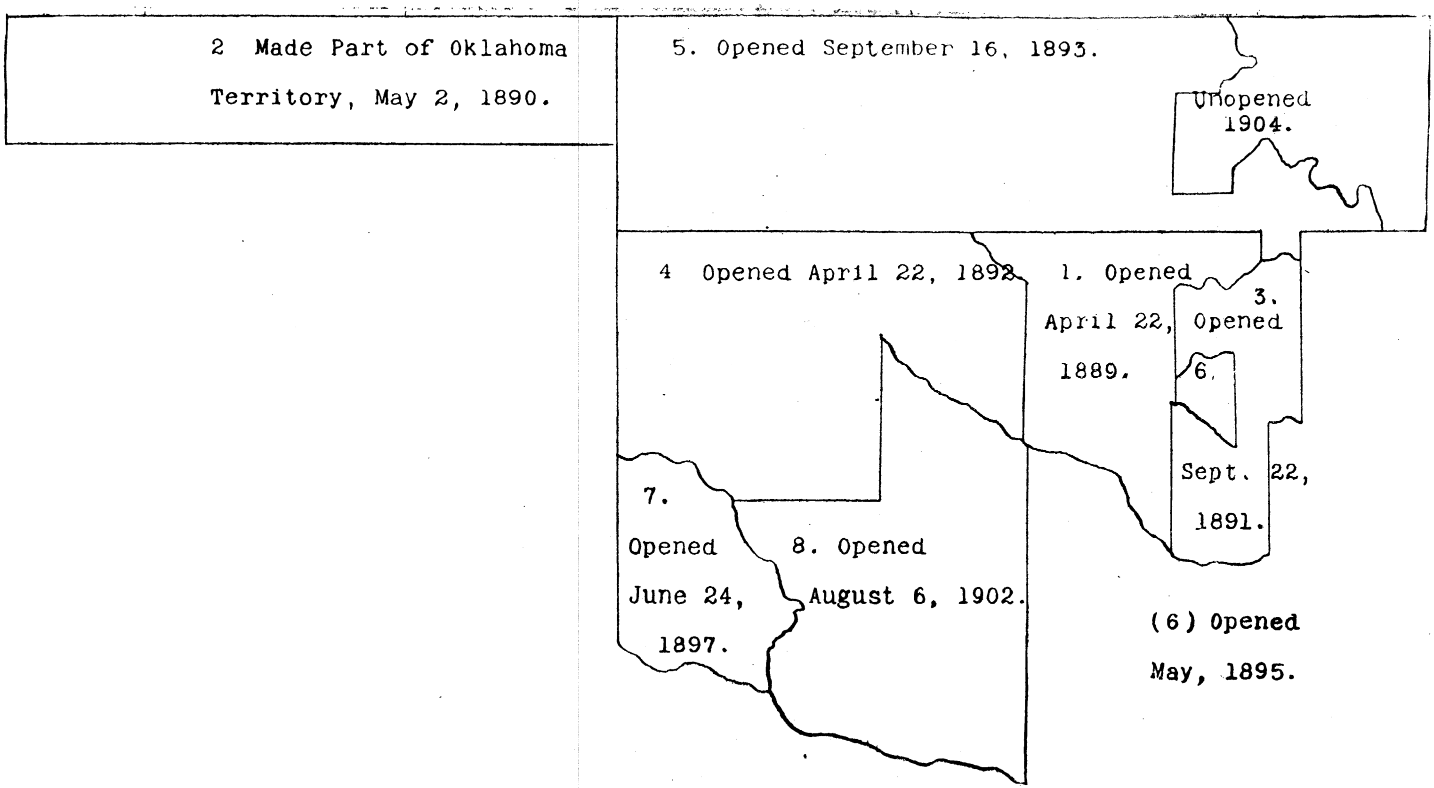
Iowa, Sac and Fox, and Pottawatomie and Shawnee reservations to settlement after twelve o'clock noon, September 22nd.[1] All lands in Oklahoma had been free to homesteaders up to this time, but the act of May 2, 1890, which organized the territory, provided that when any lands purchased from the Indians should thereafter be opened, the settler should pay the United States a sum per acre equal to the amount paid by the United States to extinguish the Indian title but in no case less than a dollar and a quarter. In accordance with this law, the homesteaders on these newly-opened lands were obliged to pay from a dollar and a quarter to a dollar and a half per acre for their farms. This act also provided that "no person who shall at the time be seized in fee simple of one hundred and sixty acres of land in any state or territory, shall hereafter be entitled to enter land in said Territory of Oklahoma."

In spite of these restrictions, twenty thousand people gathered on the borders of the reservation in anticipation of the opening, and when the signal was given the rush which took place was similar to that of 1889. Every available quarter-section was taken for a homestead before sunset of the opening day.[2] Reservations had been made for county-seats at Tecumseh and Chandler, and when these were opened during the next few days the usual wild scramble for lots took place. There were five thousand people awaiting the signal to enter and only twenty-four hundred lots at each place. A great many speculators and others who had no intention of settling on the site took part in the rush and then sold their claims to lots to the honest settlers who wished to make homes on them. The evils of this system of opening town-sites were so great that the Secretary of the Interior recommended that in future openings the lots should be sold by the government at a low valuation.[3] However, with the advantage of a territorial organization already established, and with careful management on the part of the officers, the second opening in Oklahoma was on the whole

1 Sec. Int. Rept., 1891, vol. 1, p. iv.

2 Ibid.

3 Ibid., vol. 3, p. 453.



OKLAHOMA TERRITORY; THE OPENINGS.

successfully carried out, and the former reservations soon became an integral part of the territory.[1]

It had been the intention of the Interior department to open the Cheyenne and Arapahoe reservations at the same time as the others which had been ceded, but delay had occurred in assigning the allotments to the Indians. Although they had agreed to take up land in severalty, when the time came they at first refused to act, and then, when finally induced to fulfill their part of the agreement, the supply of money for it ran short.[2] However, the difficulties were all settled by spring, and on April 12, 1892, the President issued a proclamation opening to settlement at twelve o'clock noon, April 22nd, the three million acres remaining after the Indian allotments had been made. This reservation (Tract 4, Plate XII), lying as it does in the same belt as drought-stricken western Kansas, was looked upon with suspicion by the people of the Southwest. However, the eastern part was nearly all taken up during the summer, and quite a number of successful farms were located in the western part, which proved to be a fairly good agricultural region.[3]

When the Cherokee commission was established, it was authorized to offer to the Cherokees for their Outlet the same terms as those upon which the Creeks had given up their western claims, that is a dollar and a quarter per acre, deducting all previous payments. The Indians, however, did not look with favor upon this proposition, as they were already getting a good income from the cattle leases and the corporations were offering to make a new fifteen year lease at a much higher rate.[4] In order to get rid of this competition, the Department of the Interior decided to consider these leases as invalid, and on the seventeenth of February, 1890, a proclamation was issued ordering that all live stock be removed from the Strip before October 1st. The time was afterwards extended to November 1st, and then

1 Sec. Int. Rept., 1891, vol. 1, p. iv.

2 Ibid., p. v.

3 Ibid., 1892, vol. 3, p. 474.

4 Ibid., 1889, vol. 1, p. xiii.

later to December 1st.[1] But the Cherokees still held out, and it was not until December 19, 1891, that an agreement was finally ratified by their Council by which they were to receive eight and a half million dollars for their interest in the six million acres of the Outlet. Agreements had also been made with the Tonkawas or Nez Percés, October 21, 1891, and with the Pawnees, November 21, 1891, for allotments and the cession of the surplus. These, together with the unassigned part of the Cherokee Outlet, made 6,361,135 acres in all, to be opened to settlement.

On March 3, 1893, Congress passed an act (26 Stats., 640) ratifying these agreements, with some slight changes in that with the Cherokees, and providing for the opening of the land to homesteaders at a price ranging from one dollar to two and a half dollars, according to location. This act contained an important innovation, in that it provided that "no person shall be permitted to occupy or enter upon any of the lands herein referred to, except in the manner prescribed by the proclamation of the President opening the same to settlement. . . . The Secretary of the Interior shall, under the direction of the President, prescribe rules and regulations, not inconsistent with this act, for the occupation and settlement of said lands, to be incorporated in the proclamation of the President, which shall be issued at least twenty days before the time fixed for the opening of said lands." The changes in their agreement were formally accepted by the Cherokees on the seventeenth of May, and on August 19, 1893, the President issued his proclamation.[2] It provided for a system of certificates for would-be settlers, by which speculators and unqualified persons were to be kept from occupying claims and then selling them to homesteaders as had occurred in the other openings.

A narrow strip all around the Outlet was to be open to temporary occupation beginning September 11, 1893, and on this strip nine booths were to be established, five on the north and

1 Sec. Int. Rept., vol. 1, p. xxxvi; 1891, vol. 1, p. clvi.

2 Ibid., 1893, vol. 1, p. x.

four on the south. These booths were to be kept open ten hours daily from September 11th until discontinued, and every person who desired to enter was to be required to appear at one of the booths and make a declaration in writing before one of the officers, showing his qualifications to initiate a claim. A certificate was then to be issued entitling the holder to enter after the opening, and the military officials who guarded the line were to let no one in without such certificates until the booths were discontinued. The certificates were to be issued in different forms for homestead and for town lot entry.[1]

The opening of the Outlet had been so extensively advertised by the railroad companies and the public press, that when the booths were opened, the rush for certificates was so great as to necessitate the employment of additional help and the erection of new booths; but although the number of applicants vastly exceeded the expectations of the officials, all those who were qualified were supplied with certificates before the hour of opening. There was considerable suffering at times among the thousands who were waiting to register, on account of the intense heat and stifling dust. Then, too, when twenty thousand people crowded around a single booth the water supply often ran short, for it was impossible to locate all the booths at places at once suitable for entry and provided with a sufficient supply of water. But aside from these unavoidable hardships, the plan was carried to a successful conclusion, and prevented to a large extent the wrongful occupation which had marred the first opening.[2]

Twelve o'clock noon, the sixteenth of September, 1893, was fixed as the opening hour, and at that time an area larger than many of the states was added to the public domain. One hundred and fifteen thousand certificates had been issued from the different booths, and it is presumable that at least one hundred thousand people took part in this, the wildest and most exciting run for homes that ever took place. The fertile eastern half of the Strip and the Pawnee and Nez Percés reservations

1 Sec. Int. Rept., 1893, vol. 1, pp. x–xi.

2 Ibid., p. xi.

were completely occupied before sunset, and large numbers overflowed into the drier western parts.[1]

The Governor of the territory says in his report for 1893 that although the booth system did a vast amount of good in keeping out illegal claimants, there was still, in spite of all the faithful officials could do, a large number of "sooners" who took possession of some of the best land and lots.[2] The Secretary of the Interior also reported that, "while the opening of the Strip last September was relieved of many difficulties by the regulations legally made, yet it must be confessed that the manner of entry was not satisfactory."[3]

The act under which this region was opened authorized the President and the Secretary of the Interior to divide it into counties and to establish one or more new land districts at their discretion. Acting under this authority, the Secretary divided the region into seven counties, two large ones in the western part and five smaller ones in the eastern, while Payne county in original Oklahoma was given an extension in the Outlet. Three land districts were established with offices at Alva, Enid and Perry, and the Beaver district was extended to include the western county, the office being moved to Woodward. The Secretary also reserved about half a section in the center of each county for county seats, and these were settled in the same manner as Tecumseh and Chandler had been, except that the system of certificates acted as a check on speculation. Sometimes the speculators started rival towns near the established ones, and, when they could get the favor of the railroad, were able seriously to embarrass the development of the official sites.[4] But these were only minor difficulties and did not affect the general development of the Strip, which went on so rapidly that within a year the population and resources of Oklahoma had been doubled.

---

1 Sec. Int. Rept., 1893, vol. 3, p. 460.

2 Ibid.

3 Ibid.

4 Ibid., vol. 1, p. xii.

A DECADE OF GROWTH.

After the opening of the Cherokee Strip in 1893, the territory of Oklahoma enjoyed a decade of steady, rapid growth, with but one period of boom when the Wichita and the Kiowa, Comanche and Apache reservations were settled in 1901. During this period the population advanced from two hundred and fifty thousand in 1894 to five hundred and fifty thousand in 1902, the valuation of taxable property in the same period from $19,948,000 to $72,677,000, and the amount of occupied land from 7,870,000 acres to 17,230,000 acres. Besides the opening mentioned above, which will be discussed later, the Kickapoo Indian reservation (Tract 14, Plate XII) was made available to settlement in May 1895. The agreement with the Kickapoos had been made June 21, 1891, but was not ratified by Congress until March 3, 1893 (27 Stats., 557). After the Indian allotments had been made, the territorial government selected about one hundred thousand acres of this land as indemnity school land in lieu of that which was lost by being in the Osage Indian reservation, and this left only about fifty thousand acres open to homestead settlement, enough for some three hundred farms. But the school land was rapidly leased out, and the reservation was soon all under cultivation.[1]

The next addition to the jurisdiction of Oklahoma Territory was made in March, 1896, when the Supreme Court finally decided the dispute over Greer county in favor of the United States. The Chickasaw and Choctaw Indians had also advanced a claim to interest in this district, so the President, in order to prevent complications, issued a proclamation declaring the land in this region to be not yet open to settlement.[2] The claim of the Indians having proved to be without foundation, Congress passed an act on January 18, 1897 (25 Stats., 490), providing for the opening of the land. Preference was to be given to all actual settlers and occupants at the time of the pas-

[1] Sec. Int. Rept., 1895, vol. 3, p. 524.

[2] Ibid., 1896, vol. 1, p. 108.

sage of the act, who were also to be allowed to purchase land already in use in addition to the one hundred and sixty acre homestead at one dollar per acre. Sections 16 and 36 of each township were as usual reserved for the public schools, and also sections 13 and 23 for such purposes as the legislature of the "future state of Oklahoma may prescribe." The intention probably was that these should be used for the benefit of higher institutions of learning. Under this act the county was opened to settlement on the twenty-fourth of June, 1897. A land office was established at Mangum, and the land was gradually taken up.[1]

Because of physical conditions, such as soil and situation, Oklahoma is, for the present at least, primarily an agricultural region, and so the settlement of the territory can best be traced in the occupation of the land. For this purpose, the following table, which shows the percentage of the available or unreserved land occupied in each county from 1894 to 1902, has been compiled from the reports of the General Land Office.

Table showing percentage of unreserved land occupied in each county from 1894 to 1902.

	1894	1895	1896	1897	1898	1899	1900	1901	1902
Beaver	4	5	5	11	12	12	13	14	17
Blaine	89	92	96	96	94	95	99	100	99
Caddo	......	......	......	......	......	......	......	......	99
Canadian	99	99	99	99	99	99	99	100	99
Cleveland	100	100	100	100	100	100	100	100	100
Comanche	......	......	......	......	......	......	......	......	99
Custer	58	63	72	74	80	91	92	99	99
Day	1	3	3	5	6	15	22	47	68
Dewey	22	32	38	40	49	69	84	97	96
Garfield	99	100	100	99	100	100	100	100	100
Grant	98	99	99	99	99	99	99	99	99
Greer	......	......	......	12	66	69	73	85	95
Kay	99	99	99	100	100	100	100	100	100
Kingfisher	99	99	99	99	99	99	99	100	99
Kiowa	......	......	......	......	......	......	......	......	99
Lincoln	100	99	99	99	99	99	99	99	99
Logan	100	100	100	100	100	100	100	100	100
Noble	99	99	99	100	100	100	100	100	100
Oklahoma	100	100	100	100	100	100	100	100	100
Pawnee	95	98	97	99	99	99	99	99	99
Payne	99	100	99	99	100	100	100	100	100
Pottawatomie	100	100	100	100	100	100	100	100	100
Roger Mills	42	44	45	46	72	74	79	81	96
Washita	75	85	87	88	96	99	99	99	99
Woods	60	67	71	74	78	87	92	97	99
Woodward	6	8	10	25	28	31	40	66	83
Oklahoma as a whole	51	54	55	54	60	64	67	74	82

1 Sec. Int. Rept., 1897, vol. 1, pp. 99–102, 125.

The first thing noticeable about this table is that in 1894, the year after the Cherokee Outlet was opened, practically all of the available land east of the western line of Grant, Garfield, Kingfisher and Canadian counties (see Plate XIV) was taken up, the percentage being ninety-eight or above in every county except Pawnee, where it was ninety-five. Indeed, this land was not only all taken up in 1894, but its occupation was practically contemporaneous with its opening and often there were two or even three qualified entrymen for each quarter-section. This great demand for land in eastern Oklahoma illustrates the fact, which the American people are gradually beginning to comprehend, that we have at last taken complete possession of our apparently unlimited heritage, that the frontier, so famous in American history, has finally disappeared, and that further agricultural development must be intensive rather than extensive.[1]

In western Oklahoma, we find in 1894, Greer, Caddo, Comanche and Kiowa counties not yet being opened, a percentage of occupied land running from about five in Beaver, Woodward and Day, to eighty-nine in Blaine, and averaging fifty in the intervening counties. It will be seen that the westward advance is greater in the southern counties, so that the lines of equal settlement would run from northeast to southwest. The first of the western counties to join the ranks of those whose settlement was practically complete, which for convenience we may consider to be when ninety-five per cent of the land is occupied, was Blaine, which rose from eighty-nine per cent in 1894 to ninety-six per cent in 1896; and this was soon followed by Washita, which advanced from seventy-five per cent in 1894 to ninety-six per cent in 1898.

Previous to 1898, the advance in the next tier of counties, Woods, Dewey and Custer, had been slow though gradual; but with the occupation of all available land in Blaine and Washita, these counties began to take rapid strides, and in 1901 all three joined the column of settled counties. The increase in the rate of settlement all along the line in the years from 1900

[1] Sec. Int. Rept., 1891, vol. 1, p. 49.

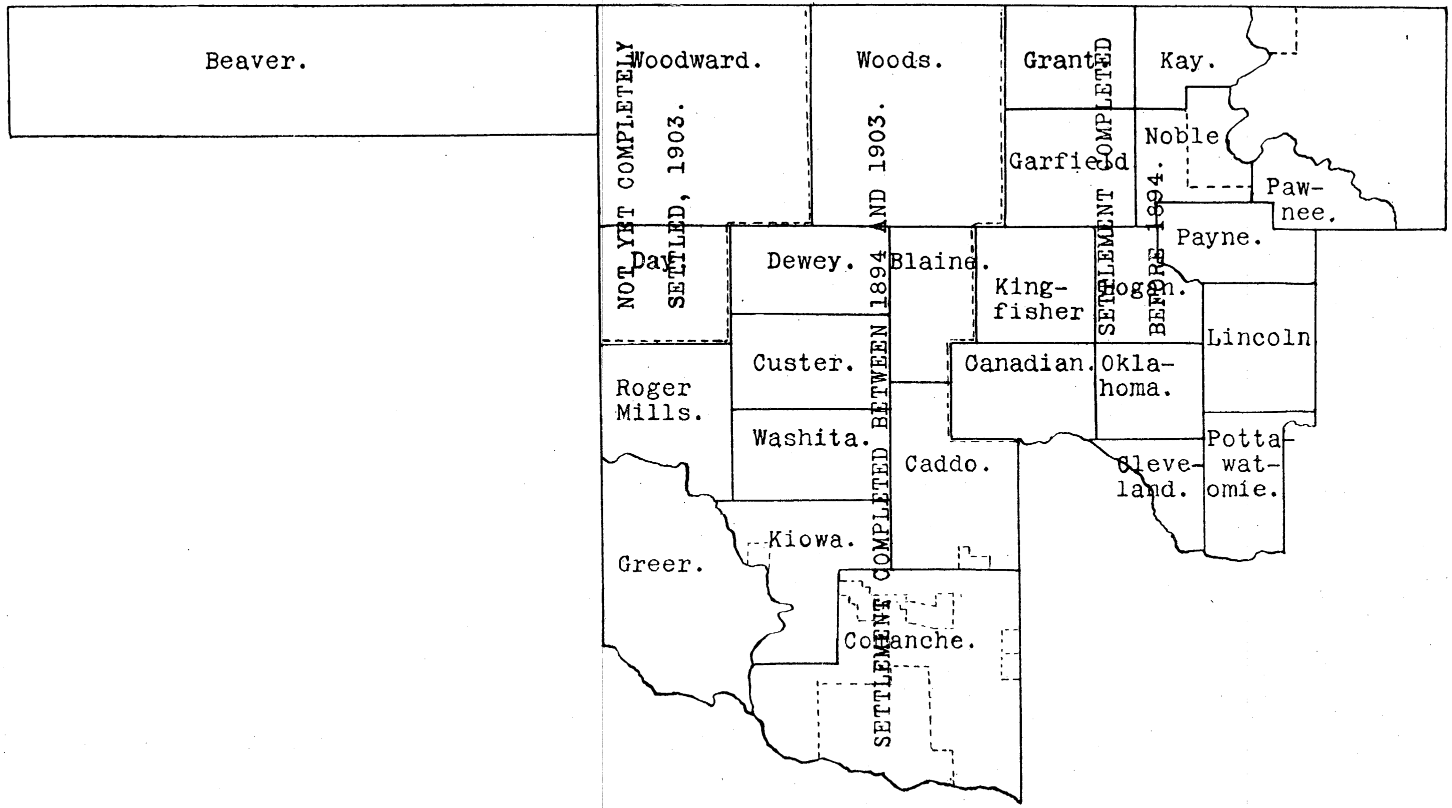
on was due to several different things. In the first place, the territory enjoyed exceptionally abundant harvests in 1899 and 1900, and this prosperity of the Oklahoma farmers was extensively advertised throughout the Union by the different advancement associations and railroads interested. Each summer the railroads ran frequent homeseekers' excursions at very low rates, bringing thousands of people into the country, many of whom remained. Moreover, the old fashioned mode of migration had not become obsolete, for, as the Governor reports in 1898, "not a day during the year but the white-topped prairie schooner can be seen wending its way from north, south, east or west toward a new abiding place in Oklahoma."[1]

Another cause of the increased rate of settlement in western Oklahoma in these years was the ultimate success of the agitation for free homes. As has been shown, a price of at least a dollar and a quarter per acre was charged of homesteaders on all land in Oklahoma except that included in the first opening of 1889 and in the Public Land Strip. The settlers of the territory were unanimous in feeling that this was an unjust discrimination, since the public domain had hitherto been free to homesteaders, and as early as 1892 local organizations were formed to agitate the subject. In 1894 the Republican party in the territory took up the cause and elected Hon. D. T. Flynn delegate to Congress to urge the issue, which he did, declaring that the people were entitled to free homes as a matter of right and justice. In 1895 a free homes convention was held at Perry, and a league was organized to carry on the work. The legislature of the territory appropriated five hundred dollars to further the objects of the league and to secure the desired legislation. In 1896 the agitation became general, and each of the three leading national party platforms declared for free homes on all public land. Even then, when success seemed assured, the efforts of all the congressmen from the public land states failed to secure its passage by both houses until May 14, 1900.[2]

---

[1] Int. Dept., Misc. Repts., 1898, p. 726.

[2] Ibid., 1901, pt. 2, p. 402.



OKLAHOMA TERRITORY; THE ADVANCE OF SETTLEMENT.

The passage of this act was beneficial to Oklahoma in diverse ways. The full payment had not been required until the final proving up of a claim, and the many thousands of farmers who had not yet made final proof found themselves suddenly from one to three hundred dollars richer. The Governor estimated that this act saved to the homesteaders in Oklahoma about fifteen million dollars, nearly all of which made its appearance in new houses and barns, additional stock and other improvements, and thus contributed materially to the general prosperity of the territory. Another result was the attraction of immigration to the western part of the territory, where many farmers who had hesitated to take up land at a dollar and a quarter per acre were now eager to settle when all price was removed.[1]

In the summer of 1901, the three counties of Caddo, Kiowa and Comanche were opened to settlement and, as may be seen by the table for 1902, entirely settled within a year. In fact, owing to the system employed by the government, one hundred and sixty-four thousand people were attracted to this opening, and as there were homesteads for only thirteen thousand in the reservations to be opened, there were one hundred and fifty-one thousand disappointed people left in the territory.[2] Most of these had come prepared to stay, so large numbers merely went west to the counties of Roger Mills and Greer, and filed on nearly all of the remaining land there. Woodward and Day also made a big advance in this year, and even in Beaver the rate of settlement increased considerably.

At present, then, we have practically all available land in Oklahoma occupied except in the three northwestern counties of Beaver, Woodward and Day, where the remaining land is suited only to grazing and is now used by unauthorized stock-raisers. An agitation has been going on for some time to bring about some different disposition of this land, the Governor having at times recommended that it be leased to the cattlemen or donated to the territory,[3] and again that it be opened to

---

1 Int. Dept., Misc. Repts., 1901, pt. 2, p. 402.

2 Sec. Int. Rept., 1901, p. lxxxvi.

3 Int. Dept., Misc. Repts., 1897, p. 682.

homesteaders in whole sections, so that the settler can have enough land to engage in cattle-raising with profit.[1] Should the latter suggestion be followed, the land in these counties will probably soon be taken up, but otherwise, little further occupation can be expected until some feasible means of irrigation is discovered.

THE GOVERNMENT'S LAND LOTTERY.

The last opening of Indian reservations in Oklahoma Territory took place in the summer of 1901, when the reservations formerly occupied by the Wichita and the Kiowa, Comanche and Apache tribes (Tracts 3 and 8, Plate XII) were given over to white settlement. The Wichita reservation (Tract 8) had been treated for by the Cherokee commission, June 4, 1891, and at the time of the Cheyenne and Arapahoe opening, the Secretary of the Interior, expecting this reservation to follow within a year, had designated it county "I" and located the county seat. However, the opening did not take place as expected, for Congress failed to ratify the agreement until March 2, 1895 (26 Stats., 895), and then, owing to legal technicalities encountered in carrying out the Indian allotments provided for, it was again delayed until 1901.[2] The agreement with the Kiowas, Comanches and Apaches had been made by the commission October 21, 1892, and provided for allotments of one hundred and sixty acres each in severalty to the Indians, and the reservation of four hundred and eighty thousand acres for grazing land. This was ratified by Congress June 6, 1900 (31 Stats., 678), and the Indian allotments having been completed in this and the Wichita reservations, another act was passed March 3, 1901 (31 Stats., 1093), providing for the opening of the remaining land to settlement.

This act provided that the lands should be opened by proclamation of the President, and, "to avoid the contests and conflicting claims which have hitherto resulted from opening similar lands to settlement and entry, the President's proclamation

---

1 Int. Dept., Misc. Repts., 1900, pt. 2, p. 671.

2 Ibid., 1899, pt. 2, p. 742.

shall prescribe the manner in which these lands may be settled upon, occupied and entered by persons entitled thereto under the acts ratifying said agreements, respectively, and no person shall be permitted to settle upon, occupy or enter any of said lands except as prescribed in such proclamation until after the expiration of sixty days from the time when the same are opened to settlement and entry."

It provided that the Secretary of the Interior should subdivide the reservation into counties and reserve three hundred and twenty acres for county seats in each. This was to be surveyed and platted to make a town-site and the lots were to be sold at auction, no person being allowed to purchase more than one business and one residence lot. The receipts were to be used to build a court house at each place, to pay the expenses of the county governments until the first collection of taxes and for the construction of roads and bridges. Two land districts were to be established, with offices at El Reno and the county seat nearest to Fort Sill.

In accordance with this act, President McKinley issued his proclamation on July 4, 1901, opening the unreserved lands to entry after nine A. M., August 6th, and prescribing the manner of entry. It was provided that from July 10th to July 26, 1901, the land offices at El Reno and Lawton near Fort Sill should be open for the registration of all desiring to homestead land in the reservations. The applicant was to give proof of his qualifications to make entry, and then be given a certificate permitting him to go upon and examine the lands. The order in which these registered applicants were to be allowed to make entry was to be determined by drawings for both districts to take place at El Reno beginning July 29, 1901. Entry was to begin August 6, 1901, in the order established by the drawing, and to continue at the rate of one hundred and twenty-five a day, and not until after sixty days was the land to be open to settlement under the homestead laws.[1]

On the 21st of June, Secretary Hitchcock established the counties of Caddo, Comanche and Kiowa, and Roger Mills,

[1] Sec. Int. Rept., 1901, p. ccxl.

Washita and Canadian were given slight extensions into the new districts in order to rectify their boundaries. The Secretary designated Hon. W. A. Richards, assistant commissioner of the general land office, to take charge of the opening under his instructions, and full powers were given to him.[1] The assistant commissioner immediately proceeded to locate, reserve and survey the three county seats of Anadarko, Lawton and Hobart, and then took charge of the registration. Estimating that three-fourths of the entries would register at El Reno, twenty-five of the thirty-three land office clerks were sent there, and the other eight were sent to the Lawton office which was for the time being located at Fort Sill.[2] Many of those who registered at Fort Sill came in wagons and went into camp in the valley of Cache Creek upon the military reservation. At times there were ten thousand people camped there, but good order prevailed throughout, both in camp and at the registration booth, which closed at six P. M., July 26th, with a total registration of twenty-nine thousand. The clerks were then transported to El Reno to assist in the drawing.[3]

At El Reno, six booths were opened for registration at nine A. M. July 10th. Here there were several thousands in line, many of whom had been waiting for twenty-four hours or more to register, and as there were quite a number of women among them, the commissioner at once established an extra booth exclusively for women. At first there was some disorder around several of the booths due to the eagerness to register early, but as soon as it was explained that all applicants would stand an equal show, no matter when they registered, the disorder ceased; and thereafter there was very little disturbance of any kind in the city, in spite of the fact that for thirty days it had to care for ten times its normal population. On July 13th an accident occurring to the pumping machinery of the El Reno waterworks threatened a serious situation, but the city officials stationed casks of ice water at convenient places on the

1 Sec. Int. Rept., 1901, pp. lxxiv, ccxliv.

2 Ibid., pp. ccviii–cclix.

3 Ibid., p. cclix.

street and no effort was spared to keep the people supplied. The waterworks were speedily repaired, but the drinking places proved so useful that they were retained throughout the registration. After the second day no unregistered applicants were left in front of the booths when they closed at night, although the incoming trains brought crowds vastly exceeding the expectations of the officials and running the total registration at El Reno to 135,416 when it closed on July 26th.[1]

On July 11th, the day after the registration began, a force of clerks was employed in separating by districts and arranging in order the applications and identification cards which had been filled out by each applicant, and these latter were placed in blank envelopes and sealed. When the registration was closed, all the clerks were employed at this work, which was completed at 4 P. M. Sunday, July 28th. The Secretary of the Interior had appointed a commission of two public men to superintend the drawing in conjunction with Assistant Commissioner Richards, and these three met July 25th and readily agreed upon a plan for the drawing.[2]

In accordance with the plan decided upon, a platform was erected in the street facing the high school grounds, which rose gradually from the platform and afforded ample space for the crowds to witness the drawing. Two boxes, ten feet long, two and one-half feet wide and two and one-half feet deep were constructed and bolts placed in each to serve as pivots for revolving them. There were three large openings on one side of each for receiving the envelopes and five numbered holes on the other to admit the hand for the drawing. On the morning of Monday, July 29th, the boxes were placed on trestles on the platform and the envelopes brought up and separated according to districts, those for one district being buff, and for the other white. With much care to avoid any possible charge of unfairness, the envelopes were put into the respective boxes, the openings sealed and the boxes revolved until the lots were thoroughly mixed. Ten young men under

---

1 Sec. Int. Rept., 1901, pp. cclx–cclxi.

2 Ibid., pp. cclxi–cclxii.

age were selected to draw, and it having been determined by lot which should draw first, twenty-five envelopes were drawn in order from the five openings in the El Reno box. Each one as drawn was passed to the commissioners, numbered consecutively, opened, and the name and description read to the people. The El Reno box was then closed, and the same number were drawn from the Lawton box, after which the session was adjourned until two o'clock. A great deal of interest was manifested by the people in this drawing, and fully thirty thousand were present. The crowd greeted the announcement of each name with great applause.[1]

In the afternoon, five hundred lots were drawn from each box in the same manner, except that the announcements were made by typewritten lists read to the people and posted on bulletin boards and afterwards printed in all the Oklahoma and many Kansas, Missouri and Texas dailies. A force of clerks was also engaged in preparing postcards which were sent out as fast as possible to those whose names were drawn, notifying them of the fact. The drawing continued at the rate of two thousand a day until sixty-five hundred were drawn from each box, that being the estimated number of possible homesteads in each district. The boxes were then removed to a building, the rest of the envelopes drawn in the same manner, and notices mailed to all so that each applicant might know that his name was placed in the box and duly drawn.[2]

On the morning of August 6th, at seven A. M., the land offices at El Reno and Lawton were opened for the entry of land. Each office was provided with a large map of the district showing the smallest legal subdivision, and each entry was marked off as made. These maps were accessible to all who wished to make entry and proved to be of great service to both applicants and officials. On the first day the first one hundred and twenty-five names were called in order at each office, and the lucky holders of these numbers, having been allowed

[1] Sec. Int. Rept., 1901, pp. cclxii–cclxiii.

[2] Ibid., pp. cclxiii–cclxiv.

to examine the land after registration, now made entry of the quarter-sections selected. Any who failed to appear were passed until the close of the day, when they were called again, and if they did not appear then their right to enter was forfeited. Very few failed to appear during the first few days, but as the good claims grew scarcer the proportion who failed to appear increased. Many who held high numbers and lived at a distance made no effort to secure a claim, and others were probably deterred by sickness or accident. The entries under the proclamation ended on October 4, 1901, with 5895 entries at Lawton, and 5743 at El Reno, or 11,638 in all.[1]

The sale of the lots in the town-sites was also under the direction of Assistant Commissioner Richards, who appointed as commissioners to have charge of such sale, J. R. Hampton for Lawton, C. C. Nesler for Anadarko, and E. P. Holcombe for Hobart. Proper auctioneers and clerks were chosen to assist the commissioners, and at 9 A. M. August 6th, the sale opened at each town-site. The commissioners were somewhat inconvenienced by the lack of accommodations at the sites, but managed to get along with tents and temporary structures. The sale proceeded regularly and rapidly at each site with no disturbance whatever, all the lots being sold before the auction closed, and at prices considerably higher than was expected. At Lawton there were 1422 lots which sold for $414,845; at Anadarko, 1129 lots at $188,455; and at Hobart, 1308 lots at $132,733. Deducting the total expense of surveying and laying out each site together with the expenses of the sale, the three county seats had left to their credit the sums of $410,594; $185,149; and $129,175 respectively, which was sufficient to start each county on a sound financial basis.[2]

The President's proclamation had provided that other town sites might be located under the homestead laws, though not near to the county seats, and eleven applications for such were accepted during the sixty days. Since then, several more have been located.[3] Although the number of homestead entries

1 Sec. Int. Rept., 1901, pp. cclxvii–cclxviii.

2 Ibid., pp. cclxiv–cclxvi.

3 Ibid., pp. ccxlii, cclxvii.

during the sixty days fell fifteen hundred below the estimated number of quarter-sections, it seems that nearly all the desirable farms were taken, and what may have been left were immediately entered under the homestead laws when the sixty days limit had expired. Thus once more a large area, this time about two million acres, excluding the Indian grazing land, the military reservation and the Wichita forest reserve, was added to the jurisdiction of Oklahoma territory and settled within a year, with a population of nearly seventy-five thousand people.

The system under which the last great opening in Oklahoma was carried on evoked considerable criticism from the public press on account of its lottery aspects, and was branded by one writer as morally and economically wrong,[1] but when we consider the people who were most deeply interested, the applicants themselves, we find almost universal satisfaction and no complaint of unfairness or injustice.[2] Of course the fact that over ten times as many people were drawn to the opening as could get homesteads seems to be a defect in the system, but the disappointed ones calmly packed up and returned home or wended their way to western Oklahoma to try their luck in another lottery where the prize was not the land, but sufficient rainfall to make the land productive. Certainly this method of opening large tracts of land was far better than any previously employed, for it did away altogether with the "sooner" element and the litigation over conflicting claims.[3]

THE PEOPLE WHO SETTLED OKLAHOMA.

A question which immediately presents itself in considering the settlement of Oklahoma is, who are the people who have settled the territory and where did they come from? Although this question has been touched upon incidentally in other places, it will be well to consider it here by itself. The best source of information on the subject is of course the United States census for 1900, where we find that in that year the

[1] John G. Speed, *Outlook*, July 20, 1901.

[2] Sec. Int. Rept., 1901, p. cclxviii.

[3] Ibid., p. lxxvi.

population of Oklahoma was 398,331.[1] While it has increased greatly in the years succeeding that census, it is necessary to take these figures as the standard for our consideration, as the statistics cannot be obtained for the later years.

The only way to get any figures as to the numbers who migrated from different states to Oklahoma seems to be to take the general nativity tables of the census, which show the place of birth of the inhabitants. While, of course, many of the settlers of Oklahoma did not come there directly from the state of their birth but had often migrated once or twice before, probably the only changes necessary in these figures to make them show the immediate sources of migration would be to increase somewhat the percentages from the western states and correspondingly decrease those from the eastern states.

The census gives the proportion of native and foreign-born in Oklahoma respectively as ninety-six and one-tenth per cent and three and nine-tenths per cent, a percentage of foreign-born far below the average for the United States as a whole.[2] Of the native-born population, seventeen and two-tenths per cent were born in Oklahoma, and the other eighty-two and eight-tenths per cent came from other parts of the United States, as shown in the following table:[3]

Table showing place of birth of native-born population in Oklahoma, 1900.

	Per ct.		Pr. ct.
Kansas	15.9	Kentucky	3.1
Missouri	12.3	Nebraska	2.4
Texas	8.8	Indian Territory	2.3
Illinois	7.2	Pennsylvania	1.5
Iowa	5.0	New York	1.0
Indiana	4.5	Alabama, Mississippi, Louisiana	2.4
Ohio	3.9		
Tennessee	3.1		
Arkansas	3.1	All others	6.3

Taking those states which are usually considered as southern, Missouri, Texas, Tennessee, Arkansas, Kentucky,

1 U. S. Census, 1900, vol. 1, p. li.

2 Ibid., p. cvii.

3 Ibid., p. cxliii.

Indian Territory, Alabama, Mississippi and Louisiana, the total percentage is thirty-five and one-tenth, while from the northern states, Kansas, Illinois, Iowa, Indiana, Ohio, Nebraska, Pennsylvania and New York, it is forty-one and four-tenths,[1] thus showing that in spite of Oklahoma's southern location the majority of her population is from the North. That is perhaps further exemplified by the fact that the political parties in the territory have always been very evenly divided, with the Republicans usually in the ascendency,[2] in contrast to the large democratic majorities of the other southern states. This may in a measure be due to the small percentage of negroes, only three and nine-tenths in the territory,[3] which allows the white citizens to be divided into two nearly equal parties without danger of negro control.

Dividing the Union now by the Mississippi river, we find that forty-nine and eight-tenths per cent of Oklahoma's native-born population comes from the states west of the Mississippi, and only twenty-six and seven-tenths[4] from those east of the river, but it will be seen that of that twenty-six and seven-tenths per cent, the Northwest furnished fifteen and six-tenths, the South eight and six-tenths and the East two and five-tenths, while the southern and northern sections west of the river are quite evenly divided, with twenty-six and five-tenths and twenty-three and three-tenths per cent respectively. Thus we see that the bulk of Oklahoma's population came from the three northwestern states of Illinois, Indiana and Ohio, and from the states between the Mississippi and the mountains excepting Minnesota and the Dakotas. To make still another arrangement of the states, we have from the four surrounding Oklahoma and Indian Territory, namely, Kansas, Missouri, Arkansas and Texas, together with Indian Territory itself, forty-two and four-tenths

1 I have considered Missouri as a southern and Kansas as a northern state, because they are usually thought of as such, although really lying in the same belt.

2 Int. Dept., Misc. Repts., 1901, pt. 2, pp. 323–24.

3 U. S. Census, 1900, vol. 1, p. cxiv.

4 In this and the previous divisions, the six and three-tenths per cent. which is not assigned to definite states has been neglected.

per cent of Oklahoma's native-born population, and from all the rest of the Union only forty and four-tenths per cent, showing that the settlers came largely from the adjacent states.

To divide the settlers of Oklahoma into any hard and fixed classes would of course be impossible, but there seem to be some more or less distinct divisions which might be made. Considering them in the light of what had been their previous occupation, we have first of all the professional "boomers" whose agitation had opened the territory and many of whom had become so used to violating the law that they now became "sooners" in their eagerness to reap the fruits of their agitation.[1] Then we have a large class of farmers who had met with failure in other parts of the country, either because of adverse conditions or for lack of those qualities which go to make up a successful farmer. It was one of this class taking part in the first rush who had as his motto painted on the canvas side of his prairie schooner: "Chinch-bugged in Illinois, Bald-nobbed in Mizzouri, Prohibited in Kansas, Oklihommy or Bust."[2]

There were also a great many men from the professional ranks, such as lawyers, druggists and physicians, and a large number of merchants who sought Oklahoma during and between the rushes as a good field in which to build up a practice or a line of business.[3] Lawyers were especially numerous at first, called by the vast amount of litigation resulting from the rush. Besides these classes there were many common workmen and day-laborers, miners, factory employes and unskilled laborers in general from the cities of the Northwest,[4] who drifted down to Oklahoma, took part in the rush and often won a home and became in time successful and independent farmers.

Looking at Oklahoma's population from the standpoint of purpose in coming into the territory, we have a possible division into three classes, those who came to make a home, those who came to make money by speculation, and those who had no settled purpose in coming. The first class includes not only

1 *Tribune Extras*, vol. 1, no. 7, p. 23.

2 Ibid.

3 Ibid., p. 24.

4 Ibid., p. 30.

the honest settler who took up a farm or bought the claim to one from a speculator, but also a large proportion of those who settled the different cities and villages of the territory and built up a business or a professional practice. Most of the would-be farmers who came with the first rush were poor men with scarcely enough laid by to tide them over to the first harvests, but later, when the success of Oklahoma as an agricultural country had been proven, a great many conservative and comparatively well-to-do settlers were attracted by a desire to escape the extreme temperatures of the North or of the far South, or to be with their more adventurous friends who had gone before.[1]

The speculators were a prominent feature in all of the Oklahoma openings, and a continual source of trouble for the officials unless they were in alliance with each other, as at Guthrie and Oklahoma City. They first made their appearance as gamblers in the crowds collected on the borders before the rush and plied their various games with considerable success among the waiting thousands who had nothing else to occupy their time and were imbued with the spirit of adventure by the element of chance in the opening itself.[2] Then there were many who took part in the rush who were not qualified to make entry under the homestead laws, but believed that here was an opportunity to "turn an honest penny" by seizing a quarter-section or a town lot and then selling the claim to the real settler. The presence of such speculators was especially noticeable in the various town site settlements,[3] and here, too, the gamblers, not content with fleecing their victims on the border, followed them in and continued to work their games without restraint among the successful and unfortunate alike.

The third division, those who came without settled purpose, were members of a class which is quite common throughout the Southwest and is generally known as the "movers."[4] They are

---

1 Int. Dept., Misc. Repts., 1899, pt. 2, p. 726.

2 C. M. Harger, *Outlook*, Aug. 17, 1901; *Tribune Extras*, vol. 1, no. 7, p. 24.

3 Sec. Int. Rept., 1891, vol. 3, p. 452.

4 C. M. Harger, *Outlook*, Feb. 2 and Aug. 17, 1901; H. C. Candee, *Forum*, June 1898.

usually people who, having changed their location several times, have finally become so imbued with the "boom-fever" that they find it impossible to settle down. Numbers of these who were wandering aimlessly around the Southwest turned their steps toward Oklahoma when the opening was announced, and took part in the first rush and in every succeeding rush thereafter. If they succeeded in getting a claim, they seldom lived on it long, but soon sold out and were up and moving again. Like the gypsies of the northern states, they often move about in small bands with two or three wagons and a small collection of horses, camp for a week or two along a stream near to some town, where they eke out a precarious existence by fishing and horse-trading, and then move on to another location.

One class of people has been left out so far in this discussion, namely the ranchmen on the western plains. As has been shown, a large part of western Oklahoma is suitable only to grazing, and here the herds of the cattle companies roam over the prairies under the care of the cow-punchers, much as they did in the rest of Oklahoma before the opening.

No discussion of Oklahoma's population is complete without some mention of the Indians, who in 1902 numbered 12,893, a decrease of twenty-six over the preceding year.[1] This does not include the three hundred Arizona Apaches held at Fort Sill as prisoners of war. The Indians of the territory are divided into six different agencies, the Osage, White Eagle and Pawnee agencies having charge of the Indians in the northeast corner of the territory.[2] Most of these Indians except the Osages have taken land in severalty and are cultivating it to some extent, although many lease part or all of their allotments to white cultivators. The Osage tribe still holds its land in common and leases the most of it to cattlemen. The Indian agents all agree that the principal thing which hinders the development of these Indians into industrious farmers is their wealth, which is sufficient to allow them to live without work in a manner satisfactory to themselves, and thus all incentive to work is taken away.

---

1 Int. Dept., Misc. Repts., 1902, pt. 2, p. 452.

2 Ibid., pp. 452–56.

The Indians of central Oklahoma, in charge of the Sac and Fox agency,[1] scattered as they are throughout their former reservations wherever they chanced to take up their allotments, are slowly succumbing to the influence of their white neighbors and are beginning to cultivate their farms. But still much of their land is leased and cultivated by white men, while the owners live in idleness on the proceeds of the leases. In western Oklahoma, the Cheyennes and Arapahoes under the Darlington agency[2] are living on their allotments along the Canadian and the North Fork in the eastern part of their former reservation. They have made some advance toward civilization since taking up allotments, and most of them have now given up the blanket for citizen's dress. In the South, the Indians under the Kiowa agency,[3] who were but recently given their land in severalty, are already showing the favorable influence of allotments and industrious white neighbors, and are making considerable efforts to improve their farms and homes.

CONCLUSION.

Since the first opening of land in Oklahoma to white settlement, in 1889, the territory has changed from an area occupied by a few Indians and cattlemen to a substantial, well settled commonwealth covered with fine farms and thriving towns and partaking largely of the characteristics of the state of Kansas. Before this territory was five years old, the agitation for admission to the Union was begun and immediately took two forms. There were those who favored immediate statehood for Oklahoma with the boundaries of the territory, and others who said that Oklahoma and Indian Territory together would make a fine state and that they should wait until the Indian Territory could be so incorporated while doing everything in their power to bring it about. Year by year the agitation increased, comparative statistics were marshaled together and every possible reason was advanced to show the justice of Oklahoma's demand

1 Int. Dept., Misc. Repts., 1902, pt. 2, pp. 453–55.

2 Ibid., pp. 456–58.

3 Ibid., pp. 459–60.

for statehood, and finally the matter was brought before Congress in 1902–3 by the bill to grant statehood to Oklahoma, New Mexico and Arizona. This bill was thoroughly discussed but failed to pass.

In the next Congress a new form of statehood bill was advanced which proposed to make one state of Oklahoma and Indian Territory combined. This bill passed the House in April 1904, but the Senate adjourned without acting upon it. However, the matter had been brought before the nation, and the agitation was continued in every session of Congress until finally in June 1906 an enabling act was passed by both houses of Congress. This act provides for the joint admission of the two territories, and so a new star will soon be added to the flag for the state of Oklahoma.

BIBLIOGRAPHY.

United States Government Documents.

Congressional Documents.

48th Congress, 1st Session, Senate Executive Document 109.

48th Congress, 2nd Session, Senate Executive Documents 17 and 50.

51st Congress, 1st Session, House Executive Document 209.

51st Congress, 1st Session, Senate Executive Document 78.

51st Congress, 2nd Session, Senate Executive Document 72.

Congressional Record, 1879-1903.

Documents of the Interior Department, 1879–1902.

Reports of the Secretaries of the Interior.

Reports of the Commissioners of Indian Affairs.

Reports of the Commissioners of the General Land Office.

Reports of the Governors of the Territory of Oklahoma.

United States Census, 1900.

Newspaper and Magazine Articles.

New York Tribune, Library of Tribune Extras, vol. 1, no. 7.

Candee, Helen Churchill: "Oklahoma," *Atlantic Monthly,* vol. 86, p. 328.

Candee, Helen Churchill: "Social Conditions in Our Newest Territory," *Forum,* vol. 25, p. 426.

Harger, Charles Moreau: "The Government's Gift of Homes," *Outlook,* vol. 68, p. 907.

Harger, Charles Moreau: "The Next Commonwealth: Oklahoma," *Outlook,* vol. 67, p. 273.

Spears, John R.: "The Story of Oklahoma," *Chautauquan,* vol. 9, p. 533.

Speed, John Gilmar: "The Oklahoma Land Lottery," *Outlook,* vol. 68, p. 667.

For other magazine articles see Poole's Index of Periodicals.

Davis, Richard Harding: "The West from a Car Window." New York, 1892.

MAPS.

A REVISION OF THE NORTH AMERICAN SPECIES OF DIAPTOMUS.

C. DWIGHT MARSH.

(With Plates XV—XXVIII)

INTRODUCTION.

The genus *Diaptomus* is of special interest to the student of plankton, because, in so many cases, it forms the major portion of that part of the plankton which is available as food for fishes. It is true that in plankton-rich bodies of water, the largest collections consist, for the most part, of vegetable material, but a large proportion of the vegetable material is waste so far as concerns its serving directly as food for animals. It is true, too, that in some cases other Copepoda or Cladocera may form the bulk of the animal part of the plankton, but commonly it is *Diaptomus* that is most prominent.

The genus occurs the world over, and is found not only in lakes, but in running streams and in temporary pools. While it is found so widely, however, but few of its species are widely distributed. Most of the species of *Cyclops* in America are identical with those of the other continents, but this is true of none of the species of *Diaptomus*. All of our species are peculiar to this continent, and some of them have a habitat of relatively narrow limits. It would appear that *Diaptomus* is quite susceptible to the influences of its environment, and this fact makes the study of the genus of peculiar interest.

In connection with lake work the author has been studying *Diaptomus*, as a side issue, for some years, and has at length accumulated enough material, apparently, to warrant publication. The collections studied have covered a wide range of country, from the Saskatchewan district on the north to Mexico and Cuba on the south, and from Long Island on the east to Washington and California on the west. It must not be assumed, however, that the collections give any complete idea of this wide extent of territory. Most of the collections are of a sporadic character. Outside the states of Wisconsin, Michigan, Minnesota and Illinois, nothing like any complete exploration has been made. Within the limits of these states, fairly complete work has been done. In the rest of the country, much less is known of the older states of the East than of the new states and territories of the West.

A study of this material shows a number of new species, and throws new light on the relationships of those already known.

It has been the ambition of the author to monograph the genus, so far as North American species are concerned, but this will not be possible for some years, for very extensive collections must be made before such a work can be possible. Meantime the important part played by the genus in plankton makes it desirable that what is already known should be put in such shape that the student of plankton may be able to identify his species. This is very difficult to do at the present time. The only papers, ostensibly covering all the North American species, are those of Herrick and Turner, and Schacht, and neither of these, for various reasons, can be easily used for the determination of species. It is very difficult, even for one who is acquainted with the genus, to recognize species without figures, and for the average student of fresh water forms, who presumably has no special training in the study of Entomostraca, it becomes a discouraging task even to guess at the species. With suitable figures, however, any one, who has the patience to make the necessary dissections, ought to be able to determine correctly the species he has in hand. The present revision is undertaken with the hope that it may not only be a contribution to our knowledge of the genus, but that it may prove a distinct help to those who are studying the problems of limnology, but have no special knowledge of Entomostraca. It seems unfortunate that so many papers on plankton list the *Diaptomi* simply under the generic name without an attempt to distinguish species, thus detracting much from the value of the observations, inasmuch as the *Diaptomi* have very distinct individual peculiarities, and react very differently to their environments.

With this in view, the author has attempted to provide sufficient figures of each species so that its identity cannot be a questionable matter. The original plan involved personal acquaintance with each species, and figures from specimens actually in the collections studied. It was found impossible, however, to carry this out in every case; for example, it was found impossible to get material of *D. novamexicanus,* as Herrick had preserved none of the original material. The papers describing Pearse's species *Wardi* and *spatulocrenatus* were received while this paper was in press and after the plates had been made, so that it was impossible to provide figures, or to do much more than to give the species their proper place in the classification. So, in other cases, because of imperfect cataloging of museum material, it was impossible to get specimens of the animals originally studied. Therefore, in some cases, it has been found necessary to reproduce the original figures of the authors of the species. Most of the figures, however, are from material in the collection of the author.

As the result of studies on other collections, it is hoped, before many years, to supplement this work, so that we may get more nearly a synopsis of all the North American species. Meanwhile it is to be expected that intermediate forms will be discovered which may change materially the specific limits as they appear at the present time.

The author would express his grateful acknowledgment to all who kindly aided in this work by assisting in making the collections on which it is based. To the following he has been especially indebted: to Professor E. A. Birge of the University of Wisconsin, not only for the exchange of material from Wisconsin, but for extensive collections made in the southern states; to Professor Chauncey Juday of the University of Cali-

fornia, for collections from Indiana, Colorado and California; to Professor Jacob Reighard of the University of Michigan, for collections from the Great Lakes and from the inland lakes of Michigan; to Professor H. B. Ward of the University of Nebraska, for collections from Nebraska, Colorado and California; to Professor C. F. Baker of the Stacion Agronomica, Santiago, Cuba, for collections from Nevada, California, Mexico, Cuba and the southern states; to Professor B. H. Brown of Whitman College for collections from Washington; and to his former pupil, Russell T. Congdon, for collections from the Saskatchewan district.

Many others have collected for me more or less material, and without this assistance, this revision would have been impossible.

A SPECULATION IN REGARD TO THE AFFINITIES OF THE NORTH AMERICAN SPECIES OF DIAPTOMUS.

I speak of this as a speculation, for the present condition of our knowledge in regard to this genus hardly justifies the use of the term theory. Until vastly more complete collections have been made, the affinities of the species and the relationships of the genus to other genera can only be guessed at.

Origin of the genus.

Practically nothing is known of the origin of the genus. Of course, its ancestors were marine, but there are no marine forms at the present time very closely related to it. It is generally considered that its nearest relative is the genus *Drepanopus,* of which three species are known. These are found in the southern oceans in a few localities, the latitude varying from 30 to 47 degrees.

We have no geological knowledge of the history of *Diaptomus.* We may assume that it was separated long before the glacial period, perhaps far back of that time, and that, prior to the invasion of the ice, the species of the eastern and western continents were distinct.

Effect of the glacial period on distribution.

Before the glacial period, we may suppose that the waters of North America were peopled with species of *Diaptomus*. Inasmuch as the continental conditions differed less than those of the present time, it is probable that the number of species was smaller. This is probable, too, from the fact that the means of communication from one body of water to another was probably easy, so that there was less opportunity for the effect of isolation. As the period progressed, the genus must have been driven further and further towards the south, being limited, on the north, during the period, very nearly to the southern limit of the ice. This limit would not have been exact, for species of *Diaptomus* live in the coldest waters.

During the decline of the glacial period it is fair to assume that, as the ice retreated, the *Diaptomi* followed towards the north. Inasmuch as the species of *Diaptomi* at the present time are limited in their distribution by climatic influences, we may assume a gradual change in the species in any given locality as the climate changed. The forms which had been living close to the ice border would retreat towards the Arctic, or might remain as a *fauna relicta* if local conditions were such as to make this possible.

If the above assumptions in regard to the origin of the genus and its geological history are accepted, we must suppose:—

First, that inasmuch as there were several, perhaps many, species before the glacial period, our modern species will probably be divided into groups, according to their phylogeny, but it is unlikely that we can trace to any one line for all species.

Second, the most primitive species will be the furthest north. We may expect to find in Arctic or sub-Arctic regions the forms most nearly related to those that dwelt in the United States during the glacial period, and these forms will be found further south only as a part of a *fauna relicta* unless they have been able to adapt themselves to great variations of climate;

generally speaking, the species of this genus adapt themselves to variations of climate only to a limited extent.

Third, if climatic conditions tend to produce new species, the more recently developed species would be in the south under warmer temperature conditions, and in the west where isolation as well as climate comes in as an important factor.

Some emphasis should be placed on the effect of isolation, for experience shows that the distribution of *Diaptomi* is brought about largely, if not entirely, by actual water carriage. It is, of course, possible that birds and winds may carry the animals or their eggs in some cases, but this is not an ordinary method. This is shown by the fact of the isolation of particular species in certain lakes. For example, *D. Reighardi* occurs in lakes in the Beaver Islands, but not in Lake Michigan close by. *D. Birgei* has been found in but one locality in Wisconsin; this also is true of *D. siciloides,* which is found only in Cedar lake, Washington county. There may be other localities for these species, but Wisconsin has been pretty thoroughly explored without finding them.

DISTRIBUTION OF SPECIES.

I have recognized thirty-four species of *Diaptomi* in North America, distributed as follows. It is to be understood that these are simply the known localities, and it is possible in many cases that the distribution is much wider. Anything like thorough collections have been made only in Illinois, Michigan, Wisconsin and Indiana. Many collections have been made in the states in the Mississippi valley, and scattered collections in the mountain regions of the West. The immediate vicinity of Lincoln, Nebraska, has been explored by the Department of Zoology in the University of Nebraska. I have only one set of collections from the Northwest Territory. The lakes of the eastern United States are unexplored.

D. albuquerquensis, New Mexico, Mexico, Colorado.

D. Ashlandi, Idaho, Washington, Great Lakes, Indiana, Michigan, Wisconsin, Oregon.

D. asymmetricus, Cuba.

D. Bakeri, California.

D. Birgei, Wisconsin, Indiana, Long Island.

D. clavipes, Iowa, Nebraska, Colorado.

D. conipedatus, Louisiana.

D. dorsalis, Louisiana.

D. Eiseni, California, Nebraska.

D. franciscanus, California.

D. Judayi, Colorado.

D. leptopus, Massachusetts, Wisconsin, Illinois, Northwest Territory, Colorado, Mississippi valley generally.

D. Lintoni, Yellowstone park.

D. minutus, Great Lakes, Yellowstone park, Michigan, Wisconsin, Newfoundland, Greenland, Iceland. Not found south of Wisconsin.

D. mississippiensis, Mississippi, Louisiana, Florida.

D. novamexicanus, New Mexico.

D. nudus, Colorado.

D. oregonensis, Oregon to Michigan, Northwest Territory to Iowa, Illinois, Indiana and Massachusetts.

D. pallidus, north to Wisconsin and Minnesota, south to Louisiana, west to Texas and Colorado, east to Illinois, Mississippi valley.

D. purpureus, Cuba.

D. Reighardi, Michigan.

D. saltillinus, Nebraska.

D. sanguineus, Massachusetts, New York to Minnesota, south to Alabama; reported from Nebraska and Washington.

D. shoshone, Wyoming, Colorado.

D. sicilis, Great Lakes, Wisconsin, Michigan, Wyoming, Minnesota, Illinois, Nebraska.

D. siciloides, California, Illinois, Indiana, Wisconsin, Colorado, Nebraska.

D. signicauda, California, Nevada, Colorado.

D. spatulocrenatus, Nantucket.

D. stagnalis, Illinois, Minnesota, Ohio, Kentucky, Alabama.

D. tenuicaudatus, Saskatchewan.

D. Trybomi, Oregon.

D. Tyrelli, California.

D. Wardi, Washington.

D. washingtonensis, Washington.

It will be noticed that some are restricted pretty closely to the Mississippi valley, some to the gulf states, and others to the northern tier of states. Generally speaking, within rather wide limits, the distribution is one of latitude. The most northern species, *D. minutus,* ranges from Iceland to southern Wisconsin, *D. oregonensis* has the same southern limit and has been found as far north as the Saskatchewan, *D. pallidus* ranges from Wisconsin to the Gulf, while *D. mississippiensis* is confined to the gulf states. Strictly confined to the western part of the United States and mostly in the mountain regions, are *D. albuquerquensis, clavipes, Eiseni, franciscanus, Judayi, Lintoni, novamexicanus, nudus, saltillinus, shoshone, signicauda, Trybomi, Tyrelli, Wardi* and *washingtonensis.*

The greater number of species in the West is doubtless largely accounted for by the results of isolation, but it should be remembered that collections have been made in only a few localities, and it may be found both that the known species have a greater range than now appears, and that intermediate forms may come to light which will affect present species limits.

RELATION OF STRUCTURE TO HABITAT.

Except in a very general way, it is difficult to correlate habitat and structure. Still, certain facts are evident.

1. Peculiar, bizarre characters are more apt to appear in animals living in shallow waters and with a narrow range of habitat. This appears in the dorsal process of *D. dorsalis,* and in the hook on the fifth foot of the male in *D. clavipes.* The process of the first abdominal segment of the female is found only in *D. signicauda* and the species associated with it, and these are limited to the mountain regions. This principle, however, does not apply as widely as we should expect.

2. There is a marked distinction between species living in deep water, and in shallow. The deepwater, or limnetic, forms

are generally transparent, apparently never permanently colored. Their bodies are elongated, and their appendages are long and slender. The species of littoral habitat, or dwelling in shallow water, have stouter bodies, are generally larger, doubtless due to greater abundance of food, their appendages are much shorter, and they are frequently highly colored. *D. shoshone* is one of the most striking examples of these peculiarities. They are also very noticeable in *D. leptopus* and *D. sanguineus.*

STRUCTURAL RELATIONSHIPS OF THE SPECIES.

In this connection will be discussed only those peculiarities used for the separation of species. It is understood that this covers only a small part of the subject, but it will be limited with some precision to what is known. The characters used for the determination of species are the following:

1. The form and segmentation of the cephalothorax.

2. The form and segmentation of the abdomen of the female. Noticeable are the presence or absence of lateral spines or of a caudal process on the first segment.

3. The length of the antennae, and the armature of the last three segments of the male antenna. This armature consists, in the main, of hyaline lateral lamellae and of a process on the antepenultimate segment which varies, being sometimes a hook, more or less prolonged, sometimes an elongated affair which may be armed with teeth.

4. The form of the fifth feet of the female. A fifth foot, as can be seen by reference to the plates, consists of two basal segments, an exopodite of two or three segments, the second segment produced into a hook, and an endopodite of one or two segments. This may vary in the following ways:

a. In the form and size of the spine of the first basal segment.

b. The exopodite may be two- or three-segmented, and, when two-segmented, may have two or three lateral spines.

c. The endopodite may be either one- or two-segmented, and varies in length and in the size of the apical spines.

5. The form of the fifth feet of the male. In the male fifth feet, there are two basal segments. In the right foot, the exopodite consists of two segments, the second segment bearing a lateral spine and a terminal hook. The endopodite is one- or two-segmented. In the left foot the exopodite is composed of two segments, the second segment terminated with two processes. The endopodite is one- or two-segmented. The principal modifications are these:

a. Form and size of the spines of the first basal segments.

b. Position of the lateral hairs of the second basal segments.

c. Relative lengths of the segments of the exopodite.

d. Position of the lateral spine of the second segment of the exopodite.

e. Form and size of the terminal hook.

f. Form and size of the processes and lamellae which sometimes occur on the segments of the right foot.

g. Form of terminal processes of second segment of the exopodite of the left foot.

h. Form, size and segmentation of the endopodite. It may be one- or two-segmented, may be rudimentary, or may acquire considerable length. Its tip may be armed with setae, or with two more or less prominent spines.

PRIMITIVE STRUCTURAL CHARACTERS.

In discussing the structural relationship of the species, it is necessary, if any phylogenetic conclusions are to be reached, to determine what are the more primitive characters. This is a matter of some difficulty and must be largely, perhaps, conjecture.

The typical copepod appendage consists of two basal segments with three-segmented exopodite and endopodite. We may assume that the fifth feet of both sexes have been derived from such a typical structure by a process of reduction. I call this an assumption, for I do not feel certain that it is true. It seems, however, most probable in the light of present knowledge. Granting this assumption, it would follow that the most primitive form would be the one that most nearly approaches this type; the more nearly equal in length the right and left feet, the more primitive the form; the more nearly the endopodite approaches a three-segmented structure of the same length as the exopodite, the more primitive the form, etc. Of course, this reduction may not have been correlated in different structures; for example, a two-segmented endopodite might possibly be found in a recent form, although in most a one-segmented condition exists. Generally speaking, however, it would be true that a species would be considered the more primitive in proportion as it approaches more or less closely to a form having its feet composed of three-segmented rami. It is to be supposed that this reduction may have gone on at the same time in two or more lines, so that the fact of a similar stage of reduction in the segments of the feet would not in all cases imply close relationship, although many times this would be true. The common presence in two or more forms of a structure that was developed rather than left behind in the process of reduction, would be pretty good evidence of close relationship.

It must be borne in mind, too, that very little is known of the amount of variation in the structures of *Diaptomi,* and further knowledge may modify present conclusions. For example, it is difficult to correlate the peculiar armature of the antepenultimate segment of the right male antenna with other structures, and it is possible that it may appear that these structures are much more variable than is now supposed.

THE OREGONENSIS GROUP.

This group includes *D. oregonensis, Reighardi, mississippiensis, pallidus,* and possibly *Bakeri* and *franciscanus.* Leaving *Bakeri* and *franciscanus* out of consideration for the time being, the members of the group agree in the following characteristics:

All are without a distinct appendage on the antepenultimate segment of the male right antenna. All have the lateral spine near the end of the second segment of the right male exopodite, and have a small spine near the inner margin of the same segment. The terminal processes of the left foot of the male are digitiform in *D. oregonensis, franciscanus* and *Reighardi,* the inner one is falciform in *D. pallidus,* while in *D. mississippiensis* and *D. Bakeri* they are elongated and digitiform. In the female the fifth feet are nearly the same in all these species. All have two spines on the second segment of the exopodite. The lateral spines of the female abdomen are most pronounced in *D. Bakeri* and *D. mississippiensis,* but are not large in any of the species. In *D. oregonensis* the right and left feet are nearly of the same length. In the other cases there is considerable difference between the lengths of the two feet.

As to distribution, *D. oregonensis* is known to live from about the parallel of 42 degrees north to the Saskatchewan region, and very likely has a still further extension towards the Arctic. *D. Reighardi* is localized, so far as is known, to the northern part of the southern peninsula of Michigan. *D. mississippiensis* is found only in the gulf states. *D. pallidus* is found in the Mississippi valley from Wisconsin south, and as far west as the Rocky mountains. *D. Bakeri* and *D. franciscanus* have been found only in California, and each only in a single locality, although, of course, it is probable that they will be found to have a wider distribution.

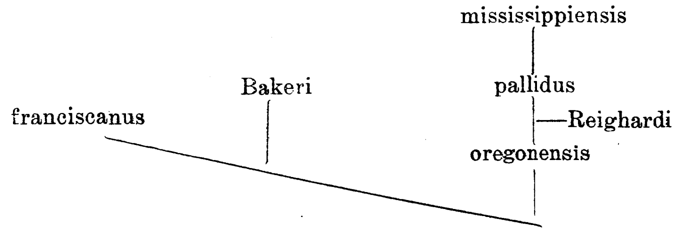
It seems to me that *D. oregonensis, pallidus, Reighardi* and *mississippiensis* have clearly a very close relationship, as shown by the absence of the antennal appendage and the very close resemblance in the male fifth feet; this is noticeable in the proportions of the segments, the location of the lateral spine, and especially in the presence of the small spine near the inner margin. *D. Bakeri* and *D. franciscanus* have this small spine, which makes me feel quite certain that they must be in the same line.

The phylogeny of part of the group seems to me quite clear. *D. oregonensis* is the most primitive form. Its wide distribution in the cold temperate region is entirely in harmony with this supposition. It or its immediate ancestor inhabited the waters of the United States south of the ice at the height of the glacial period. As the ice disappeared, it gradually moved towards the north, adapting itself only in a slight degree to the changes of the environment. *D. pallidus* may be derived from *D. oregonensis.* It has gradually taken the place of *D. oregonensis* through the Mississippi valley. The difference in structure between *D. oregonensis* and *D. pallidus* is doubtless due to minor influences of the environment, accompanied by isolation. It is not likely that the morphological differences can be traced to any specific influences of environment. *D. mississippiensis,* which is still further removed from *D. oregonensis,* is of later origin, and in a more limited habitat has developed more pronounced structural differences.

D. Bakeri and *D. franciscanus* differ from the other members of the group in that they have an appendage on the antepenultimate segment of the right male antenna. If it should appear that this appendage is an invariable character, these two species should, doubtless, be separated from the group. The position of the lateral spine on the right exopodite of the male fifth foot and the presence of the small inner spine on the same segment make one feel that these two species must belong in the *oregonensis* group.

The endopodites of the male fifth feet in *D. Bakeri* are two-segmented, and the right exopodite in *D. franciscanus* is frequently two-segmented. The endopodites of the female fifth feet in *D. Bakeri* are also two-segmented, and in both *D. Bakeri* and *D. franciscanus* the exopodites of the female fifth feet are three-segmented. Thus *D. Bakeri* and *D. franciscanus* have many of the characteristics of what I have assumed to be primitive structures, and it is possible that these peculiarities have been retained in their somewhat limited habitat; this must be a matter of conjecture, however, because of our slight knowledge of the distribution of the California species.

The relationships of the members of the group may then be expressed in the following way:

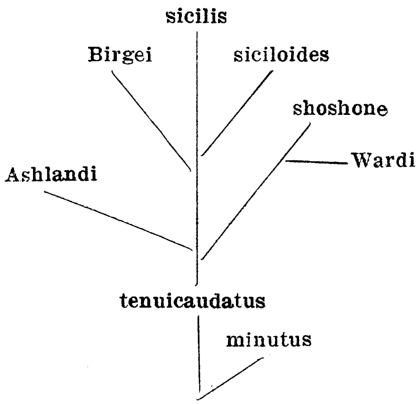


THE TENUICAUDATUS GROUP.

This group includes *D. tenuicaudatus, sicilis, Ashlandi, minutus, Birgei, siciloides, Wardi* and *shoshone.* All, with the exception of *Birgei* and *siciloides,* agree in having a slender straight appendage on the antepenultimate segment of the right antenna of the male; these, however, are not the only species with this appendage. The male fifth feet of *D. tenuicaudatus, D. sicilis* and *D. shoshone* resemble each other very closely. In *D. Ashlandi* and *D. Birgei* the most marked difference is in the position of the lateral spine.

D. Birgei has an exceedingly short appendage on the antepenultimate segment of the male right antenna, and *D. siciloides* has a short hook. In all members of the group, with the exception of *D. shoshone* and *D. minutus,* there is a hyaline lamella on the posterior surface of the first segment of the right exopodite. This peculiarity is found in some species outside this group, especially in those of the *signicauda* group, and may indicate a common structural relationship between the groups. *D. minutus* differs not only in the position of the lateral spine, but in the form of the terminal hook, and in the rudimentary right endopodite. In the female fifth foot, too, *D. minutus* differs in that the endopodites are rudimentary, and that they have three spines on the second segment of the exopodite. *D. shoshone* has elongated terminal spines on the endopodite of the female fifth foot and has a distinctly three-segmented exopodite. *D. shoshone* by its size is separated from the rest of the group, but its structural relationships seem to be very close.

D. minutus is most widely distributed, being found from the northern United States to Greenland and Iceland, but not on the Eastern Continent. *D. Ashlandi* and *D. sicilis,* so far as known, are limited to the northern tier of states in the United States. *D. Birgei* and *D. siciloides* belong to warmer waters but probably do not occur south of the Ohio river, while *D. shoshone* is peculiar to the mountain region of the West. *D. tenuicaudatus* is a recent find, and is, so far, reported from only one locality, in the Saskatchewan region. *D. sicilis* and *D. Ashlandi* are distinctly lovers of cold water. In Green lake *D. sicilis* occurs in the winter months and *D. minutus* in the summer months. (Marsh, '97, Marsh, '03.) *D. tenuicaudatus* is considered the most primitive form because of the slender female abdomen without armature, the nearly equal length of the male fifth feet, and the two-segmented endopodite of the left fifth foot of the male. *D. sicilis* is the most nearly related to *D. tenuicaudatus.* *D. shoshone* comes very close to it, but if it is in this line it must have been subjected to peculiarly favorable circumstances of food to have developed such an enormous size. *D. Ashlandi* might easily have been derived from *D. tenuicaudatus,* but the separation must have taken place at a comparatively remote time. *D. siciloides* and *D. Birgei* are somewhat more specialized forms from the same stock as *D. sicilis.* *D. minutus,* according to the standard I have set up, is the most specialized of the group; there is a marked difference in the lengths of the fifth feet of the male, and there is a striking reduction of the endopodites in the fifth feet of both sexes. The only noticeable primitive character is the three spines of the second segment of the exopodite of the fifth feet of the female. From its wide distribution we might well think of *D. minutus* as an early form from which the others have been derived, were it not for its specialized characteristics. As it is, we must think of it, perhaps, as not derived from *D. tenuicaudatus,* but as having a common ancestry with this form. The relationship of this group, then, may be expressed by the following diagram:



D. Tyrelli has no appendage of the antepenultimate segment of the right male antenna, but the structure of the male fifth foot leads me to think that it should be classed with this group. It must be considered as somewhat distinctly separated from the rest of the group, and its phylogeny is uncertain.

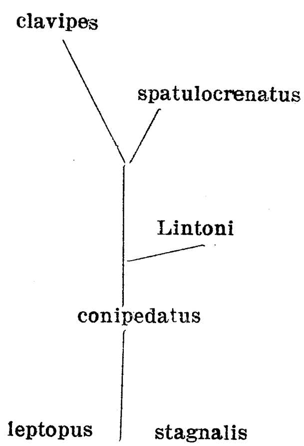
THE LEPTOPUS GROUP.

This includes *D. leptopus, leptopus* var. *piscinae, conipedatus, stagnalis, Lintoni, spatulocrenatus* and *clavipes*... *D. conipedatus, D. spatulocrenatus* and *D. stagnalis* have a hook on the antepenultimate segment of the right antenna of the male. The others have a lateral hyaline lamella. *D. leptopus, D. leptopus* var. *piscinae, D. conipedatus* and *D. clavipes* have a hook in the posterior face of the second basal segment of the right fifth foot of the male, this hook being most pronounced in the case of *D. clavipes.* The published figures do not indicate the presence of such a hook in *D. Lintoni* or *D. stagnalis,* but Schacht's description of *D. stagnalis* speaks of the presence of a "large, smooth, hyaline lamella." This may represent the hook of the other species. In the female fifth foot, the second segment of the exopodite has either two or three spines in *D. leptopus,* and three in *D. clavipes, D. conipedatus, D. spatulocrenatus* and *D. Lintoni.* In *D. stagnalis* the exopodite is distinctly three-segmented. The endopodites of the female fifth feet in *D. stagnalis* are two-segmented.

D. Lintoni has been found only in the Yellowstone park. *D. conipedatus* has thus far been found only in Louisiana, and *D. clavipes* in Iowa and Nebraska. *D. spatulocrenatus* has been found only in the island of Nantucket. *D. stagnalis* probably occurs generally throughout the Mississippi valley, and *D. leptopus* not only in the Mississippi valley but north into British America. , ,

I have called this the *leptopus* group because *D. leptopus* is the most common species. In many respects, however, *D. stagnalis* may be considered the more primitive. This is notably the case in the characters of the female fifth feet—the threc-segmented exopodite, and the two-segmented endopodite. From its distribution, one would think of *D. leptopus* as the more ancient form. In the antennal armature, *D. stagnalis, D. conipedatus, D. spatulocrenatus* and *D. Lintoni* are most nearly alike.

I think one can do little more than guess at the relationships of the members of the group. *D. clavipes* is apparently the most specialized. The probable relationships may be put, provisionally, as follows:



THE SIGNICAUDA GROUP.

This consists of *D. signicauda, washingtonensis, nudus* and *Judayi*. They are put together because of the common character of the posterior process on the female abdomen. *D. Judayi* has a straight process on the antepenultimate segment of the right antenna of the male. The others agree in having a hook. *D.*

signicauda and *D. Judayi* have a hyaline lamella on the first segment of the right exopodite. *D. washingtonensis* alone has the primitive character of a two-segmented endopodite in the male fifth foot. *D. Judayi* has the most pronounced spines on the first segment of the female abdomen. It seems that there should be no question of putting these species together on the ground of the posterior process of the first segment of the female abdomen, although this appears late in the development of the individual and it is very possible that the peculiarity originated in different lines.

With this group I should place *D. Trybomi,* although it is somewhat aberrant in many details of structure. The asymmetry of the female abdomen would lead us to conjecture a relationship with the *signicauda* group, but a relationship much more remote than that of the other members. The male fifth foot, while peculiar in many respects, yet bears a marked resemblance to the fifth feet of the group in question. In the "dorsal hump," too, there is a reminder of *D. signicauda.* The group seems to be nearly related to the *tenuicaudatus* group, and is probably an offshoot of it.

One species of this group can hardly be picked out as the most primitive. I have called it the *signicauda* group, simply because that was the first of the species to be described.

THE ALBUQUERQUENSIS GROUP.

In this group are included *D. albuquerquensis, dorsalis, asymmetricus, purpureus* and *saltillinus.* All have a hooked process on the antepenultimate segment of the right antenna of the male. The principal reason for putting them together, however, is the similarity of the male fifth feet. In all, the endopodites are short and composed of a single segment. In all, except *D. albuquerquensis* and *D. saltillinus,* there is a hyaline process on the inner margin of the second basal segment of the right foot; *D. saltillinus* has a tubercle on the inner margin, and both *D. saltillinus* and *D. albuquerquensis* have a peculiar process on the posterior surface of this segment. In all there is a transverse ridge on the posterior surface of the first segment of the right exopodite; in most cases this runs across the segment. In all, except *D. saltillinus,* there is an oblique ridge on the posterior surface of the second segment of the right exopodite. In all, except *D. purpureus,* the terminal segment of the exopodite of the left foot is armed with a digitiform process and a slender articulated spine; this spine in *D. saltillinus* is curved. The fifth feet of the females, too, resemble each other. In all, the exopodites are three-segmented. The endopodites are short, and in all, except *D. saltillinus,* are armed with two rather prominent spines. The female abdomens, with the exception of *D. asymmetricus,* resemble each other; in *D. dorsalis* and *D. purpureus* the first segment is especially long and slender, but it is stouter in *D. saltillinus* and *D. albuquerquensis.* In *D. asymmetricus* the general form is like that of *D. purpureus,* but there is the marked peculiarity of the lateral process.

D. albuquerquensis, D. dorsalis and *D. saltillinus* differ from the other species of the group in the peculiar dorsal processes of the fifth thoracic segment.

I have called the group the *albuquerquensis* group, not because there is any reason to think that this species is the most primitive, but because it was the first described. There would seem to be little question of the close affinity of all the members of the group. *D. saltillinus* differs more widely than do the others. *D. saltillinus,* too, is the most northern species, the others being distinctly southern, *D. albuquerquensis* being found in Colorado, New Mexico and Mexico, and *D. purpureus* and *D. asymmetricus* in Cuba.

It is hardly possible, with the present knowledge, even to guess at the phylogenetic relationships of the group.

D. sanguineus and *D. Eiseni* I am not prepared to locate, even tentatively. It should be noticed, perhaps, that *D. albuquerquensis, dorsalis, saltillinus, Trybomi, sanguineus* and *signicauda* all have a pronounced dorsal process or hump. This may indicate some relationship, but it does not seem clear enough to lead to a grouping of these species.

Of the groups I have formed, it seems to me that the *tenuicaudatus* group is the nearest to the primitive form; it does not appear likely, however, that the others are derivatives of this, but rather that they go back to a common ancestry which resembled *tenuicaudatus* more nearly than the others.

FACTORS CONTROLLING THE DISTRIBUTION OF THE DIAPTOMI.

I think it will appear evident from the discussion of the groups of the *Diaptomi* that there are two great factors controlling their distribution. One is ease of water communication, the other is temperature. There is no reason to think that, under ordinary circumstances, species are distributed in any way except by water carriage. The existence of species isolated in particular localities seems pretty conclusive evidence of this; this is seen in the peculiarly localized habitat of *D. Reighardi,* in the distribution of *D. Birgei,* and in the presence of *D. siciloides* in Cedar lake, Wisconsin, although it has been found in no other part of the state.

An examination of the distribution of the members of the different groups shows very clearly the prominence of the two factors mentioned above. In the *oregonensis* group, *D. Reighardi, D. Bakeri* and *D. franciscanus* are localized species. *D. oregonensis* is a distinctly northern species, while *D. mississippiensis* is as distinctly southern. *D. pallidus* has a somewhat wider range, but apparently through communicating waters.

Of the *tenuicaudatus* group, none are found in the South. *D. tenuicaudatus* has been found only in the far North. *D. minutus* has the widest range, being found from Iceland to southern Wisconsin. *D. sicilis* and *D. Ashlandi* are confined to the northern tier of states, while *D. siciloides* and *D. Birgei* are probably limited, speaking in a very general way, to the region between the parallels of 39° and 43°. The distribution with reference to latitude is very marked in the case of most of the members of this group.

Of the *leptopus* group, *D. leptopus* is the most widely distributed, being found not only through the Mississippi valley but north into British America. *D. clavipes* and *D. Lintoni* are probably somewhat localized. *D. stagnalis* is found from

Illinois south, while *D. conipedatus* is found only in the South. Here again is pretty clear evidence of the importance of the factors of water carriage and temperature.

The *signicauda* group is confined to the mountain region of the West, and I assume it to be a product of isolation. There is no evidence of the effect of temperature in the distribution of the members of this group.

The *albuquerquensis* group is distinctly southern. *D. saltillinus,* the most aberrant member of the group, is found as far north as Nebraska and as far south as Florida, if I am correct in supposing that *D. albuquerquensis* Schacht is *D. saltillinus* Brewer. The distribution of this group, as in the case of the others, gives distinct evidence of the effect of latitude.

Both Forbes and Ward, following European authors, have thought that elevation was a controlling factor in the distribution of fresh water organisms. So far as *Diaptomi* are concerned, I see no reason for thinking that elevation has any effect in controlling the distribution of our American species, except in the indirect way that elevation is accompanied by low temperature. It seems clear to me that the species of *Diaptomi* are commonly confined within rather narrow limits of temperature.

DIAPTOMUS Westwood.

1785. *Cyclops* O. F. Müller.
1820. *Monoculus* Jurine.
1836. *Diaptomus* Westwood.
1838. *Cyclopsina* Milne-Edwards.
1838. *Glaucea* Koch.
1848. *Cyclops* Nicolet.
1889. *Diaptomus* De Guerne and Richard.
1897. *Diaptomus* Schacht.

Although the number of described species of *Diaptomus* has greatly increased since the publication of De Guerne and Richard's *Révision,* and it might be thought wise to subdivide the genus, it has not seemed to me best. The description as given by them is exact, and it seems undesirable to make any change in it.

The following description is taken from the *Révision* without any change:[1]

"Cephalothorax segmentis constans 7, quorum anteriora duo indistincte sejuncta caput componunt. Segmentum ultimum thoracale in femina sat magnum, postice in medio profundius emarginatum adque latera saepius utrinque in laminam exiens biangulatam. Abdomen breve thorace angustius, in femina (ramis caudalibus inclusis) segmentis 4, quorum primum in parte antica dilatatum saepiusque utrinque mucrone laterali armatum est; in mare vero segmentis 6 ejusdem fere latitudinis compositum. Rami caudales setis 5 uniarticulatis et plumosis, setaque alia multo tenuiore intus adfixa praediti. Frons

1 The following translation of the original account of the genus *Diaptomus* may be given:

Cephalothorax always of seven segments, of which the two anterior, indistinctly separated, form the head. The last thoracic segment in the female is rather large, posteriorly in the middle rather deeply emarginate, and quite frequently produced laterally on both sides into a biangulate lamina. Abdomen short, narrower than the thorax, in the female, including the caudal rami, of four segments, of which the first is dilated anteriorly, and commonly armed with a lateral spine on each side; but in the male it is composed of six segments of nearly equal width. The caudal rami are armed with five uniarticulate plumose setae, and with another much more slender seta attached on the inner side. The front is provided with two very minute tentaculiform appendages. The antennae of the first pair are composed of twenty-five segments, which increase a little in length toward the tip; the right antenna of the male is geniculate with the articulation between the eighteenth and nineteenth segments; the six preceding are swollen, and the five following more or less united into two segments. The outer ramus of the second pair of antennae is longer than the inner, composed of seven segments, the last segment longest of all and armed with very long apical setae; the setae attached to the preceding segments are short and nearly equal. The second pair of maxillae are short and thick; the third pair are elongate, turned forward, of seven segments, and furnished with short setae. The eight anterior swimming feet are biramose, the inner ramus of the first pair of two segments, and of the following pairs of three segments; the feet of the last pair, different from the others, are of five segments, with the second segment arm on the inner side with a small attendate for rudiment of an inner ramus; in the female they are short, equal to each other, the last segment very short and rudimentary, the penultimate always produced into a strong hook, curved inward; the right foot of the male is subcheliform, with the last segment formed into a very long movable hook. The eye is single.

appendicibus tentaculiformibus 2 minimis instructus. Antennae primi paris articulis 25 apicem versus parum longitudine crescentibus compositae; dextra maris articulatione inter articulum 18-mum et 19-mum geniculans, antecedentibus 6-tumidis, sequentibus 5 in 2 modo confluentibus articulos. Ramus antennarum 2-di paris exterior interiore longior 7-articulatus, articulo ultimo omnium maximo setisque longissimis apicalibus instructo; setae articulis antecedentibus inhaerentes breves et fere equales. Maxillae 2-di paris breves et crassae; 3-tii paris elongatae et antice vergentes 7-articulatae setisque brevibus obsitae. Pedes anteriores 8 biramosi natatorii, ramo interiore in 1-mo pari 2-, in sequentibus 3-articulato pedes ultimi paris ceteris dissimiles 5-articulati, articulo 2-do intus appendice parva vel rudimento rami interioris instructo; in femina breves inter se equales, articulo ultimo perbrevi et rudimentari, penultimo sine fine in unguem validum introrsum curvatum exeunte; dexter maris subcheliformis, articulo ultimo in unguem mobilem longissimum conformato. Oculus unicus."

ANALYTICAL KEYS.

Artificial keys are always unsatisfactory, and yet they seem necessary in order to help one to a determination of species. In the following keys an attempt has been made to indicate the groupings of species by a few salient points. The result is not what could be wished, but it is hoped that it will be of assistance, especially to those who are not familiar with the classification of the genus. The synopses of DeGuerne and Richard are by all odds the most satisfactory of those hitherto published; accordingly these analyses are based on their work. No attempt has been made to carry the analysis of the characteristics of the females far enough to determine all the species, for it is impossible, in some cases, to separate the females of related species. A final determination can be made only when one has the male forms.

ANALYTICAL KEY TO THE NORTH AMERICAN SPECIES OF DIAPTOMUS BASED ON THE CHARACTERS OF THE MALE.

Antepenultimate segment of the male right antenna without a district appendage,
- Antepenultimate segment slightly produced at the distal end into a blunt point, first segment of right exopodite with marked quadrangular hyaline appendage, ... ***Birgei***
- Right and left feet nearly equal in length, terminal hook of right foot symmetrical, ... ***oregonensis***
- Left foot shorter than right,
  - Left foot reaching beyond first segment of the exopodite,
    - Terminal hook of right foot uniangular, right endopodite equal in length to first segment of the exopodite, ... ***Reighardi***
    - Terminal hook biangular, right endopodite large, longer than first segment of the exopodite, ... ***mississippiensis***
  - Left foot reaching end of first segment of the exopodite,
    - Inner process of the terminal segment of the left exopodite falciform, no hyaline appendage of first segment of right exopodite, ... ***pallidus***
    - Inner process of terminal segment of left exopodite digitiform, a hyaline appendage on internal distal angle of first segment of right exopodite, ... ***Tyrelli***

Antepenultimate segment of male right antenna with hyaline lamella,
- Hyaline lamella broad, extending beyond the end of the segment, second basal segment of the right exopodite armed on the posterior surface with a small hook, ... ***leptopus***
- Hyaline lamella narrow, extending beyond the end of the segment slightly, if at all, first basal segment armed with a hook equal in length to the first segment of the exopodite, ... ***clavipes***

Antepenultimate segment of the right antenna bears a slender straight process,
- This process is much shorter than the penultimate segment,
  - Right endopodite rudimentary,
    - Lateral spine of the second segment of the right exopodite is terminal, ... ***Lintoni***
    - Lateral spine of the second segment of the ex-

opodite is near the proximal end, the antennal process is dentate on the outer margin, ... ***Trybomi***

Right endopodite about equals in length the first segment of the exopodite, lateral spine median, ... ***Judayi***

The process of the antepenultimate segment of the right antenna nearly equals or equals the penultimate segment,

The right endopodite equals in length the first segment of the exopodite, spines of the first basal segment large, ... ***tenuicaudatus***

The right endopodite exceeds the length of the first segment of the exopodite, spines of the first basal segment small, ... ***sicilis***

The process of the antepenultimate segment of the antenna exceeds in length the penultimate segment,

Large. Lateral spine of the second segment of the male exopodite is terminal or nearly so,

The antennal appendage only slightly longer than the penultimate segment, antennae equal in length to cephalothorax, ... ***shoshone***

Antennal appendage exceeding in length the ultimate segment, antennae reaching the furca, ... ***Wardi***

Small. The lateral spine of the second segment of the right exopodite is on the proximal half of the segment, the antennae reach beyond the furca,

Lateral spine of the second segment of the right exopodite short, right endopodite rudimentary, ... ***minutus***

Lateral spine long, right endopodite equals in length the first segment of the exopodite, ... ***Ashlandi***

The antepenultimate segment of the right antenna bears a curved process,

The appendage equals or exceeds in length the penultimate segment,

The appendage about equals in length the last two segments, the second basal segment of the right foot is dilated on the inner margin, the endopodites are two-segmented, ... ***Eiseni***

The appendage slightly exceeds in length the penultimate segment, second basal segment of the right foot not dilated on the inner margin, the left endopodite one-segmented, ... ***franciscanus***

The appendage is shorter than the penultimate segment,

One or both terminal processes of the last segment of the left exopodite are distinctly falciform, The right endopodite is small, shorter than the first segment of the exopodite,

Terminal segment of the right exopodite is elongate,

Right endopodite rudimentary, left endopodite 2-segmented, spatulate in form, ... *spatulocrenatus*

Terminal segment of right exopodite much the broadest at the distal end, lateral spine nearly terminal and straight, left endopodite elongate, ... *conipedatus*

Terminal hook of right exopodite falciform, lateral spine at the distal third of the segment, second basal segment of the right foot broad at the distal end with process at the external distal angle, ... *sanguineus*

Terminal segment of right exopodite of usual length,

Lateral spine terminal,

Inner surface of left endopodite rugose, a very large species, ... *stagnalis*

Segments of right foot short and broad, terminal hook long and strongly curved, lateral spine long and straight, ... *saltillinus*

The right endopodite is distinctly longer than the first segment of the exopodite,

The first segment of the right exopodite has an oblique ridge on its dorsal surface,

The first segment of the right exopodite has a transverse ridge, the lateral spine of the terminal segment is about one-half as long as the segment, ... *asymmetricus*

The first segment of the right exopodite has two curved processes on its dorsal surface, the lateral spine of the terminal segment equals or exceeds in length the segment, ... *dorsalis*

The first segment of the right exopodite does not have a transverse ridge on the dorsal surface,

The lateral spine of the terminal segment of the right exopodite is terminal, the endopodites are distinctly two-segmented, ... *Bakeri*

The lateral spine is situated on the distal third of the terminal segment of the right exopodite, the right endopodite is indistinctly two-segmented, the left one-segmented, ... *washingtonensis*

The right endopodite equals or only slightly exceeds the first segment of the exopodite,

The terminal segment of the right exopodite has a transverse ridge on its dorsal surface, the lateral spine exceeds in length the segment, ... *albuquerquensis*

The terminal segment of the right exopodite does not have an oblique ridge on its dorsal surface, the lateral spine is short, about one-half the length of the segment, ... *novamexicanus*

The terminal processes of the left exopodite are digitiform, the right endopodite shorter than the first segment of the exopodite,

The right endopodite triangular in form, first segment of the exopodite without hyaline appendage, ... *nudus*

The first segment of the right exopodite with hyaline appendage,

Appendage at the inner distal angle, endopodite about equals the first segment of the exopodite, ... *signicauda*

Appendage on inner distal half, quadrangular in form, endopodite much shorter than the first segment of the exopodite, ... *siciloides*

The first segment of the right exopodite with a transverse ridge, second segment with oblique ridge and hyaline process near the outer margin, ... *purpureus*

ANALYTICAL KEY TO THE NORTH AMERICAN SPECIES OF DIAPTOMUS BASED ON THE CHARACTERS OF THE FEMALE.

The endopodites of the fifth feet are shorter than the first segments of the exopodites,

The first antennae do not reach the end of the furca,

The endopodites are one-segmented,

The exopodites are two-segmented, the fifth cephalothoracic segment has a dorsal process, the first abdominal segment is asymmetrical, its distal end being expanded to the right, ... *Trybomi*

The exopodites are three-segmented, there is no dorsal process, the abdomen is symmetrical, ... *purpureus*

The fifth cephalothoracic segment has a dorsal process, the first abdominal segment is asymmetrical, its distal end being expanded to the right, ... *Trybomi*

The endopodites are two-segmented,

Terminal spines of endopodite fully as long as the endopodite, a large species, ... *stagnalis*

Terminal spines of endopodite short, a moderate sized species, ... *Eiseni*

The first antennae equal or exceed the length of the whole body including the furca,

The endopodite is rudimentary, ... *minutus*

The endopodite equals in length about one-half the first segment of the exopodite,

Fifth cephalothoracic segment with dorsal process, endopodite one-segmented, ... *saltillinus*

Fifth cephalothoracic segment with dorsal process, endopodite commonly two-segmented, . . *albuquerquensis*

The endopodite exceeds in length one-half the first segment of the exopodite,

The fifth cephalothoracic segment is armed with two dorsal processes, ... *dorsalis*

The first segment of the abdomen has a prominent swelling on the right side.............. *asymmetricus*

The endopodite equals or exceeds in length the first segment of the exopodite,

There is a digitiform process on the right posterior border of the first abdominal segment. This process is variable in length, typically, in *signicauda*, extending far beyond the second segment, *signicauda*, *nudus*, *washingtonensis*, *Judayi*

(These species can be satisfactorily separated only by the characteristics of the male. Generally the abdominal process is much more pronounced in *signicauda*. The lateral projections of the abdomen are strongest in *Judayi*, less pronounced in *nudus* and about equally prominent in *washingtonensis* and *signicauda*).

The first abdominal segment bears no process on its right hand posterior margin,

The lateral spines of the abdomen are either absent or very minute,

The exopodite is distinctly three-segmented,

Antennae equal to cephalothorax, a very large species, ... *shoshone*

Antennae reach to furca, ... *Wardi*

The exopodite is two-segmented, the abdomen elongated,

The abdomen is very much elongated, the lateral swelling of the first segment very slight, ... *tenuicaudatus*

Lateral swelling of first abdominal segment distinct, *sicilis, Ashlandi, oregonensis, pallidus, Reighardi, mississippiensis, Lintoni, spatulocrenatus.*

(These species cannot be satisfactorily separated by the characteristics of the female, although the limits of size will help somewhat.)

The lateral spines of the abdomen are distinct,
The exopodite is distinctly three-segmented, the endopodite is two-segmented, ...*Bakeri*

The exopodite is two-segmented, the endopodite one-segmented, the second segment of the exopodite has three spines, *conipedatus, clavipes, Tyrelli, leptopus.*

(These cannot be separated by the characteristics of the female.)

The second segment of the exopodite has two spines, *siciloides, sanguineus, Birgei, novamexicanus.*

DIAPTOMUS OREGONENSIS Lilljeborg.
Plate XV, figs. 1, 4, 7.

1889. *Diaptomus oregonensis* DeGuerne and Richard, p. 53; pl. II, fig. 5; pl. III, fig. 8.

1893. *Diaptomus oregonensis* Marsh, p. 200; pl. IV, figs. 4, 5.

1895. *Diaptomus oregonensis* Marsh, p. 8; pl. VII, fig. 5.

1895. *Diaptomus oregonensis* Herrick and Turner, p. 72; pl. IV, figs. 7–12; pl. IX, fig. 3.

1897. *Diaptomus oregonensis* Schacht, p. 151; pl. XXIX, figs. 1 and 2.

1906. *Diaptomus pygmaeus* Pearse, p. 244; figs. 1, 2 and 3.

Of medium size. Cephalothorax widest at the middle. The first segment of the cephalothorax exceeds in length the three following segments. The last segment is slightly produced laterally and armed with two minute spines.

The first segment of the female abdomen equals in length the rest of the abdomen. It is slightly expanded laterally, and sometimes bears two very minute lateral spines; these, however, are not always present. The second segment is shorter than the third, and the third shorter than the furcal rami. The length of the furcal rami is twice their width; they are finely ciliate on the inner margin.

The antennae are 25-segmented and nearly reach the ends of the furcal setae. The right male antenna is swollen anterior to the geniculating joint; the antepenultimate segment has no special armature.

The first basal segments of the female fifth feet have the spines of the posterior surface of moderate size. The lateral hair of the second basal segment is of moderate size. The first segment of the exopodite is twice as long as wide. The hook of the second segment is slender and rather slightly curved. It is finely denticulate on the inner margin. The third segment is ordinarily represented by two spines, of which the outer is the longer. In some cases, however, the inner spine arises from a small segment, which represents the third segment of the exopodite. The endopodite slightly exceeds in length the first segment of the exopodite. It is obtusely pointed, is setose at the tip, and armed with two rather long terminal spines.

The first basal segments of the male fifth feet have the spines of the posterior surface of moderate size. The second basal segment is a little less than twice as long as wide. The lateral hair is situated at the beginning of the distal third. The first segment of the exopodite is trapezoidal in form, its length and breadth are about equal, and it is somewhat produced on the distal exterior angle. The second segment is twice as long as its width and is slightly curved on the exterior margin. On the posterior surface near the internal margin it bears a small spine; this is situated at the end of the proximal third of the segment. The lateral spine is situated near the end of the segment; it is about two-thirds as long as the segment, is slightly curved, and minutely denticulate on the inner margin. The terminal hook is slender, regularly curved, and nearly equals in length the whole of the right foot. It is finely denticulate on the inner margin. The endopodite is one-segmented, rather stout, and exceeds in length the first segment of the exopodite. It is setose at the tip. The left foot equals in length the right. The second basal segment is in form like the corresponding segment of the right foot, but is somewhat smaller. There is a slight projection on its inner margin. The lateral hair is situated at the beginning of the distal third. The first segment of the exopodite is twice as long as wide.

The outer margin is convex, the inner sinuate and setose. The second segment is produced into two finger-like processes, one exterior and one interior. The exterior one is finely denticulate on the inner margin. The interior process bears a small process on its base which projects inwards. The inner surface of the segment is setose.

Length of female, 1.5 mm. Length of male, 1.4 mm. These are the figures of Lilljeborg. There is considerable variation in the length of specimens from various localities.

This is one of the most widely distributed of the North American species. The type specimens were from Portland, Oregon. It is by far the most common species in the lakes of Wisconsin and Michigan, and occurs, though not in great numbers, in the Great Lakes. It is found in Iowa, northern Illinois and northern Indiana, in Minnesota, and I have specimens from Kinistino, Northwest Territory. No extensive collections have been made in the eastern states, but it is found in eastern Massachusetts, and I think it probable that this species is distributed all over North America north of the latitude of northern Illinois. In southern Illinois and in the southern states its place seems to be taken by *D. pallidus.*

It is rather remarkable that a species of such wide distribution should show so little variability.

I have not seen specimens of Pearse's *pygmaeus,* but I have gone over his description and figures very carefully, and I see no reason to separate it from *oregonensis.* The only possible points of difference which I can see, are the form of the hook of the exopodite of the male right fifth foot, the form of the endopodite of the left fifth foot of the male, and the form of the female abdomen. Pearse states in his description that the hook is curved somewhat "sharply." His figure, however, shows no sharper curvature than would be true of *oregonensis.* The endopodite of the left fifth foot of the male is more pointed than in typical *oregonensis,* but the form of this segment varies, and frequently is as sharp as in his figure. Apparently, from his figure, the abdomen of the female is somewhat broader than in the type. These differences, however, if they are recognizable differences, could hardly be considered more than varietal.

DIAPTOMUS REIGHARDI Marsh.

Plate XV, figs. 2, 6, 9.

1895. *Diaptomus Reighardi* Marsh, p. 9; pl. I, figs. 1-4.
1897. *Diaptomus Reighardi* Schacht, p. 169; pl. XXVIII, fig. 1.

Of moderate size. The first cephalothoracic segment nearly equals in length the rest of the cephalothorax; the suture of this segment is very distinct. The last cephalothoracic segment is armed on each side with a minute spine.

The first segment of the female abdomen is elongated, nearly equaling in length the remainder of the abdomen and the furca. It is dilated laterally and in front. The lateral dilatations are slight, and are armed on each side with a minute spine. The second segment is about one-third shorter than the third. The third segment is slightly shorter than the furcal rami. The furcal rami are ciliate on the inner margin.

The antennae are 25-segmented and reach to the end of the furca. The right male antenna is swollen anterior to the geniculating joint; the antepenultimate segment has no appendage.

The spines of the posterior surface of the first basal segments of the female fifth feet are very small. The first segment of the exopodite is twice as long as wide. The second segment is prolonged into a sharp hook which is denticulate on the inner margin. The third segment is represented by two spines. The endopodite is one-segmented, slightly longer than the first segment of the exopodite, is setose at tip, and armed with two rather long spines.

The spines of the first basal segments of the male fifth feet are moderately prominent. The second basal segment of the right foot is about one-half longer than broad. The lateral hair is situated at about two-thirds of its length. The length of the first segment of the exopodite is about equal to its width. It bears a slight fold on its posterior surface near the distal end. The second segment is more than twice as long as wide, and concave on the inner margin. At about one-third of its length is a small spine near the inner margin. The lateral spine, situated at the beginning of the distal third of the segment, is slightly curved, and finely denticulate on the inner margin. The terminal hook is slender, and equal in length to the whole right foot. At slightly less than half its length there is an abrupt angle. Distad of the angle, the inner margin of the hook is denticulate. The endopodite is one-segmented, rounded at tip, and equal in length to the first segment of the exopodite. The left fifth foot of the male reaches a little beyond the middle of the second segment of the right exopodite. The second basal segment is a little longer than wide, and somewhat shorter than the corresponding segment of the right foot. The lateral hair is situated at the beginning of the distal third. The first segment of the exopodite is about as long as wide, its distal end considerably narrower than the proximal. The inner margin is strongly convex and setose. The second segment is about twice as long as the first, and is armed at the tip with two finger-like processes; the outer of these processes is much the larger, and is armed on its inner surface with a minute setose pad. The inner process is separated from the main part of the segment by a suture. The endopodite is slender, twice as long as the first segment of the exopodite, and setose at the tip.

Length of female, 1.1395 mm. Length of male, 1.0248 mm.

This species was found in collections made in connection with the scientific work of the Michigan Fish Commission in Intermediate lake, and in North lake on Beaver island. It also occurred in a collection made by Dr. R. H. Ward in Crooked lake. It was associated with *D. oregonensis,* to which it is closely related. It is apparently a rather narrowly localized species, for, although collections have been made quite generally in the Michigan and Wisconsin lakes, it has, so far, been found only in these three localities.

DIAPTOMUS MISSISSIPPIENSIS Marsh.

Plate XV, figs. 3, 5, 8.

1894. *Diaptomus mississippiensis* Marsh, p. 15; pl. I, figs. 1–3.

1895. *Diaptomus mississippiensis* Herrick and Turner, p. 78; pl. XLVII, figs. 1–3.

1897. *Diaptomus mississippiensis* Schacht, p. 173; pl. XXXIII, figs. 1–4.

Of moderate size. The suture of the first cephalothoracic segment is very distinct. This segment is about equal in length to the three following. The last cephalothoracic segment is armed on each side with a minute spine.

The first abdominal segment of the female is as long as the remainder of the abdomen and the furca. It is dilated laterally and in front, and bears two lateral spines of which the right one is ordinarily somewhat the larger. The second segment is somewhat shorter than the third, and the third and the furca are about equal in length. The length of the furcal rami considerably exceeds their width, and they are ciliate on the inner margin. The furcal setae are short and stout.

The antennae are 25-segmented and reach beyond the furca. The right antenna of the male is much swollen anterior to the geniculating joint; the antepenultimate segment has no appendage.

The female fifth feet are rather short and stout. The spines of the first basal segments are small. The lateral hairs of the second basal segments are moderately long. The length of the first segment of the exopodite is less than twice its width. The hook of the second segment is short, acuminate and slightly curved. It is denticulate on the inner margin. The third segment is represented by two spines, of which the inner is the longer. The endopodite is one-segmented and slightly exceeds the length of the first segment of the exopodite. It is setose at tip and bears two terminal spines.

In the fifth feet of the male the spines of the first basal segment are rather large. The second basal segment of the right foot is broader than long and much swollen on the inner side. The lateral hair is at the beginning of the distal third. The first segment of the exopodite is trapezoidal, and as broad as long. The second segment is stout, its length exceeding its breadth by about one-half. At the middle of its inner margin is a small spine. The lateral spine is of moderate length, nearly straight, and denticulate on the inner margin. It is situated at the distal angle of the segment. The terminal hook has the symmetry of the curve broken by two rather abrupt angles; its inner margin is finely denticulate. The endopodite is stout and somewhat spindle-shaped. It is attached to the side of the second basal segment. It is setose at the tip, and reaches nearly to the middle of the second segment of the exopodite. The second basal segment of the left fifth foot is quadrate and nearly equal in length to the corresponding segment of the right foot. The lateral hair is situated well towards the distal end of the segment. The first segment of the exopodite is trapezoidal, the distal end being very narrow. The second segment consists of an oval base and two elongated digitiform processes. The basal part is setose on the inner margin. Of the terminal processes, the posterior one is the longer. The anterior one is enlarged and denticulate at tip and is separated from the segment by a distinct joint. The endopodite is one-segmented and nearly equal in length to the exopodite. The whole foot reaches to the middle of the second segment of the exopodite of the right foot.

Length of female, 1.2 mm. Length of male, 1.1 mm.

The original description was from material sent by Professor Birge and obtained in Jackson, Mississippi. I have since found it in collections made by Professor Birge in Guzman and Slidell, Louisiana, and Schacht reports it from lakes in Florida.

DIAPTOMUS PALLIDUS Herrick.

Plate XVI, figs. 1, 2, 3.

1879. *Diaptomus pallidus* Herrick, p. 91; pl. II, figs. *a-d.*
1883. *Diaptomus pallidus* Herrick, p. 383; pl. VII, figs. 1-6.
1884. *Diaptomus pallidus* Herrick, p. 142; pl. Q, fig. 17.
1889. *Diaptomus pallidus* DeGuerne and Richard, p. 62; fig. 34.
1893. *Diaptomus pallidus* Marsh, p. 196; pl. III, figs 6, 7, 9.
1895. *Diaptomus pallidus* Herrick and Turner, p. 73; pl. IV, figs. 1-6; pl. V, fig. 10; pl. XIII, fig. 17.
1897. *Diaptomus pallidus* Schacht, p. 144; pl. XXVII, fig. 3.
1905. *Diaptomus pallidus* Pearse, p. 147.

A slender species of medium size. First cephalothoracic segment considerably longer than the three following; the last cephalothoracic segment bears two small lateral spines.

The first abdominal segment of the female nearly equals in length the rest of the abdomen, is slightly dilated laterally, and bears two minute lateral spines. The second segment is slightly shorter than the third, and the third slightly shorter than the furcal rami. The furcal rami are ciliate on the inner margin.

The antennae are 25-segmented and reach slightly beyond the end of the furcal rami. The right antenna of the male is swollen anterior to the geniculating joint, and without special armature.

The female fifth feet are short and stout, the spines of the first basal segments small. The lateral hairs of the second basal segments are rather long. The exopodite is composed of two segments, the third segment being represented by two spines. The second segment is prolonged into a rather long hook, and serrulate on the inner margin. The endopodite is slightly longer than the first segment of the exopodite; the tip is setose, and armed with two rather long spines.

In the male fifth foot the spines of the posterior surface of the first basal segments are small. The second basal segment of the right foot is twice as long as broad, and the rather long lateral hair is situated at about two-thirds of its length. The first segment of the exopodite is longer than broad. The second segment is twice as long as the first, and bears upon its inner margin at the end of the proximal third a small spine. The outer distal angle of the segment is truncated, and the lateral spine, which is slender and slightly curved, is situated at the beginning of this truncation. The terminal spine is slender, curved, and slightly angular, and about once and a half the length of the first segment of the exopodite. It is denticulate on the inner margin. The right endopodite is slender, of one segment, pointed at the tip, with minute terminal setae, and equal in length to the first segment of the exopodite.

The left male fifth foot reaches about one-third the length of the second segment of the right exopodite, although its length is somewhat variable. The second basal segment is quadrate and longer than broad. The lateral hair is situated at about three-fourths of its length. The first segment of the exopodite equals in length the corresponding segment of the right foot; the distal end is about one-half the width of the proximal. The second segment is one-half as long as the first. It is armed with an outer finger-shaped process which has a small pad on its inner margin, and an inner slender falciform process which curves over the tip of the segment. This falciform process is armed with a blunt spine on its inner margin. I fail to verify the armature as described by Herrick ('95, p. 73.) The endopodite is slender, pointed, with minute terminal setae, and is equal in length to the first segment of the exopodite.

Length of female, 1.18 mm. Length of male, 1.043 mm. These lengths are averages from specimens from St. Louis. They are larger than I had obtained from Wisconsin specimens, but not as large as the figures given by Herrick.

Herrick's original description was of specimens found in Minnesota. He afterwards reported a species "like *pallidus*" in Alabama. (Herrick, '87, p. 11.) In his final report he speaks of it as in the entire Mississippi valley, but without specifying definite locations.

Schacht ('97, p. 146) says it is extremely abundant near Havana, Ill. I have found it in only one locality in Wisconsin,—Heart lake near Marquette. I have also found it in collections from Elk lake, Clay county, Iowa. From the southern states I have found it from Missouri, Tennessee, Arkansas, Louisiana and Texas. It occurs, too, in Lake Minnequa in Pueblo, Colorado, and in eastern Nebraska, and the presumption is that it occurs at intermediate points between the Rocky mountain region and the observed stations farther east. So it would appear that it is not only found throughout the Mississippi valley, but that it is pretty well confined to that valley, and much more abundant in the middle and southern part of the region.

DIAPTOMUS FRANCISCANUS Lilljeborg.

Plate XXVI, figs. 7, 11. Plate XXVII, figs. 1, 2.

1889. *Diaptomus franciscanus* DeGuerne and Richard, p. 48; pl. I, figs. 12, 13, 34; pl. III, fig. 23.

1895. *Diaptomus franciscanus* Herrick and Turner, p. 58; pl. VIII, figs. 12 and 16.

1897. *Diaptomus franciscanus* Schacht, p. 160; pl. XXX, figs. 1-4.

Rather large. Cephalothorax widest at the middle, the last two segments confluent above. The lateral lobes, seen from above, are short and obtuse posteriorly, and armed on each side with two small spines. The first segment of the abdomen is about equal in length to the rest of the abdomen, is moderately dilated in front, rounded at the sides, bears two small lateral spines, but lacks lateral processes. The indications of a joint—an imperfect suture—remain long after maturity in the posterior part of this segment. The second abdominal segment is much shorter than the third, its test more delicate and easily pushed together. The furcal rami are short, their length to their breadth as one and one-half to one; they are ciliate on both inner and outer margins.

The first pair of antennae in the female are 25-segmented, and reach about to the furca. The antepenultimate segment of the right antenna of the male bears an unguiform process, slightly longer than the penultimate segment.

In the female fifth foot, the exopodite is three-segmented. The first segment is somewhat elongate, its length being nearly three times its width. The second segment is prolonged into the customary hook. The hook is arcuate, denticulate on the inner margin, the last tooth being the largest. The segment bears a small spine at its outer distal angle. The third segment is small but distinct, and bears two small spines. The endopodite is one-segmented, about equal in length to the first segment of the exopodite, and bears at the tip two unusually long spines which are ciliate at base.

In the male, the second basal segment of the right foot is quadrate, longer than wide, and bears the lateral seta a little beyond the middle. The first segment of the exopodite is quadrate and short, being only about one-half the length of the second basal segment. The second segment is rectangular, rather less than twice the length of the first; the lateral spine is situated at the distal angle, and about midway of the inner margin there is a minute spine. The terminal hook is long, equaling the whole right foot exclusive of the first basal segment, is sigmoid, and slender towards the apex. The endopodite is small, barely reaching the middle of the second segment of the exopodite, is imperfectly two-segmented or one-segmented, and bears a spine at the apex.

The left fifth foot of the male reaches about to the middle of the second segment of the exopodite of the right foot. The second basal segment is longer than broad, shorter than the corresponding segment of the right foot, is concave on the outer margin and convex on the inner; the lateral hair is situated at about three-fourths of its length. The first segment of the exopodite is twice as long as wide, nearly as long as the second basal segment. The second segment is about equal in length to the first, is almost triangular, and thinner on the inner margin. The outer part of this segment is thicker, has a short spine in the middle, and ends in a short and obtuse process. The oblique apical margin of the inner surface has three small incisions. The inner margin of this segment is finely ciliate. The endopodite is one or two-segmented, slender, attenuate towards the apex, and reaches to about the middle of the second segment of the exopodite.

Length of female, 2.3 mm. Length of male, 2 mm.

Found in the neighborhood of San Francisco.

The above is the description of DeGuerne and Richard with some slight additions. The species has thus far been found only in the original locality.

DIAPTOMUS BAKERI sp. nov.

Plate XVI, figs. 4, 5, 6, 9.

A small species. The first cephalothoracic segment is as long as the three following, the second, third and fourth being about equal in length. The last cephalothoracic segment is armed with two minute spines on each lateral lobe.

The first segment of the female abdomen equals in length the rest of the abdomen, including the furcal rami. It is broad, dilated in front and laterally, with two small lateral spines about midway of its length. The second segment is very short. The width of the third segment is greater than its length. The furcal rami are about equal in length to the third segment, and are ciliate on the inner margin.

The antennae are 25-segmented and barely reach the end of the furcal rami. The right antenna of the male is much swollen anterior to the geniculating joint. The antepenultimate segment bears a hook-shaped process which is fully half as long as the penultimate segment.

The first basal segments of the female fifth feet are armed with rather small spines. The lateral hairs of the second basal segments are short. The exopodite consists of three segments. The second segment is prolonged into a hook which is quite strongly recurved. The hook is denticulate on its inner margin, the distal denticulations being unusually large. The outer angle of the second segment has a small spine. The third segment is short, but distinct, and armed with two spines. The endopodite equals in length the first segment of the exopodite. It is two-segmented, and the distal segment is armed at the tip with three spines, one rather stout and plumose, the other two long and slender.

The spines of the first basal segments of the male fifth feet are rather small. The second basal segment of the right foot is quadrate, its length being to its width as three to two. The lateral hair is near the middle but on the distal portion. The first segment of the exopodite is very short, its width being about twice its length. The outer margin is prolonged distally, and the inner margin, on the posterior face, bears a hyaline lamella which is much wider at the distal end of the segment. The second segment of the exopodite is twice as long as broad and is quadrate in form. At about a third of its length, on the posterior face, nearer the inner margin, is a small spine. The lateral spine is on the outer distal angle, of medium length, and nearly straight. The terminal hook is as long as the whole right foot exclusive of the first basal segment, is slender, and with a marked angle about midway of its length. The right endopodite is two-segmented, extends something less than one-half the length of the second segment of the exopodite, and is tipped with two small, blunt spines. The second basal segment of the left foot is quadrate, about two-thirds the length of the corresponding segment of the right foot. The lateral hair is near the distal angle. The first segment of the exopodite is long and slender, being nearly four times as long as broad. It is trapezoidal in form, and bears on its inner margin a rounded hyaline projection. The second segment of the exopodite is very slender, and bears two finger-like processes. Near the base on the inner margin is a prominent ciliated pad. The endopodite is slender, two-segmented, reaches about midway of the length of the second segment of the exopodite, and is terminated by two minute spines.

Length of female, 1.27 mm. Length of male, 1.124 mm.

This species was found in material collected by Professor C. F. Baker in Lake Lagunita, Palo Alto, California.

This form is closely related to *D. franciscanus* Lillj. The general form of the male fifth feet is the same, but there are marked differences in the exopodite of the left foot. The projection of the antepenultimate segment of the right male antenna is shorter. The endopodite of the female fifth foot is two-segmented, while it is composed of a single segment in *D. franciscanus*. The endopodite in *D. Bakeri* is armed with three terminal spines, while there are only two in *D. franciscanus*. The very close relationship, however, is shown in that in both species the exopodite is three-segmented, and both have the peculiar denticulation of the inner margin of the second segment with the larger teeth towards the distal end.

DIAPTOMUS TENUICAUDATUS sp. nov.

Plate XVI, figs. 7, 8. Plate XVII, figs. 2, 3.

The first cephalothoracic segment is nearly as long as the rest of the cephalothorax. The last segment bears two minute lateral spines.

The abdomen of the female is unusually long and slender. The first segment is considerably longer than the next two, and is somewhat enlarged in front and laterally, but has no lateral spines. The second segment is slightly longer than the third, and the furcal rami about equal in length to the second segment. The length of the furcal rami is about three times their breadth.

The antennae hardly reach the end of the furca. The right antenna of the male is swollen anterior to the geniculating joint, and the antepenultimate segment bears a straight process, which equals in length the penultimate segment.

The first basal segments of the female fifth feet are armed with the customary spines. The lateral hairs of the second basal segments are rather long. The exopodite is composed of two segments, the third segment being represented by two spines. The second segment is prolonged into the customary hook, which is very finely denticulate on the inner margin. The endopodite slightly exceeds in length the first segment of the exopodite, is delicately hairy at the tip, and is armed with two rather short terminal spines.

The first basal segments of the male fifth feet are armed with large spines. The second basal segments are rudely trapezoidal in form with the inner margins curved, and with the lateral hairs situated at about one-third the length of the segments from the distal ends; the segment of the right foot is considerably larger than that of the left. The first segment of the exopodite is quadrate, its length and breadth being nearly equal. It bears upon the outer distal angle a rounded hyaline lamella, and another rounded hyaline lamella projects on the posterior surface from the distal part of the segment; this lamella projects slightly over the second segment of the exopodite. The second segment is much shorter than the combined length of the first segment and the second basal segment. The lateral spine is situated at about three-fourths its length. The terminal hook is falciform, and about a third longer than the two segments of the exopodite. The endopodite is slender, hairy at the tip, and slightly exceeds in length the first segment of the exopodite. The two segments of the left exopodite are rudely oval in form, about equal in length. The inner margin of the terminal segment and the distal third of the inner margin of the first segment are ciliate. The second segment bears two short finger-like processes. The left endopodite is slender, reaching nearly half the length of the second segment, and is indistinctly two-segmented.

Length of male, 1.195 mm. Not enough mature females were secured to get an average of lengths.

This species was found in material collected by Mr. Russell T. Congdon in Glen lake, Saskatchewan.

The noticeable peculiarities which distinguish this from other forms are the elongated female abdomen, without lateral spines, and the hyaline lamellae of the first segment of the exopodite of the right male fifth foot.

DIAPTOMUS SICILIS Forbes.

Plate XVII, figs. 1, 4, 5, 9.

1882. *Diaptomus sicilis* Forbes, p. 645; pl. VIII, figs. 9, 20.
1884. *Diaptomus pallidus* var. *sicilis* Herrick, p. 142; pl. Q, fig. 18.
1889. *Diaptomus sicilis* DeGuerne and Richard, p. 23; figs. 13, 14; pl. II, fig. 18.
1891. *Diaptomus sicilis* Forbes, p. 702; pl. I, fig. 6.
1893. *Diaptomus sicilis* Marsh, p. 197; pl. III, figs. 8, 10.
1895. *Diaptomus sicilis* Herrick and Turner, p. 60; pl. V, figs. 1–7; pl. XIII, fig. 18.
1895. *Diaptomus sicilis* Marsh, p. 7; pl. VII, figs. 1, 11.
1897. *Diaptomus sicilis* Schacht, p. 122; pl. XXI, figs. 1–3.
1905. *Diaptomus sicilis* Pearse, p. 147.

A rather small, slender species. The suture of the first cephalothoracic segment is very distinct. This segment is somewhat shorter than the rest of the cephalothorax. The last segment is armed with a minute spine on each side.

The abdomen of the female is elongated. The first segment is shorter than the rest of the abdomen. It is moderately dilated laterally. Schacht figures small lateral spines, but I do not find them in my specimens. The second and third segments and the furcal rami are nearly equal in length. The furcal rami are more than twice as long as wide. The setae are long and slender.

The antennae are 25-segmented and reach beyond the furca. The right antenna of the male is slightly swollen anterior to the geniculating joint. The antepenultimate segment bears a slender, straight process, slightly swollen at the tip, and nearly equal in length to the penultimate segment.

The spines of the first basal segments of the female fifth feet are small. The lateral hair of the second basal segment is of moderate length. The first segment of the exopodite is twice as long as wide. The hook of the second segment is moderately curved, and finely denticulate on the inner margin. The third segment is represented by two spines, of which the inner is the longer. The endopodite is slender, slightly exceeding in length the first segment of the exopodite. It is setose at tip and bears two rather long terminal spines. It is commonly composed of one segment, but sometimes has two.

The male fifth feet are of moderate length. The spines of the first basal segments are slender and rather long. The second basal segment of the right foot is longer than wide, and its inner and outer margins are convex. The lateral hair is short, and situated at the beginning of the distal fourth. The first segment of the exopodite is as long as broad, and somewhat produced at the distal outer angle. From the posterior surface near the internal distal angle extends a hyaline lamella. The second segment is more than twice as long as its width, is strongly convex on the outer margin, and slightly concave on the inner. The distal end is about one-half as wide as the proximal. The lateral spine is slightly curved, about half as long as the segment and situated near the beginning of the distal third. The terminal hook is slender, falciform, symmetrically curved, somewhat less in length than the rest of the right foot. The endopodite is slender, either one- or two-segmented, and considerably longer than the first segment of the exopodite. The second basal segment of the left foot is quadrate, slightly longer than broad, with the lateral hair situated at the beginning of the distal fourth. The first segment of exopodite is longer than wide, its inner surface strongly curved and setose. The second segment is twice as long as wide. The inner margin has two setose convexities, the distal one being continuous with the rounded end of the segment. This segment is terminated by two finger-like processes, the inner being shorter and more slender. The left foot reaches to about the middle of the second segment of the right exopodite. The endopodite is long and slender, reaching about two-thirds the length of the second segment of the exopodite. It is composed of either one or two segments, and is setose at the tip.

Length of female, 1.25 mm. Length of male, 1.15 mm.

In the material I have examined, the endopodites of the male fifth feet have more commonly been one-segmented. Only rarely have I found the endopodites of the female fifth feet two-segmented.

The original description was from material collected by Dr. Forbes in Lake Michigan. It is a common limnetic species in all the Great Lakes. It occurs in Pine lake, Michigan, which has an almost direct connection with Lake Michigan. It occurs in Green lake, Wisconsin; in this lake it is a winter form. (Marsh, '97, p. 193. Marsh, '03, p. 23.) I have found it once in Tomahawk lake, Wisconsin, and Schacht reports that Dr. Forbes found it in Lake Michigamme, Michigan, and in Yellowstone park collections. In general, it may be said that it is pretty largely confined to the large, deep lakes. It has, thus far, never been found north or south of the Great Lakes, with the exception that it has been reported by Beardsley ('02) from Seely lake, Colorado, and by Pearse ('05) from Nebraska.

DIAPTOMUS MINUTUS Lilljeborg.

Plate XVII, figs. 7, 11. Plate XVIII, figs. 1, 7.

1889. *Diaptomus minutus* DeGuerne and Richard (Lillj.), p. 50; pl. I, figs. 5, 6, 14; pl. III, fig. 25.
1891. *Diaptomus minutus* Marsh, p. 212.
1893. *Diaptomus minutus* Marsh, p. 199; pl. IV, figs. 1–3.
1895. *Diaptomus minutus* Marsh, p. 8; pl. VII, fig. 3.
1895. *Diaptomus minutus* Herrick and Turner, p. 59; pl. VIII, fig. 9.
1897. *Diaptomus minutus* Schacht, p. 156; pl. XXX, figs. 5-8.

Of small size. The greatest width of the cephalothorax is in front of the middle. The first segment equals fully one-half the length of the whole cephalothorax. The last segment has rounded lobes which are each armed with a minute spine.

The first segment of the female abdomen is nearly as long as the rest of the abdomen. It is slightly dilated laterally at the anterior part, and is armed with two very minute spines. The second segment is much shorter than the third, and the two are sometimes only indistinctly separated. The furcal rami are about equal in length to the third segment; they are twice as long as broad. The setae are unusually long.

The antennae are 25-segmented, and reach beyond the end of the furca. The right antenna of the male is swollen anterior to the geniculating joint, but not markedly so; the antepenultimate segment bears a long, slender process, slightly curved at the end, which reaches, sometimes, almost to the end of the last segment. The setae of the swimming feet are unusually long.

The spines of the first basal segments of the female fifth feet are rather small. The lateral hair of the second basal segment is of moderate length. The first segment of the exopodite is slender, its length being considerably more than twice its width. The hook of the second segment is only slightly curved, and is finely denticulate on the inner margin. There is a short spine on the outer distal angle. The third segment is rudimentary, not completely separated from the second. It is armed with two spines, of which the inner is the longer. The endopodite is acuminate, very small and rudimentary.

The spines of the first basal segments of the male fifth feet are small. The second basal segment of the right foot is quadrate, longer than broad. The lateral hair is situated at the beginning of the distal third. The first segment of the right exopodite is of the same form and size as the second basal segment. The second segment is twice as long as the first. The lateral spine is small and situated proximad of the middle. The terminal hook is short, thick, symmetrically curved, and slightly denticulate on the inner margin. Its length is somewhat less than that of the rest of the exopodite. The endopodite is very small and rudimentary. The second basal segment of the left foot is quadrate, and much wider than long. The lateral hair is situated well towards the distal end. The first segment of the exopodite is longer than wide, its inner and outer margins are convex, and its distal end is only about one-half as wide as the proximal. It is setose on its inner margin. The second segment is more than twice as long as broad, its outer margin straight, and its inner with two setose convexities. It is terminated with a finger-like process and a smaller spine nearer the inner margin. The foot reaches to the end of the first segment of the right exopodite. The endopodite is slender, attenuate towards the apex, and reaches to about the middle of the second segment of the exopodite.

Length of the female, 1 to 1.1 mm. Length of the male, hardly 1 mm.

Lilljeborg states that the female carries only two eggs. This was not true of the Wisconsin individuals, for they commonly had as many as six. This was first described from material collected in Greenland, where it is found as far north as Disco island. It appears to be very abundant in the southern part of Greenland. It was afterwards reported by DeGuerne and Richard from Iceland. (DeG. and R., '92.) It is found in Newfoundland. It is perhaps the most common of the *Diaptomi* in the Great Lakes and Lake St. Clair. It occurs in a number of lakes in the northern part of the southern peninsula of Michigan, but these are, for the most part, connected rather closely with the Great Lakes. In Wisconsin it is found in the following lakes: Birch, Maple, Tomahawk, Stone, Chain o' Lakes, Elkhart, Green and Geneva; all these are of the deeper lakes of the state, although there are others, equal in depth to some of these, where it is not found. The most southern point at which the species has been found is Lake Geneva. To my surprise, I did not find it in my collections from the Northwest Territory, but all those collections were in very shallow water. One would expect to find it all over British America, wherever the environment was favorable. I think it probable that it is distributed all over North America east of the Rocky mountains and north of the latitude of perhaps 43 degrees.

DIAPTOMUS ASHLANDI Marsh.

Plate XVII, figs. 6, 8, 10.

1893. *Diaptomus Ashlandi* Marsh, p. 198; pl. III, figs. 11-13.
1895. *Diaptomus Ashlandi* Herrick and Turner, p. 60; pl. VI, figs. 4–6.
1895. *Diaptomus Ashlandi* Marsh, p. 7; pl. VII, fig. 2.
1897. *Diaptomus Ashlandi* Schacht, p. 166; pl. XXXII, figs. 1–4.

A small, slender species. The suture of the first cephalothoracic segment is very marked. The first segment equals the three following in length. The last segment is armed with minute lateral spines.

The first segment of the female abdomen equals in length the rest of the abdomen. It is somewhat dilated laterally and bears two minute lateral spines. The second segment is shorter than the third, and the third and the furcal rami are about equal. The furcal rami are ciliate. The setae are very long and slender; the internal seta is much more nearly equal to the others than is generally the case.

The antennae are 25-segmented and reach beyond the end of the furca. The right male antenna is swollen anterior to the geniculating joint, and bears on the antepenultimate segment a slender appendage, slightly enlarged at the tip, which slightly exceeds in length the penultimate segment. The form of this appendage varies somewhat, the enlarged tip not being always evident.

The spines of the first basal segments of the female fifth feet are very small. The lateral hair of the second basal segment is very long, equaling the length of the first segment of the exopodite. The first segment of the exopodite is twice as long as wide. The hook of the second segment is long and slender and slightly curved. It is finely denticulate on the inner margin. The whole second segment slightly exceeds in length the first segment. The third segment is represented by two spines, of which the outer is the longer. The endopodite is slender, terminating in a blunt point. It is a little longer than the first segment of the exopodite. It is setose at tip, and has two rather long terminal spines.

The spines of the first basal segments of the male fifth feet are small and acute. The second basal segment of the right foot is twice as long as broad. The lateral hair is situated at the beginning of the distal third. The first segment of the exopodite is broader than long, the proximal end being much narrower than the distal. The inner distal angle bears a small hyaline appendage. The second segment equals in length the combined length of the second basal segment and the first segment of the exopodite. The segment is widest at the end of the proximal third, and from this point springs the lateral spine; this is rather long, acute, with a rather abrupt curvature just above the base. The terminal hook is slender, falciform with a symmetrical curvature, and considerably exceeds in length the rest of the exopodite. It is minutely denticulate on the inner margin. The endopodite is slender, equaling or exceeding in length the first segment of the exopodite. The left fifth foot extends to about the end of the first segment of the exopodite. The second basal segment is about half the length of the corresponding segment of the right foot. The lateral hair is long and slender, and situated at the beginning of the distal third. The first segment of the exopodite equals the second basal segment in length; its length exceeds its width by about one-half. The second segment equals in length the first, but is much narrower; it is terminated by two small finger-like processes. Both segments of the exopodite are setose on the inner margin. The endopodite is long, slender, curved, and reaches to about the middle of the second segment of the exopodite.

Length of female, 0.97 mm. Length of male, 0.89 mm.

The original description was from material collected by Professor Birge at Ashland, on Lake Superior. It occurs in all the Great Lakes, and I have found it in Michigan in Pine lake and Round lake at Charlevoix, which are intimately connected with Lake Michigan. I have not found it in other localities, although Schacht reports it from Indiana, Michigan, Oregon, Idaho, Washington and Yellowstone park.

DIAPTOMUS SHOSHONE Forbes.

Plate XVIII, figs. 2–5.

1893. *Diaptomus shoshone* Forbes, p. 251; pl. XLII, figs. 23–25.

1895. *Diaptomus shoshone* Herrick and Turner, p. 61; pl. V, fig. 11.

1897. *Diaptomus shoshone* Schacht, p. 141; pl. XXVI, figs. 1–3.

1904. *Diaptomus shoshone* Marsh, p. 147; pl. XXX, fig. 3; pl. XXXI, figs. 1–3.

Conspicuous because of its size, as it is larger than any other described American species except *D. stagnalis* Forbes.

First cephalothoracic segment indistinctly divided. The first segment equals in length the four following. The last cephalothoracic segment terminates in two minute lateral spines.

The first abdominal segment of the female is somewhat shorter than the rest of the abdomen, and is strongly dilated laterally about midway of its length. The second segment is very short. The third segment is a little less than one-half the length of the first, and is slightly shorter than the furca. The branches of the furca are ciliate on both the inner and outer margins. The furcal setae are very long, being more than three-fourths the length of the abdomen exclusive of the furca.

The antennae about equal in length the cephalothorax. The right antenna of the male is swollen anteriorly to the geniculating joint, and bears upon the distal extremity of the antepenultimate segment a straight process. This process extends to rather less than half the length of the ultimate segment.

The first basal segments of the female fifth feet are armed with rather small spines. The lateral hairs of the second basal segments are delicate. The exopodite is composed of three segments. The first segment is stout, its length being to its breadth as 1½ to 1. The second segment is produced into the customary hook, which is armed with short hairs on its inner margin and with a spine on the outer distal angle. The third segment is distinct and armed terminally with two spines, the inner being distinctly plumose. The endopodite is nearly a third longer than the first segment of the exopodite, and is indistinctly divided into two segments. It is terminated with two rather long spines, and is armed on the inner surface of the tip with short, stout hairs.

In the male fifth feet, the spines of the first basal segments are also rather small. The second basal segment of the right foot is considerably longer than broad, and its inner and outer margins are curved. The lateral hair is situated at three-fourths of its length. The first segment of the right exopodite is nearly square. The second segment is more than twice the length of the first, and the lateral spine is situated nearly at the end of the segment. The terminal hook is falciform, quite symmetrical in its form, and equals in length the combined lengths of the basal segments and of the exopodite. It is finely denticulate in the inner margin. The endopodite is slender and somewhat longer than the first segment of the exopodite. The left fifth foot of the male extends to about one-half the length of the second segment of the right exopodite. The lateral hair of the second basal segment is situated very near the end of the segment. The first segment of the exopodite is about twice as long as broad, and armed on its inner surface with a setose pad. The second segment is rather more than half the length of the first and is armed terminally with two blunt processes. It has also two setose pads, one nearly terminal and the other on the proximal half of the inner surface. The endopodite is indistinctly two-segmented, is slender, and slightly longer than the first segment of the exopodite.

Forbes, in the original description, speaks of the female abdomen as being asymmetrical. This did not appear to be the case in my specimens, and in this my observations agree with those of Schacht.

Length of female, 2.62 mm. Length of male, 2.595 mm. These are the figures of Forbes. In my specimens there was more difference between the males and the females. The females of the Pike's Peak specimens averaged 2.9 mm., and the males 2.495 mm.

The original description of Forbes was from material collected in Lake Shoshone. It occurs in many lakes in the Yellowstone park region according to him. In material sent to me by Professor H. B. Ward, it occurred in collections in Dead lake, Mirror lake and Lake Rocks in the Pike's Peak region.

The species is very striking because of its great size. It is highly colored, the specimens from Dead lake showing very deep blues and reds; the cephalothorax was of a deep blue, while the antennae, maxillipedes and abdomen were red.

DIAPTOMUS WARDI Pearse.

1905. *D. Wardi* Pearse, pp. 148–9; pl. XIII, figs. 1–4.

"A rather large species, one-fourth to one-third as wide as long. Cephalothorax rather stout and broadest about the middle; all the segments distinct, the first longer than the second, and these two together making about one-half the cephalothorax. Lateral lobes of the last thoracic segment seen from above obtuse posteriorly and armed with a minute spine at the inner and outer angles. First abdominal segment shorter than the remainder of the abdomen and broader than the following segments. Second segment of the abdomen much shorter than the third. Furcal rami short, about one and one-half times longer than broad, and ciliate on the inner margin in the male. (The number of specimens of the female was so few that no satisfactory examinations of the furca could be made.)

"First pair of antennae reflexed extend about to the furca; composed of twenty-five articles. Antepenultimate article of right male antenna provided with a long, blunt process which surpasses the distal end of the ultimate article.

"The outer ramus of the fifth pair of feet in the female three-segmented, the third segment small but distinct and bearing two small spines. The basal segment bears a short, thick spine at its outer distal angle. The unguiform process of the second segment of this ramus is rather arcuate, denticulate within and roughened on the outer margin. In addition to the two spines on the third segment, this segment has a minute spine. The inner ramus is simple and almost equal to the first segment of the outer ramus, is ciliated at the apex, and bears two long equal spines.

"Right fifth foot of male rather robust. The basal segment is provided with a small spinous process near its inner proximal angle. Second segment of the outer ramus short, being about one and one-fourth times as long as broad, and bearing the marginal spine at the distal angle. Terminal hook long, usually sigmoid, very minutely denticulate on the inner margin and tapering toward the apex. Inner ramus narrow and barely reaching the middle of the second segment of outer ramus, one-segmented and ciliate at tip. The second segment of the left male fifth foot is triangular, and ends in a short, obtuse process. The inner side is expanded, ciliated, and a strong, sharp spine projects a little below the middle of this margin. The inner ramus is simple, slender, and ciliated at the tip.

"Length of female, 2.16 mm. Length of male, 1.60 mm.

"This species resembles *D. franciscanus* Lillj. and *D. sicilis* Forbes. It differs from the former in the armature of the male antenna and the form of the male fifth feet. From the latter it differs in the structure of the female fifth feet, the size and the shape of the male fifth foot. Both these species have two-jointed inner rami in the male fifth foot, while in *D. Wardi* they are simple.

"The specimens upon which this description is based were from the collections of Prof. H. B. Ward, for whom the species is named, and were collected by Edward Butler at Spokane, Washington."

While this paper was going through the press, the publication of Mr. Pearse, containing the above description, was received. It was too late to secure material to verify the description, or to prepare figures. I have therefore taken his description verbatim. Although his description of the female is somewhat incomplete, it would appear that the species may be well founded. It falls into the *tenuicaudatus* group, and is closely related to *D. shoshone* Forbes. It is very possible that a careful examination of a large number of specimens will show that it is only a variety of this species. The points of marked difference, besides that of size, are the greater length of the appendage of the antepenultimate segment of the right male antenna, the form of the terminal segment of the left exopodite of the male fifth foot, and the two-segmented endopodite of the female fifth foot. The endopodite of the female fifth feet is only indistinctly two-segmented in *shoshone,* and this condition might be easily overlooked in the examination of a few individuals. The appendage of the antepenultimate segment of the right male antenna, too, may be somewhat variable. Inasmuch as Pearse gives no figure of the female abdomen, we are left in doubt in regard to its form. While it is very possible that we have here a variety of *D. shoshone,* it seems best to recognize the species for the present.

DIAPTOMUS BIRGEI Marsh.

Plate XVIII, figs. 6, 8. Plate XIX, figs. 1, 6.

1894. *Diaptomus Birgei* Marsh, p. 16; pl. I, figs. 4–6.

1895. *Diaptomus Birgei* Herrick and Turner, p. 79; pl. XLVII, figs. 4–6.

1897. *Diaptomus Birgei* Schacht, p. 172.

1903. *Diaptomus Birgei* Juday, p. 123.

Of moderate size. The first segment of the cephalothorax is nearly equal in length to the three following. The last cephalothoracic segment is armed laterally with two minute spines.

The first segment of the female abdomen is as long as the remainder of the abdomen and the furca. It is much dilated on the ventral surface, and moderately dilated laterally. The lateral dilatations are situated at the distal third of the segment, and each lobe bears two small spines. The second segment is very short, and is nearly concealed by the first. The third segment and the furca are about equal in length. The furcal rami are ciliate on both the inner and outer margins.

The antennae are 25-segmented and extend beyond the furcal rami. The right antenna of the male is much swollen anterior to the geniculating joint; the antepenultimate segment is produced on its distal end into a short, blunt process, which makes very nearly a right angle with the longitudinal axis of the segment.

In the female fifth feet, each of the first basal segments is armed on the posterior surface with a very strong tooth-like projection in place of the customary spine. The lateral hair of the second basal segment is rather stout. The length of the first segment of the exopodite is twice its breadth. The hook of the second segment is strongly curved, and is denticulate on its inner margin. The third segment is represented by two spines; these spines are unusually long. The endopodite is slender and somewhat longer than the first segment of the exopodite. Its tip is setose, and armed on the inner side with two long, slender spines.

In the fifth feet of the male, each of the first basal segments is armed on its posterior surface with a strong tooth-like process in addition to the customary spines. The second basal segment of the right foot is longer than broad. On the posterior distal surface near the inner margin is a small hyaline process. The first segment of the exopodite is quadrate; it is prolonged slightly on its outer distal angle, and on its posterior surface near the inner margin bears a broad quadrate hyaline process, whose length nearly equals that of the segment. The second segment of the exopodite is twice the length of the first, is broad at the proximal end, and narrow at the distal end. The proximal end is nearly three times as broad as the distal. The lateral spine is situated at the proximal third, is long, strongly curved, and serrulate on its inner margin; its length about equals the length of the segment. The terminal hook is as long as the rest of the right foot. It is slender, strongly curved, slightly angular, and denticulate on its inner margin. The endopodite is one-segmented, conical in form, slightly exceeds in length the first segment of the exopodite, and is setose at tip.

The left fifth foot of the male reaches slightly beyond the first segment of the right exopodite. The second basal segment is quadrate, considerably smaller than the corresponding segment of the right foot. The lateral hair is situated near the distal end of the segment. The first segment of the exopodite is twice as long as broad, narrowing to the distal end. The outer margin is curved, and the inner has a rounded elevation at its middle. The second segment is slightly longer than the first. It is setose, especially on its inner surface. It is terminated with a long finger-like process, which is apparently jointed, and a slender falciform process on the inner side. The endopodite is one-segmented, slender, conical, setose at the tip, and extends to nearly one-half the length of the second segment of the exopodite.

Length of female, 1.31 mm. Length of male, 1.22 mm.

The original description of this species was from material collected by Professor Birge near New Lisbon, Wisconsin. Very few individuals were found, but as it seemed so distinct in its characteristics from any other American species, there was no hesitation in describing it. As time went on, however, and no other specimens were found, although the state of Wisconsin was pretty thoroughly explored, it became a question whether it were not an abnormal form. It was something of a relief to the author, therefore, when the identical form was found in material collected by Mr. Chauncey Juday in Winona lake, Warsaw, Indiana. In Mr. Juday's collections it was present in considerable numbers, associated with *D. oregonensis.* The two species were easily separated, as *D. Birgei* is distinctly larger than *D. oregonensis.*

In the fall of 1904 I collected the species at Richmond, Indiana, and, just as I was finishing the preparation of this report, I found it in material collected by Professor H. S. Pratt at Cold Spring Harbor, Long Island. It is not likely that it occurs in many other Wisconsin localities, for pretty extensive collections have been made in that state, but it would seem probable that it must occur in many localities between the Mississippi valley and the sea-board.

In the description, as given above, the original description is modified by the more complete knowledge made possible by the study of a larger number of individuals.

DIAPTOMUS SICILOIDES Lilljeborg.

Plate XVIII, fig. 9. Plate XIX, figs. 4, 5, 7.

1889. *Diaptomus siciloides* Lillj., DeGuerne and Richard, p. 54; pl. I, figs. 7, 8, 28, 32.

1895. *Diaptomus siciloides* Herrick and Turner, p. 69; pl. VIII, fig. 10.

1897. *Diaptomus siciloides* Schacht, p. 154.

1898. *Diaptomus siciloides* Brewer, p. 125.

1905. *Diaptomus siciloides* Pearse, p. 147; pl. XIII, fig. 5; pl. XIV, figs. 7, 8.

A small species. The first segment of the cephalothorax about equals in length the three succeeding segments. The last segment terminates in two lateral spines.

The first abdominal segment of the female a little exceeds in length the rest of the abdomen. It is expanded laterally and in front, and bears two small lateral spines. The second segment is considerably shorter than the third, and the third and the furcal rami are about equal. The furcal rami are ciliate on the inner margin.

The antennae are 25-jointed and reach the extremity of the furcal rami. The right male antenna is much swollen anterior to the geniculating joint. The antepenultimate segment bears a hook which equals in length one-half of the penultimate segment.

The first basal segments of the female fifth feet are armed with the customary spines, and the second basal segments with the usual lateral hairs. The exopodite is composed of two segments, the third segment being represented by two spines.

The second segment is prolonged into the usual hook, which is denticulate on the inner margin. The endopodite equals the length of the first segment of the exopodite, and the tip is armed with hairs and the two terminal spines.

The fifth feet of the male are slender, and the left foot reaches the distal end of the first segment of the right exopodite. The first basal segments are armed with rather large spines. The second basal segment of the right foot has the lateral hair situated at about two-thirds of its length. The length of this segment is about twice its width; it bears upon the distal half of its inner margin a thin hyaline lamella, quadrangular in form. This projects rather from the posterior surface than immediately from the inner margin. The second segment of the exopodite is about twice the length of the first segment. It bears a small spine on its inner margin at about one-third of its length. The lateral spine is small, curved, and situated at about two-thirds of its length. The terminal hook is falciform, symmetrically curved, and nearly equals in length the rest of the foot. The right endopodite is small and slender, and reaches about one-half the length of the first segment of the exopodite. It is armed at the tip with minute hairs. The lateral hair of the second basal segment of the left foot is situated near the distal end of the segment. The two segments of the exopodite are about equal in length and are oval in form. The first segment is setose on its inner margin. The second segment is swollen at the base on its inner margin into a cushion which is setose. The tip is setose and armed with two short finger-like processes. The endopodite is very slender, reaches about one-half the length of the second segment of the exopodite, and is hairy at the tip.

The above description is like that of Lilljeborg with a few corrections and additions. In his description he states that there is a hyaline appendage of the first segment of the exopodite of the male fifth foot that is "somewhat dilated." In his figure this appendage is made somewhat triangular in form. In all the specimens I have seen, the appendage has been distinctly quadrangular as I have figured it. I have not seen Lilljeborg's types, nor have I seen any specimens from the locality in which his specimens were obtained. If his figure is correct, the form which I have seen would be a variety of *D. siciloides,* but as the agreement in all other details is so close, one cannot help thinking that the exact form of this appendage was overlooked. The endopodite of the right male fifth foot I have found to vary considerably in length, sometimes being nearly as long as the first segment of the exopodite.

Length of the female, according to Lilljeborg, 1.3 mm. I have found considerable variation in the length from different localities. My southern specimens measured as follows:—female, 1.225 mm.; male, 1.1125 mm. The Wisconsin specimens were somewhat smaller, the females being 1.06 mm. and the males 1.01 mm.

The type specimens were found in Lake Tulare, near Fresno, in California. Schacht states that it was the most abundant species in the Illinois river near Havana. He has found it also in collections from Spirit lake, Iowa. I have found it in material collected by Professor Eigenmann in Turkey lake, Indiana, and in collections made by Professor Birge in Hutchins, Texas, and in Crève Coeur lake, St. Louis. Pearse finds it in Nebraska. It was present in collections made for me by Mr. Shelford in Kansas, and I have recently found it near Hugo, Colorado. It seems likely that it will be found in the mountain region, thus bridging over the space between Colorado and California. I have found it in one locality in Wisconsin, in Cedar lake, Washington county, where it seems to be the only species.

The distribution of the species is a matter of a good deal of interest. It is found from Indiana on the east to California on the west, and from Texas on the south to Wisconsin on the north, but nevertheless seems to be a peculiarly localized species. Doubtless many other localities will be found, for our knowledge of the distribution of Entomostraca is still very meager; but some localities have been pretty thoroughly studied; we know the Wisconsin fauna quite well, and it seems strange that the species should have localized itself to such an extent in Cedar lake.

DIAPTOMUS TYRELLI Poppe.

Plate XIX, figs. 2, 3, 8.

1888. *Diaptomus Tyrelli* Poppe, p. 159.
1889. *Diaptomus Tyrelli* DeGuerne and Richard, p. 39; pl. I, figs. 17, 18; pl. IV, fig. 26.
1895. *Diaptomus Tyrelli* Herrick and Turner, p. 76; pl. X, fig. 9.
1897. *Diaptomus Tyrelli* Schacht, p. 176.

Of medium size. The suture of the first cephalothoracic segment is rather distinct. The first segment is considerably less in length than the three following. The last cephalothoracic segment is expanded into large lateral processes, and is armed with rather large lateral spines.

The first segment of the female abdomen equals in length the rest of the abdomen. It is broad, dilated in front, and moderately dilated laterally. It bears prominent lateral processes, which are tipped with acute spines. The second segment is shorter than the third, and the two together are somewhat longer than the furca. The furcal rami are stout and ciliate on both the inner and the outer margins.

The antennae are 25-segmented and reach about to the end of the furca. The antepenultimate segment of the right male antenna is without any special appendage.

The fifth feet of the female are slender. The spines of the first basal segments are small and acute. The lateral hair of the second basal segment is of moderate length. The first segment of the exopodite is more than twice as long as wide. The second segment is long and slender, exceeding in length the first segment. The hook is slightly curved and denticulate on the inner margin. It is armed with three spines of which the inner is the longest. The two inner spines represent the third segment. The endopodite is long and slender, exceeding in length the first segment of the exopodite. It is setose at the tip, and armed with two long terminal spines which are inserted well back from the end of the endopodite.

In the male fifth feet, the spines of the first basal segments are prominent and acute. The second basal segment of the right foot is twice as long as broad. The lateral hair is situated at the beginning of the distal third. The first segment of the exopodite is quadrate, and bears a hyaline process on the inner distal angle. The second segment is strongly curved and equals in length the first basal segment. The lateral spine is straight and rather small and situated just distad of the middle. The terminal hook is slender, slightly curved, and equal in length to the rest of the foot with the exception of the first basal segment. It is denticulate on the inner margin. The endopodite is small, much less in length than the first segment of the exopodite. It is ordinarily pointed, but in some cases the tip is rounded. The left foot reaches to the end of the first segment of the right exopodite. The second basal segment is as long as wide, and strongly convex on the inner margin. The lateral hair is situated near the distal end. The first segment of the exopodite is much longer than wide and setose on the inner margin. The second segment is about one-half the length of the first, and the inner surface is a convex setose pad. The segment is terminated with two digitiform processes, of which the outer is the longer. The endopodite is long and slender, reaching to the middle of the second segment of the exopodite. It is either one-segmented or indistinctly two-segmented. The tip is distinctly setose.

Length, accordng to Poppe: female, 1 mm.; male, 1.5 mm.

Length, according to Lilljeborg: female, 1.9 mm.; male, 1.8 mm.

My specimens averaged: female, 1.258 mm.; male, 1.15 mm.

The original description by Poppe was from material collected at Summit lake in the Rocky mountains, at a height of 5300 feet. Lilljeborg's material was from Centerville, near Fresno, California.

The material from which my drawings were made was collected by the U. S. Fish Commission in Alturas lake, Idaho. Probably, then, it is widely distributed in the mountain region of the West.

In the description as given above, I have adhered very closely to the description given in De Guerne and Richard's *Révision,* and the changes which I have made have been mostly in the way of minor additions. It would appear that the specimens of the three localities thus far known are very nearly identical in their structure.

DIAPTOMUS LEPTOPUS Forbes.

Plate XX, figs. 1, 2, 5, 7.

1882. *D. leptopus* Forbes, p. 646; pl. VIII, figs. 17-19.
1884. *D. longicornis* var. *leptopus* Herrick, p. 140.
1889. *D. leptopus* DeGuerne and Richard, p. 21; pl. II, fig. 19; pl. III, fig. 9.
1893. *D. leptopus* Marsh, p. 195; pl. III, figs. 4, 5.
1895. *D. leptopus* Herrick and Turner, p. 64; pl. II, figs. 1-10; pl. IX, fig. 9.
1897. *D. leptopus* Schacht, p. 130.

The last cephalothoracic segment is armed laterally with two minute spines.

The first abdominal segment of the female is somewhat less in length than the remainder of the abdomen and the furca. It is dilated on the sides, and armed laterally with minute spines. The second segment is very short, and hardly distinguished from the first. The third segment and the furca are very nearly equal in length. The inner margins of the furca are ciliate.

The antennae reach to the end of the furca. The right male antenna is much swollen anterior to the geniculating joint; the antepenultimate segment is armed with a hyaline lamella extending its whole length, and prolonged slightly beyond the distal end of the segment.

The first basal segment of the female fifth foot is armed with the customary spine. The second basal segment has the minute lateral hair at about the middle of its outer margin. The exopodite is composed of two segments. The third segment is represented by two spines, the outer being the smaller. The endopodite nearly equals in length the first segment of the outer ramus. The two terminal spines are rather long, and the inner margin of the tip is setose.

The first basal segment of the right fifth foot of the male is armed with a spine of moderate size. The second basal segment is quadrangular in form, its length being about twice its width. The lateral hair is situated nearly at the distal end of the segment. Near the distal end of the segment, on the posterior surface, is a shelf-like projection, from which arises a blunt hook which extends distally over the proximal end of the first segment of the exopodite. The first segment of the exopodite is quadrangular, about twice as long as wide. The second segment of the exopodite is rather slender, its length being somewhat less than three times its width. The lateral spine is short, and situated well towards the distal end of the segment. The terminal hook equals in length the preceding segment, is slightly curved, and is serrulate on its inner margin. The endopodite is somewhat variable in length, sometimes being about two-thirds the length of the first segment of the exopodite, and at others nearly equaling that segment. It is armed with fine hairs at the tip. In the left fifth foot of the male, the spine of the first basal segment and the lateral hair of the second are situated as in the right foot. The length and width of the second basal segment are about equal. The first segment of the exopodite is about twice as long as wide, quadrangular in form, with its inner distal angle setose. The second segment is irregular in form, about four times as long as wide, setose on the inner margin. It is armed on the distal extremity with a finger-like process and a long, curved spine; this spine is setose. The endopodite is slender, somewhat curved at its distal part, and considerably longer than the first segment of the exopodite. It is setose on the inner margin of the tip.

Authors vary somewhat in regard to the length. In Forbes's original paper, the average length is given as 1.778 mm., no distinction being made as to sex. De Guerne and Richard give the length as about 1.5 mm. Herrick and Turner give the length of the female as 1.5 to 1.7 mm., and that of the male as

1.4 mm. Schacht's measurements are somewhat larger—viz., female, 1.89 mm., and male, 1.83 mm. The differences in these measurements are not very great, and probably arise from the measurement of a comparatively small number of specimens in each case.

This species seems to be generally distributed through the Mississippi valley.

DIAPTOMUS LEPTOPUS var. PISCINAE Forbes.

Plate XX, figs. 3, 6, 8. Plate XXI, fig. 7.

1893. *Diaptomus piscinae* Forbes, p. 253; pl. XLI, fig. 22.
1895. *Diaptomus piscinae* Herrick and Turner, p. 74; pl. V, fig. 13.
1897. *Diaptomus piscinae* Schacht, p. 125; pl. XXII, figs. 1–4.

The original description of this form by Forbes was from specimens obtained from a small lake near Gardiner, Montana. Schacht reports it in collections from Portage Slough, Manitoba. I have found it in collections made by Mr. Congdon in Birch Hills, Alberta, and in material sent by Mr. Juday from a lake on the University campus in Boulder, Colorado. The points of difference made by Forbes to distinguish this from *D. leptopus* are the length of the setae on the endopodite of the female fifth foot, the more slender form of the fifth feet of the male, and the absence of the antennal hook. These differences undoubtedly exist with the exception of the absence of the antennal armature. I find in all my specimens the hyaline lamella of the antepenultimate segment of the right male antenna just as in *D. leptopus,* but not quite so pronounced. Professor Forbes kindly loaned me some slides of *D. piscinae,* and in the only one which showed the male antennae the hyaline lamella was present, though the antenna was turned so that it might easily escape notice.

I have noticed certain other points of difference between the two forms. The endopodites of the male fifth feet are considerably longer in *D. piscinae.* The third segment of the exopodite is indistinctly separated, is armed with two spines, and there is a third spine on the second segment. This spinal armature was remarked by Forbes, but Schacht speaks of the third segment as armed with "two or three spines." Schacht also speaks of three spines in *D. leptopus,* and the figure of De Guerne and Richard has three spines. In my statement, as given before, I have said that there are only two spines in *D. leptopus,* as that has uniformly been the case in the specimens I have examined. It is very possible that this is a variable feature, and while I have considered this one of the points of difference of the variety, I think it very likely that it is not a matter of even varietal distinction. The second segment of the abdomen in *D. piscinae,* I have found considerably longer than in typical *D. leptopus.*

It seems to me that these differences are so slight that they certainly should not be considered specific, and it is a question whether they should even be thought enough to constitute a variety. I have no doubt that further collections will bring to light connecting forms, but it may be best, for a time at least, to retain the varietal name.

DIAPTOMUS STAGNALIS Forbes.

Plate XXVII, figs. 3, 6, 7.

1882. *Diaptomus stagnalis* Forbes, p. 646; pl. VIII, figs. 8, 10, 11, 12, 14.

1882. *Diaptomus giganteus* Herrick, p. 222: pl. II, figs. 3, 11, 15.

1884. *Diaptomus stagnalis* Herrick, p. 139; pl. Q, figs. 11, 13.

1889. *Diaptomus stagnalis* DeGuerne and Richard, p. 23; figs. 15, 16; pl. IV, fig. 14.

1895. *Diaptomus stagnalis* Herrick and Turner, p. 66; pl. III, figs. 1–12; pl. XIII, figs. 11, 13.

1897. *Diaptomus stagnalis* Schacht, p. 138; pl. XXVIII, fig. 2.

"Head distinct from thorax; fifth and sixth thoracic segments confluent. Lateral angles of last thoracic segment strongly produced backward, each angle bilobed, the outer lobe about twice as large as the inner (in the male this segment is salient). Abdomen peculiar in that there is a sudden narrowing at the beginning of the third segment. First abdominal segment of the female armed with a large spine on each side; second and third segments subequal, about twice as wide as long. Furcal rami subquadrate, ciliate on the inner margin. Furcal setae rather short, densely plumose. There is but little difference in the length of the abdominal segments of the male.

"Antennae 25-segmented, reaching to the middle of the abdomen. The right antenna of the male is greatly swollen anterior to the geniculating joint. The antepenultimate segment bears a broad hook-like process, which does not reach to the end of the penultimate segment.

"Second basal segment of the fifth foot of the female with the usual delicate hair at the outer margin. First segment of the exopodite short and broad. Second segment large, about one and one-half times as long as the first, armed on the middle third of the inner margin with seven or eight very large, strong, pointed spines, and on the outer margin and opposite the upper spines of the inner margin with three or four spines. Third segment distinct, armed with two spines, the outer one short, thick, sharp, smooth, the inner one about twice as long and armed with a few rather strong spinules. Just without these spines, on the second segment, is a shorter smooth spine. The endopodite of the fifth foot of the female is distinctly two-segmented, the first segment subquadrate, the second as wide as the first and nearly twice as long, and armed at the tip with two thick, heavy spines reaching to the end of the second segment of the exopodite. These spines are armed with heavy spinules. Disregarding the spines, the endopodite reaches just to the end of the first segment of the exopodite.

"Second basal segment of the right fifth foot of the male subquadrate, about twice as long as wide; on the posterior surface a large, smooth, hyaline lamella occupying about a third of the inner margin near the middle, and near the outer distal angle a minute cuticular process bearing a delicate hair. First segment of the exopodite almost three times as long as broad; second segment about as long as the first and for about the proximal third nearly as wide, but beyond this considerably broader. Marginal spine near the outer distal angle; straight, very strong and thick, a little less than half as long as the segment. Terminal hook rather short and very stout, irregularly curved, heavily and closely denticulate at the distal half of the inner margin. Endopodite of the right fifth leg spatulate, not nearly reaching the middle of the first segment of the exopodite; apex rounded, armed with a few strong spines.

"Second basal segment of the left fifth foot armed at the outer margin, a short distance above the distal angle, with a short, thick, pointed spine. First segment of the exopodite about three times as long as wide, armed at the distal third of the inner margin with a few strong hairs. Second segment about half as long as the first, having on the inner margin two cushion-like processes (the upper, smaller one hairy, and the lower densely tuberculate), and being armed at the tip with two processes forming a forcipate structure, the outer broad, plowshare-shaped, the inner a long and narrow spine, hairy within. Endopodite of left fifth foot one-segmented, of the same width throughout, with a broadly rounded tip; inner margin rugose.

"Length of female, 4 to 4.5 mm. Length of male, 3.5 to 4 mm.

"This *Diaptomus* is the largest of the American species and a very beautiful one. Dr. Forbes states in his original description that all were red throughout. Specimens taken in April, 1897, from ponds south of Urbana, Illinois, when they were in the height of sexual activity, were colored as follows; thorax and anterior appendages (all but the first pair of antennae) blue; first pair of antennae, fifth pair of legs (in the male), and abdomen red. In the female all the legs were blue."

The preceding description was taken from Schacht and was, presumably, prepared under the supervision, or with the cooperation, of Professor Forbes. I have been unable to obtain any of the Illinois material for verification of the description, and the species has not occurred in the territory from which my collections have been made, although it is reported as occurring not only in Illinois and Minnesota, but in Ohio, Kentucky and Alabama.

The segmentation of the fifth feet of the female would indicate that this is one of the least specialized of the members of the *leptopus* group.

DIAPTOMUS CONIPEDATUS sp. nov.

Plate XX, fig. 4. Plate XXI, figs. 2–4.

A rather large species. The first cephalothoracic segment is nearly as long as the succeeding three segments. The last cephalothoracic segment has two minute spines on each lateral lobe.

The first abdominal segment of the female is somewhat less in length than the rest of the abdomen and the furca. It is dilated in front, and slightly dilated at the sides. The lateral dilatations are armed with small spines. The second and third segments are about equal in length, and are broader than long. The rami of the furca are somewhat longer than the third segment and are ciliate on the inner margin.

The antennae hardly reach the end of the furca. The right male antenna is much swollen anterior to the geniculating joint. The antepenultimate segment is armed with a hook-shaped process, which is not strongly recurved; it is rather less than half as long as the penultimate segment.

The first basal segment of the female fifth foot has the usual spine upon its posterior surface. The second basal segment has the customary lateral hair. The first segment of the exopodite is short and stout. The second segment is stout and prolonged into the usual hook which is denticulate on the inner margin. The third segment is represented by two spines. There is also a third spine situated outside these two. The endopodite is much longer than the first segment of the exopodite, is armed with short hairs on the inner margin of the tip, and has two rather long terminal spines.

The spines of the first basal segments of the male fifth feet are long and slender. The second basal segment of the right foot is nearly twice as long as wide. The lateral hair is long and slender and situated on the distal fourth of the segment. On the posterior surface not far from the middle line are two hyaline lamellae projecting inward. The proximal lamella is accompanied with a spine, and the distal lamella with a recurved hook. The first segment of the exopodite is twice as long as broad, and has a blunt process on its outer distal angle. The second segment is twice as long as the first, is slender, very narrow at the proximal end, and grows gradually wider towards the distal end. The lateral spine is near the distal end, is rather long, and nearly straight. The terminal hook is very stout, almost conical in shape, and much shorter than the second segment. The endopodite is very small, appearing as a small process on the inner distal angle of the second basal segment. The length of the second basal segment of the left male fifth foot is a little less than twice its width. It is slightly concave on the outer margin. The lateral hair is situated well towards the distal end of the segment. The fi st segment of the exopodite is three times as long as wide, and somewhat concave on both the inner and outer margins. The distal inner angle is setose. The second segment of the exopodite is slightly concave on the inner margin, and is terminated with a finger-like process and a longer falciform spine. The endopodite is long and slender, reaching beyond the first segment of the exopodite, is obscurely two-segmented, and is setose at the tip.

Length of female, 1.49 mm. Length of male, 1.325 mm.

This was found in collections made by Professor Birge at Slidell, Louisiana. Only a few specimens were found, but it seems to be a well-marked species. It resembles in many respects *D. Lintoni* and *D. stagnalis,* but differs in some marked particulars.

The noticeable points of difference from *D. Lintoni* are the form of the appendage of the antepenultimate segment of the right male antenna, the form of the terminal segment and hook of the right male exopodite, and the terminal setae of the endopodite of the female fifth foot. It resembles *D. stagnalis* in the antennal armature and in the general form of the male fifth feet; but it differs in the male fifth feet, in the form of the second segment of the exopodite, and in the form and size of the endopodite. It differs in the female fifth feet in the fact that the terminal spines are shorter, and that the third segment is not distinct.

DIAPTOMUS CLAVIPES Schacht.

Plate XX, fig. 9. Plate XXI, figs. 1, 5, 6.

1897. *Diaptomus clavipes* Schacht, p. 178; pl. XXXIV, figs. 1-3; pl. XXXV, figs. 1, 2.
1898. *Diaptomus nebraskensis* Brewer, p. 123; pl. VII, figs. 1-4.
1902. *Diaptomus clavipes* Beardsley, p. 45.
1905. *Diaptomus clavipes* Pearse, p. 147; pl. XIII, fig. 6.

A large species. The first segment of the cephalothorax is equal in length to the three following. The last segment of the cephalothorax is armed with two small lateral spines.

The first segment of the female abdomen is longer than the rest of the abdomen. It is much dilated in front and somewhat laterally. The lateral dilatations are not abrupt as in many species. There are two small lateral spines. The third segment is very short. The furca is about equal in length to the two preceding segments. The furcal rami are ciliate on the inner margin.

The antennae are 25-segmented, barely reaching the end of the furca. The right antenna of the male is much swollen anterior to the geniculating joint; the antepenultimate segment is armed with a lateral hyaline lamella.

The spines of the first basal segments of the female fifth feet are rather small and blunt. The lateral hairs of the second basal segments are of moderate length. The length of the first segment of the exopodite is less than twice its width. The second segment is stout, and the hook is almost straight. It is strongly denticulate on the inner margin and less so on the outer. It is armed with three spines. The inner two are upon a distinct base, which represents the third segment. These two spines are pectinate, and the inner is considerably the longer. The endopodite is slender, about equal in length to the first segment of the exopodite. It is setose at tip and armed with two long plumose spines.

The spines of the first basal segments of the male fifth feet are small and acute. The second basal segment of the right foot is quadrate, with the lateral hair situated near the distal angle. Upon its posterior surface near the inner distal angle is a short hook-like process. On the inner margin at a little less than half its length is a small conical process. From the middle of the posterior surface near the distal end arises a stout falciform process which nearly equals in length the first segment of the exopodite. The first segment of the right exopodite is equal in length to the second basal segment. It is arcuate, the inner surface being concave and the outer convex. The second segment is longer than the first, quadrangular, and has the lateral spine at the outer distal angle. The terminal hook is rather stout, falciform, symmetrically curved, and equal in length to the segments of the exopodite. The inner margin is markedly denticulate. The endopodite springs from the inner margin of the second basal segment. It nearly equals one-half the length of the first segment of the exopodite. It is setose at tip.

The left foot reaches to the end of the first segment of the right exopodite. The second basal segment is trapezoidal in form, as wide as long, and has the lateral hair near the distal angle. The first segment of the exopodite is longer than wide and setose on the inner distal angle. The second segment of the exopodite is long and slender, arising from the outer half of the distal end of the preceding segment. Its margins are slightly concave, and the inner margin is setose. It is terminated by a digitiform process and a stout spine. This spine is armed on its inner surface with stout spinules. The endopodite is long and slender, reaching one-half the length of the second segment of the exopodite. It is spatulate in form, armed at the tip with blunt spines, and with very minute spines over its whole surface.

Length of the female, according to Schacht, 1.37 mm. Length of male, 1.68 mm. According to Brewer, the female varies from 2.25 mm. to 2.5 mm. I have not at hand enough mature specimens to get a good average of size.

Found, according to Schacht, in West Okoboji lake, Iowa. Brewer's material was found near Lincoln, Nebraska. Found by Beardsley in Greeley, Colorado.

The above description was written from material sent by Brewer. Schacht's description does not correspond in all details. He states that the female abdomen is asymmetrical. This asymmetry was not noticeable in my material. He speaks of the peculiar hook of the male fifth foot as on the first segment of the exopodite. In my specimens it is on the second basal segment, and his figures show the same situation. This lack of correspondence between Schacht's figure and description has already been noted by Beardsley ('02). On the second segment of the exopodite of the female fifth foot, Schacht says there are two spines, of which the outer is the longer. I find three spines, and the innermost is the longest. His figure makes the inner the longest. His figure, too, omits the terminal spines of the endopodite of the female fifth foot, although he speaks of them in his text. There is a difference, too, in the length of the abdominal segments as compared with the Nebraska material.

If these differences exist and are constant, *D. nebraskensis* must be considered a variety of *D. clavipes*. I think it probable, however, that if material were available for a comparison of specimens from the two localities, it would appear that there is not even a varietal difference.

DIAPTOMUS LINTONI Forbes.

Plate XXVII, figs. 4, 5, 7.

1893. *Diaptomus Lintoni* Forbes, p. 252; pl. XLII, figs. 26–28.

1895. *Diaptomus Lintoni* Herrick and Turner, p. 68; pl. V, fig. 12.

1897. *Diaptomus Lintoni* Schacht, p. 127; pl XXVII, fig. 1.

"A large red species occurring commonly with *D. shoshone;* but distinguishable from it at a glance by its different shape, its longer antennae, its smaller size, and by characters derived from the right antenna and the fifth foot of the male. The thorax is symmetrically elliptical in shape, broadest at the middle. The posterior angles are not produced or bifid, but are each armed with a minute spine. The first segment of the abdomen of the female is not especially produced, but bears at its broadest part a minute spine on each side. The abdomen itself is very short, its length contained about three and one-third times in that of the cephalothorax. The antenna of the female is long and slender, 25-jointed, reaching a little beyond the tip of the abdomen.

"The fifth pair of legs in this sex is similar to those of *D. shoshone,* but much smaller. The inner ramus is not jointed. It is longer than the basal joint of the outer ramus, bears two stout plumose setae at its tip, somewhat shorter than the ramus itself, and has likewise at its inner tip a patch of small spines or fine hairs. The second segment of the outer ramus with its terminal claw is two-thirds as long again as the preceding segment, the breadth of the latter two-thirds its length. The third joint is indicated by a single long, stout seta and one or two smaller ones.

"In the male the geniculate antenna is relatively rather slender, its last two joints without special appendages, its penultimate with a slender transparent apical process, reaching about to the middle of the succeeding segment, acute at tip, but neither serrate nor emarginate.

"Fifth pair of legs in the male usually without internal ramus to the right leg, but this ramus sometimes represented by a small rudiment. The limb is usually slender, and its terminal claw short. The basal segment of the outer ramus is nearly as long as the adjacent segment of the pedicel, and the slender second segment of this ramus is fully as long. Long lateral spines are borne near the tip of this segment. The terminal claw is about two-thirds as long as the segment, is somewhat abruptly angulated near its base, and slightly recurved at the tip. The inner ramus of the left leg is very stout and long, reaching almost to the tip of the outer ramus, is slightly curved outwards, and has the apex minutely hairy. The basal segment of the outer ramus is thick, two-thirds as broad as long, somewhat inflated within, where it extends downward beyond the articulation with the second segment as a rounded expansion covered with extremely fine hairs. Second segment of this ramus longer than first, but only half as wide, bearing at its tip, within, a rather small, obliquely projecting cushion covered with cilia, and with two stout terminal spines, one short, blunt, straight, smooth, the other curved and plumose, its length about half that of the segment to which it is attached.

"The total length of this species is about 2.5 mm., excluding caudal setae; depth, .42 mm.

"This species is closely related to *D. stagnalis* Forbes, from which it differs conspicuously by its smaller size, more symmetrical cephalothorax, without prominent or bifid angles, and longer and more slender antennae, with longer and more slender appendage to the antepenultimate segment.

"In the fifth legs of the female this species differs from *D. stagnalis*, especially with respect to the inner ramus, which is larger and longer than in the other, lacks the characteristic segmentation of *D. stagnalis*, and bears at its tip shorter and broader setae. In the male the terminal claw of the outer ramus of the right fifth leg is much more slender than in *D. stagnalis*, and the inner ramus is much less developed. The left leg of this pair is different in a number of details, especially in the length and strength of the inner ramus and the length and dissimilarity of the setae at the end of the outer.

"Common in lakes and pools in Yellowstone park."

The above is a verbatim copy of the description of Professor Forbes. Nothing was added by Herrick or Schacht. The species has not appeared in the collections which have come to me, and I regret that I have not had an opportunity to study the original collections. The figures of the plate are copies of the original figures of Forbes.

DIAPTOMUS SPATULOCRENATUS Pearse.

1906. *Diaptomus spatulocrenatus* Pearse, p. 246; figs. 6–9.

Of moderate size. The first cephalothoracic segment is three-fourths the length of the cephalothorax; it has a transverse groove at about its middle. The last segment is produced posteriorly and armed with two sharp spines on each lateral lobe.

The abdomen of the female is stout. The first segment is longer than the remainder of the abdomen. The second segment is one-sixth as long as the first and one-half as long as the third. The furcal rami are one-fourth longer than wide and ciliate on the inner margin.

The antennae are 25-segmented and reach to the end of the furca. The right antenna of the male is swollen anterior to the geniculating joint. The antepenultimate segment bears a hook-shaped process, which is fully half as long as the penultimate segment.

The first basal segments of the fifth feet of the female are armed with strong spines. The lateral hairs of the second basal segments are weak. The exopodite consists of two segments. The second segment is prolonged into a hook, which is denticulate on the inner margin; it bears on its outer margin three spines, of which the inner is the longest and is distinctly plumose. The endopodite exceeds in length the first segment of the exopodite, is setose at the tip, and bears two long plumose spines.

The spines of the first basal segments of the fifth feet of the male are rather long and slender. The second basal segment of the right foot is about twice as long as broad, and convex on inner and outer margins. The lateral hair is situated at about two-thirds of its length. It bears a small tubercle on the posterior surface, near the inner margin, at about one-third its length. The first segment of the right exopodite is twice as long as wide, convex on the outer margin and concave on the inner; the second segment is three times as long as wide, strongly concave on the inner margin and convex on the outer. The lateral spine is near the outer distal angle, is of medium length and slightly curved. The terminal hook is stout, nearly as long as the segment, bent sharply at about the middle. It is denticulate on the inner margin. The endopodite is rudimentary, being represented by a short, curved process.

The left foot, in length, does not reach the end of the first segment of the exopodite of the right foot. The second basal segment of the left foot is trapezoidal in form, three-fourths as long as the corresponding segment of the right foot. The lateral hair is at about two-thirds its length. The first segment of the exopodite is one-half as wide as the second basal segment, is twice as long as wide, with rounded apical angles; the inner distal angle is setose. The second segment is less than two-thirds the length of the first, is concave on the inner margin and convex on the outer. It is armed at the tip with a stout finger-like process at the outer angle, and a slender curved process at the inner angle. The process at the outer angle is finely denticulate on the inner margin, and the process at the inner angle is setose. The inner margin of the second segment is setose. The endopodite is two-segmented and nearly equals in length the exopodite. The first segment is slender. The second segment is oval, crenate on the inner margin, and setose at the tip and on the inner and anterior surfaces.

Length of female, 1.47–1.58 mm. Length of male, 1.30–1.33 mm.

This was found in Wigwam pond, Nantucket.

Pearse's paper containing the description, of which the above is nearly a verbatim copy, modified only to correspond to the order of the other descriptions, was received while this paper was going through the press. Consequently the author has not seen the type specimens, and there has been no opportunity to prepare figures. Pearse speaks of it as related to *Lintoni,* and it is evident that it falls into the *leptopus* group, being closely related to *stagnalis* as well as *Lintoni.* The form of the endopodite of the left fifth foot of the male is a distinctive characteristic.

DIAPTOMUS SIGNICAUDA Lilljeborg.

Plate XXI, figs. 8, 10, 11. Plate XXII, fig. 3. Plate XXIII, fig. 3.

1889. *Diaptomus signicauda* DeGuerne and Richard, p. 55; pl. I, figs. 15, 16, 31; pl. III, fig. 22.
1895. *Diaptomus signicaudatus* Herrick and Turner, p. 63; pl. VIII, fig. 13; pl. IX, fig. 10.
1897. *Diaptomus signicauda* Schacht, p. 164; pl. XXIX, figs. 3-6.

A small species. The cephalothorax is broadest in front of the middle at the second segment. The first segment is about twice the length of the second. The last two segments are confluent, and the last segment has rather broad projecting lateral lobes with acute posterior angles ending in small spines. The fourth thoracic segment has a slight dorsal gibbosity.

The first abdominal segment of the female is expanded in front and laterally, and is armed laterally with minute spines; on the posterior end on the right side it bears a finger-like process which projects backward. This process is somewhat variable in length. The second abdominal segment varies in length. In some cases it is hardly to be distinguished from the first segment (Pl. XXI, fig. 11), while in others it equals in length the third segment (Pl. XXIII, fig. 3). The furcal rami vary in length from one and a half times the breadth to twice the breadth. They are setose on the inner margin.

The antennae are 25-segmented, and extend a little beyond the furcal rami. The antepenultimate segment of the right male antenna is armed with a small recurved hook.

The first basal segments of the fifth feet of the female are armed with rather large spines. The lateral hair of the second basal segment is short and weak. The exopodite is composed of two segments, the third segment being represented by two small spines. The second segment is prolonged into a rather stout hook which is delicately denticulate on the inner margin. The endopodite is slightly longer than the first segment of the exopodite, is composed of one segment, armed on the inner margin of the tip with hairs, and with two rather long terminal spines. The terminal spines are delicately ciliate.

The fifth feet of the male are rather slender. The first basal segments are armed with the customary spines. The second basal segment of the right foot is trapezoidal in form, and somewhat longer than broad. The lateral hair is situated at about two-thirds of its length. The first segment of the exopodite is also trapezoidal in form, of about half the length of the second basal segment, and is armed on its inner border with a hyaline lamella which is widened at the distal end and extends beyond the distal angle of the segment. The second segment of the exopodite about equals the combined lengths of the second basal segment and the first segment of the exopodite. The lateral spine is situated at the end of the second third of the segment. The terminal hook is symmetrically curved, and is somewhat longer than the two segments of the exopodite. The endopodite is broad, acuminate, and shorter than the first segment of the exopodite.

The second basal segment of the left fifth foot of the male has its lateral hair situated almost at the distal angle of the segment. The first segment of the exopodite is longer than broad, its inner and outer margins are curved, and it is setose on the distal third of its inner margin. The second segment of the exopodite is twice as long as wide, the inner margin expanded both at the base and at the distal end, and setose. The distal end of the segment is setose, and armed with two finger-like processes. The endopodite is long and slender, reaching well towards the end of the second segment of the exopodite. It is setose on the inner margin of the tip.

Length of female, 1.5 mm. Length of male, 1.3 mm.

The original description was written from material obtained in the Sierra Nevada in California. It is probably pretty widely distributed through the mountain region of the West. I have found it in collections from Marlette lake, Nevada, obtained by Professor C. F. Baker, from Boulder lake, Colorado, and Hosketts lake, California, collected by Professor Chauncey Juday, and from several lakes in the Lake Tahoe region collected by Professor H. B. Ward. One peculiarity not given in the diagnosis should be noted, namely that the lateral spine of the exopodite of the male fifth foot does not lie in the same plane with the segment, but is curved to one side.

The projection on the first abdominal segment of the female, from which the species is named, is not present in the immature specimens, appearing only at maturity.

DIAPTOMUS NUDUS Marsh.

Plate XXI, fig. 9. Plate XXII, figs. 1, 2.

1904. *Diaptomus nudus* Marsh, p. 147; pl. XXX, figs. 1, 2, 4, 5.

Of moderate size. The first cephalothoracic segment is nearly equal in length to the rest of the cephalothorax. The last cephalothoracic segment is armed laterally with two minute spines.

The first abdominal segment of the female is somewhat longer than the rest of the abdomen. It is dilated laterally and armed on each side with a sharp spine. These spines are at about the termination of the first third of the segment. The distal margin of the segment is extended on the right side in a conical process which extends beyond the second segment. The second segment is very short, and is nearly covered by the first. The third segment is about one-third the length of the first, and is somewhat shorter than the furca.

The antennae reach slightly beyond the end of the furca. The right antenna of the male is swollen anterior to the geniculating joint. The antepenultimate segment bears upon its distal extremity a hook-like process which is rather less than half the length of the penultimate segment.

In the female fifth feet, the spines of the first basal segments are very pronounced. The second basal segments are armed with rather delicate lateral hairs. The first segment of the exopodite is stout. The second segment is of the usual form, and the hook is denticulate on its inner margin. The third segment is represented by two spines. The endopodite equals in length the first segment of the exopodite, and is armed at the tip with two spines and with short hairs.

In the male fifth feet, the spines of the first basal segments are very pronounced. The second basal segment of the right foot is trapezoidal in form, and its length exceeds its average width by about one-half. The lateral hair is at about one-third of its length from the distal end. The first segment of the right exopodite is about as broad as long, and has its distal angle somewhat produced. The second segment of the exopodite is elongate, being more than three times the length of the first. The lateral spine is situated at about one-third the distance from the proximal end, is hook-shaped, and is inserted at an angle with the plane of the segment—that is, it does not lie in the same plane with the flat surface of the segment. The terminal hook is elongate, falciform, with a regular curvature. The endopodite is short, rather less in length than the first segment of the exopodite, and is of a somewhat triangular form.

The second basal segment of the left foot is similar in form to the corresponding segment of the right foot, and is about one-half as long. The lateral hair is situated well towards the distal end. The first segment of the exopodite about equals the basal segment in length, but is more slender. The second segment is short, armed with a terminal pad, a pad on its inner surface, and with two blunt spines near the distal end. The pads are armed with short, stiff hairs. The endopodite is very slender and very nearly equals in length the two segments of the exopodite.

Length of female, 1.132 mm. Length of male, 1.115 mm.

This species was found in material collected by Professor H. B. Ward in Dead lake, Lake Michigan, Lake Rocks, and Mirror lake,—all these lakes being in the vicinity of Pike's Peak. It was especially abundant in the collections from Lake Michigan.

DIAPTOMUS WASHINGTONENSIS sp. nov.

Plate XXII, figs. 5, 8, 9. Plate XXIII, fig. 2.

One of the smaller species. The first cephalothoracic segment is somewhat longer than the combined length of the three following segments. The last cephalothoracic segment is armed with minute lateral spines. The first segment of the female abdomen is as long as the rest of the abdomen. It is expanded laterally and in front and bears two small spines laterally. On the posterior end on the right side it bears a finger-like process projecting backward. The second segment is ordinarily about one-half the length of the third. The furcal rami are about twice as long as their width and are setose on the inner margin.

The antennae are 25-segmented, slightly longer than the entire body. The right male antenna is much swollen anterior to the geniculating joint, and the antepenultimate segment bears a recurved hook which is continuous with a lateral lamella extending back one-half the length of the segment.

The first basal segments of the female fifth feet are armed with rather large spines. The lateral hairs of the second basal segments are very long and slender. The exopodite is composed of two segments, the third segment being represented by two small spines. In addition to these spines, there are sometimes present two other very minute spines. The second segment is prolonged into the customary hook, which is denticulate on the inner margin. The endopodite is slightly longer than the first segment of the exopodite, is composed of one segment, and armed on the inner margin of the tip with hairs, and has two rather long terminal spines.

The fifth feet of the male are slender. The first basal segments are armed with the customary spines. The second basal segment of the right foot is trapezoidal in form and longer than broad. The rather long lateral hair is situated at about two-thirds of its length. The first segment of the exopodite is quadrate, its length considerably less than its width. The length of the second segment is somewhat greater than the combined lengths of the second basal regment and the first segment of the exopodite. The lateral spine is situatcd beyond the middle of the segment. The terminal hook is symmetrically curved and is considerably longer than the first two segments of the exopodite. The endopodite is triangular in form, much longer than the first segment of the exopodite, and is sometimes indistinctly two-segmented.

The second basal segment of the exopodite of the fifth foot of the male has its rather long lateral hair situated almost at the distal angle of the segment. The first segment of the exopodite is about as long as broad, its inner and outer margins curved, the inner margin setose on its distal third. The second segment is half again as long as broad, the inner margin expanded at the base and at the distal end and setose. The distal end is setose and armed with two finger-like processes. The endopodite is slender, reaches well towards the tip of the second segment of the exopodite, and is setose at the tip.

Length of female, about 1.187 mm. Length of male, about 1.137 mm.

This species was found in material collected for me by Professor B. H. Brown in Walla Walla, Washington.

The close relation of this form to *D. signicauda* is apparent. In the female there are distinctive differences. In the male, however, the structure of the antepenultimate segment of the right antenna and of the fifth foot are so different that I think the validity of the species cannot be questioned. The lateral lamella of the antennal segment I have never found in *D. signicauda,* while it is characteristic of *D. washingtonensis.* The whole male fifth foot is much shorter and stouter in *D. washingtonensis,* the first segment of the right exopodite has no hyaline lamella, the endopodite is longer and is sometimes indistinctly two-segmented. The left endopodite is very much shorter in *D. washingtonensis.*

DIAPTOMUS JUDAYI sp. nov.

Plate XXII, fig. 6. Plate XXIII, figs. 1, 5.

A small species. The first cephalothoracic segment is considerably longer than the three following. The last segment is armed with minute lateral spines.

The first segment of the female abdomen is longer than the rest of the abdomen. It is expanded laterally and in front and bears two small lateral spines. On the posterior end of the right side it bears a finger-like process projecting backward. This process is somewhat shorter than in the other species of the *signicauda* type. The second segment is about half the length of the third. The furcal rami are rather less than twice as long as their width, and are ciliate on the inner margin.

The antennae are 25-segmented and extend a little beyond the furcal rami. The right antenna of the male is much swollen anterior to the geniculating joint, and bears a straight process on the antepenultimate segment. This process is two-thirds the length of the penultimate segment.

The first basal segments of the female fifth feet are armed with the customary spines. The second basal segments have rather long lateral hairs. The exopodite is composed of two segments, the third segment being represented by two spines. The second segment is prolonged into the usual hook-like process, and is denticulate on the inner margin. The endopodite about equals in length the first segment of the exopodite, is armed on the inner margin of the tip with hairs, and has two rather long terminal spines.

In the fifth feet of the male, the first basal segments are armed with rather large spines. The second basal segment of the right foot is trapezoidal in form and considerably longer than broad. The lateral hair is situated at about two-thirds of its length and is rather long. The first segment of the exopodite is trapezoidal in form, and its length and width are about equal. It bears a thin hyaline lamella resembling that in *signicauda,* but it is more pointed at the distal end. This hyaline lamella is not inserted on the inner margin, but on the posterior surface, so that as viewed from some directions only the distal end is visible, although it really extends the whole length of the segment. The second segment of the exopodite is somewhat shorter than the combined lengths of the first segment and the second basal segment. The lateral spine is situated proximad of the middle of the segment. The terminal hook is symmetrically curved, and is somewhat longer than the two segments of the exopodite. The endopodite is broad, acuminate, nearly equaling in length the first segment of the exopodite. The second basal segment of the left fifth foot of the male has the rather long lateral hair situated almost at the distal angle of the segment. The first segment of the exopodite is slightly longer than broad, has its inner and outer margins curved, and is setose on the distal third of its inner margin. The second segment is nearly three times as long as broad, and has the inner margin expanded near the base and setose. It terminates in two finger-like processes, one of which is much larger than the other. The endopodite is long and slender, reaching two-thirds the length of the second segment of the exopodite.

Length of female, 0.93 mm. Length of male, 0.9 mm.

This form was found in material collected by Mr. Chauncey Juday in Twin lakes, Colorado, and the name is given in recognition of the many collections which Mr. Juday has had the kindness to send to me. The species in most respects bears a very close resemblance to *D. signicauda.* The male fifth foot differs in the proportions of the segments, the form of the lamella of the first segment of the right exopodite, the position of the lateral spine on the second segment of the same exopodite, and in the form of the segment and the terminal processes of the second segment of the left exopodite. The most noticeable point of difference, however, and the one that at once separates this species from the others of the *signicauda* group, is the form of the appendage of the antepenultimate segment of the right male antenna.

DIAPTOMUS TRYBOMI Lilljeborg.

Plate XXVIII, figs. 1–4.

1889. *Diaptomus Trybomi* DeGuerne and Richard (Lillj.), p. 58; pl. I, fig. 35; pl. II, fig. 6; pl. III, fig. 14; pl. IV, fig. 28.

1895. *Diaptomus Trybomi* Herrick and Turner, p. 57; pl. VIII, fig. 17; pl. IX, fig. 4; pl. X, fig. 13.

1897. *Diaptomus Trybomi* Schacht, p. 158; pl. XXXI, figs. 1-5.

"Of moderate size. Cephalothorax with greatest width at about the middle; last two thoracic segments distinctly separated, and the last of these as seen from above slightly produced laterally, armed with two spines (one minute) on each side; besides, on the right side of this segment appears a large dorsal appendage, triangular in form, mucronate at the apex, and produced towards the right side. The first abdominal segment of the female is especially characteristic of the species (in the male it is formed in the ordinary manner), as in *D. signicauda* asymmetrical, surpassing in length the rest of the abdomen. On the anterior part this segment is armed with a short mucronate lateral process on either side, and on the posterior part with a large triangular process extending almost directly to the right and slightly acuminate at the apex. The furcal rami are quite short, not twice as long as broad.

"The first pair of antennae of the female are 25-segmented, hardly reaching the base of the furca. The antepenultimate segment of the prehensile antenna of the male is armed with a straight and quite slender process, almost reaching the middle of the penultimate segment, and provided on the outside to the apex with small teeth.

"The exopodite of the fifth pair of feet of the female is two-segmented, with the unguiform process of the second segment slightly curved, robust, denticulate on the middle part of the inner margin, the last teeth being broader and spine-like. The third segment is wanting and is represented only by two spines, the outer half as long as the inner. Endopodite one-segmented, hardly equal to the first segment of the exopodite, with the apex obliquely acuminate, provided with two quite long subequal spines.

"The second segment of exopodite of right foot in male is very long, surpassing in length the first segment and the basal segment taken together. The marginal spine of this segment is placed within the middle. The terminal hook is slightly curved, with the inner margin denticulate. The endopodite is curved, ovate, broad, turning inward, mucronate at the apex, hardly reaching the end of the first segment of exopodite. In the left foot, the first and second segments of the exopodite are setose within, the second obovate, hairy towards the apex, and bearing two short spines, one of which turns inward. The endopodite is one-segmented, slender, equaling in length the first segment of the exopodite.

"Length of female, about 1.5 mm.; length of male, 1.4 mm."

The above is the description as given by DeGuerne and Richard. It is added that the species was found in great numbers at "Multrooma Falls," Oregon. As Schacht suggests, it is probable that the locality is Multnomah Falls.

DIAPTOMUS DORSALIS sp. nov.

Plate XXIII, figs. 8, 9. Plate XXIV, figs. 2, 3, 5, 6.

A small species. The first segment of the cephalothorax considerably exceeds in length the three following. The last two cephalothoracic segments are confluent. The fifth segment has two dorsal teeth, the first of which is the more prominent and projects backward; the second is rounded and undulate on its anterior margin. The last segment bears two minute lateral spines.

The first abdominal segment of the female is slender and about once and a half as long as the rest of the abdomen. It is dilated in front and laterally. The lateral expansions are well forward, and are terminated with lateral spines. The second segment is short, less than one-half the length of the third. The furcal rami are much longer than the third segment, and much wider at the distal than at the proximal end. They are setose on the inner margin.

The antennae are 25-segmented and slightly exceed in length the furcal rami. The antepenultimate segment of the right antenna of the male bears a hook which is considerably shorter than one-half of the penultimate segment.

The first basal segments of the female fifth feet are armed with small spines. The second basal segments have short lateral hairs. The exopodite consists of three segments. The third segment is very small, and is tipped with a spine. There is also a small spine on the distal outer angle of the second segment. The second segment is prolonged into a rather blunt hook which is denticulate on the inner margin. The endopodite is shorter than the first segment of the exopodite, and is tipped with small hairs. The two terminal spines are very small.

The first basal segments of the male fifth feet are armed with prominent spines. The lateral hairs of the second basal segments of both feet are situated near the distal end of the segment. The length and breadth of these segments are about equal, and both are strongly curved on the inner margins. From the middle of the inner margin of the second basal segment of the right foot extends a small quadrangular hyaline lamella. The first segment of the exopodite of the right foot is short, its length and breadth being about equal. On its posterior surface are two hyaline shelf-like projections. The second segment is considerably longer than the combined lengths of the second basal segment and the first segment of the exopodite. Its outer margin is strongly curved. The lateral spine is large, strongly curved, and situated about midway of the length of the segment. From near the base of the lateral spine a transverse ridge extends across the posterior surface of the segment. The terminal hook is falciform and nearly equals in length the whole right foot. The endopodite is small and slender, considerably exceeding in length the first segment of the exopodite.

The left fifth foot in length reaches the distal extremity of the first segment of the exopodite of the right foot. The first segment of the exopodite is somewhat longer than broad and is armed on its inner margin with small hairs. The second segment is almost circular in outline, and also has the inner margin setose. It is tipped with a finger-like process and with a longer slender spine. The endopodite is slender, somewhat conical in shape, and reaches to about the middle of the second segment of the exopodite.

Length of female, 1.13 mm. Length of male, 1.069 mm.

This species was found in collections made by Professor Birge at Guzman and Milneburg, Louisiana. In the Guzman collections it was associated with *D. mississippiensis.* The form of the male fifth feet, however, and the dorsal process of the female make it easy to distinguish the two species. The particularly distinguishing features of *D. dorsalis* are the hyaline appendages of the segments of the right male fifth foot, and this dorsal process. The process very probably resembles that in *D. gibber* Poppe, but as DeGuerne and Richard give no figure, one cannot be certain.

DIAPTOMUS SALTILLINUS Brewer.

Plate XXIII, figs. 4, 6, 7, 10. Plate XXIV, fig. 1.

1897. *Diaptomus albuquerquensis* Schacht, p. 146; pl. XXVII, figs. 2, 4.

1898. *Diaptomus saltillinus* Brewer, p. 127; pl. VII, figs. 5–9.

1905. *Diaptomus saltillinus* Pearse, p. 148; pl. XIV, figs. 9, 10.

Of moderate size. The first cephalothoracic segment equals in length the three following. The last cephalothoracic segment is expanded in lateral lobes, each of which bears two minute spines. The fifth segment of the female has a projecting tooth at the middle of the dorsal surface.

The first abdominal segment of the female exceeds the rest of the abdomen in length. It is much dilated in front. The lateral dilatations are rather slight, at the proximal fourth of the length, and armed with minute spines. The second and third segments are about equal in length, and each is somewhat shorter than the furca. The furcal rami are longer than broad and ciliate on the inner margin.

The antennae are 25-segmented and reach to the end of the furca. The right antenna of the male is much swollen anterior to the geniculating joint; the antepenultimate segment bears a stout hook which is about one-half the length of the penultimate segment.

The spines on the posterior surface of the first basal segments of the female fifth feet are prominent. The lateral hairs of the second basal segments are slender. The length of the first segment of the exopodite is more than twice its width. The second segment is prolonged into a hook of slight curvature, and is denticulate on the inner margin. The third segment is distinct and armed with two spines. The endopodite is one-segmented, about one-half the length of the first segment of the exopodite, and setose at the tip.

The first basal segments of the fifth feet of the male are each armed with a prominent slender spine as in the case of the female fifth feet. The second basal segment of the right foot is as broad as long. It has a tooth-like process at the middle of its inner margin and a small hyaline process on the posterior surface near the distal end of the segment. The lateral hair is near the distal end. The first segment of the exopodite is short, its length being a little more than one-half its breadth. It is produced at the outer distal angle, and bears a small fold on the posterior surface near the distal end. The second segment is stout, its length being to its breadth in the proportion of three to two. The lateral spine is situated towards the distal end, is straight, and equals in length the two segments of the exopodite. The terminal hook is slender, and so sharply curved at the middle that the two parts make very nearly a right angle with each other. Its length equals that of the whole right foot. It is finely denticulate on the proximal half of the inner margin. The endopodite is short, stout and pointed, equaling in length the first segment of the exopodite. It is setose at the tip. The left foot reaches beyond the middle of the second segment of the right exopodite. The second basal segment is longer than broad, and nearly equals in length the corresponding segment of the right foot. The lateral hair is near the distal end. The first segment of the exopodite is twice as long as wide, and setose on the inner margin. The second segment is spherical in form, setose on its inner margin, and is terminated by a setose finger-like process and a slender falciform spine. The endopodite is slender, equal in length to the first segment of the exopodite, and setose at tip.

Length of female, 1.5 mm. Length of male, 1.25 mm.

Locality, temporary pools near Lincoln, Nebraska.

If *D. albuquerquensis* Schacht is identical with *D. saltillinus,* this species is also found in Florida. The relationship of *D. albuquerquensis* Schacht to *D. saltillinus* is discussed under *D. albuquerquensis.*

DIAPTOMUS ALBUQUERQUENSIS Herrick.

Plate XXIV, figs. 4, 7–10. Plate XXV, fig. 1.

1895. *Diaptomus albuquerquensis* Herrick, p. 45; figs. 16–26.
1895. *Diaptomus albuquerquensis* Herrick and Turner, p. 67; pl. VI, figs. 1–3; pl. VII, figs. 1–11.
1904. *Diaptomus Lehmeri* Pearse, p. 889; figs. 1–4.

Of moderate size. The cephalothorax is broadest at the middle. The first segment is about equal in length to the three following. The last segment in the female bears a blunt dorsal tooth; the segment is expanded laterally, each wing bearing two rather prominent spines.

The first abdominal segment of the female equals in length the remainder of the abdomen and the furca; it is dilated laterally and in front, and bears a strong spine on each side. The second segment is short, being only about one-half the length of the third. The third segment and the furcal rami are about equal in length. The furcal rami are ciliate on both the inner and outer margins.

The antennae are 25-segmented, and reach to the end of the furca. The right antenna of the male is much swollen anterior to the geniculating joint; the antepenultimate segment bears a slightly recurved hook considerably less in length than the penultimate segment. In the female fifth feet, the spines of the first basal segments are pronounced. The first segment of the exopodite is about twice as long as wide. The hook of the second segment is nearly as long as the first segment, is slightly curved, and is denticulate on the inner margin. The hook has a single fine tooth on the outer margin. There is a small spine at the base of the third segment. The third segment is distinct, and bears two spines of which the inner is the longer. The endopodite is indistinctly two-segmented, and is about one-half the length of the first segment of the exopodite. It is setose at tip.

In the male fifth feet, the spines of the first basal segments are stout. The length of the second basal segment is somewhat less than twice its width; it is trapezoidal in form, and wider at the distal end. The lateral hair is situated close to the distal end of the segment. The proximal inner angle is expanded into a wing-like process. At a little less than one-half its length, there is on the inner margin a recurved hyaline tooth. On the posterior surface of the segment is a two-headed hyaline process. The first segment of the exopodite is short, its length being only about one-half its width. The outer distal angle is somewhat extended. The segment has a hyaline lamella on its posterior surface, and a small hyaline projection from its posterior distal border. The second segment of the exopodite is between three and four times as long as the first segment. The lateral spine is situated at about four-fifths of its length, is long, nearly straight, and finely denticulate on its inner margin. On the posterior surface of the segment, about midway of its length, is an oblique ridge. The terminal hook is longer than the rest of the foot, regularly curved and finely denticulate on the inner margin. The right endopodite is one-segmented, about equal in length to the first segment of the exopodite, and is setose at the tip.

The left foot reaches beyond the end of the first segment of the exopodite. The second basal segment is elongate, but shorter than the corresponding segment of the right foot. The lateral hair is situated at rather more than two-thirds the length of the segment. The first segment of the exopodite is about twice as long as wide; the inner margin is convex and setose. The second segment of the exopodite is about equal in length and width; it is terminated by a blunt process and a slender, curved spine; its inner margin has two setose pads. The endopodite is slender, one-segmented, equal in length to the first segment of the exopodite, and setose at the tip.

Length of female, 1.765 mm. Length of male, 1.581 mm.

Localities: Albuquerque, New Mexico, City of Mexico, and Hugo, Colorado.

It was found impossible to get authoritative examples of this species, as the material was not preserved by Herrick, and the author was unsuccessful in dredging in the same locality. The description is from the material obtained in pools near Hugo, Colorado. Herrick does not mention or figure the tooth on the inner margin of the first basal segment of the right fifth foot of the male, or the dorsal tooth on the cephalothorax of the female. While it is possible that these features, which were not described either by Pearse, are local variations, it does not seem probable, inasmuch as the correspondence is so complete as far as the published descriptions go. It seems probable that these features were overlooked.

It may be noticed that *D. albuquerquensis, D. dorsalis* and *D. saltillinus* are very closely related to each other, and it is possible that intermediate forms may be found.

Schacht describes *D. albuquerquensis* from material collected in Florida. Just what Schacht had it is pretty difficult to tell, as he gives only two figures, but it seems evident that *D. albu-*

querquensis Herrick and *D. albuquerquensis* Schacht are not identical. The figure of the male fifth foot given by Schacht is very different from that figured by Herrick, and I think it probable that it belongs to *D. saltillinus* Brewer. The figure of the female fifth foot is of neither *D. saltillinus* nor *D. albuquerquensis,* as both species have a short endopodite. Schacht states that his *D. albuquerquensis* was found in connection with *D. mississippiensis,* and his figure would correspond very well to the fifth foot of the female of that species. It seems probable, then, that Schacht's description is a composite of *D. saltillinus* and *D. mississippiensis,* and that he had no specimens of *D. albuquerquensis.*

DIAPTOMUS ASYMMETRICUS sp. nov.

Plate XXV, fig. 6. Plate XXVI, figs. 1, 3, 4.

A small species. The first cephalothoracic segment is longer than the three following. The second, third and fourth segments are about equal in length, the fifth somewhat longer. The lateral expansions of the last thoracic segment are armed on each side with an acute spine.

The first segment of the female abdomen is much longer than the rest of the abdomen. It is expanded laterally at a little less than one-third its length; the dilatations are armed with acute spines which are slightly recurved. The dilatation on the front of the segment is very pronounced. At about two-thirds the length of the segment, and on the right side, is a blunt, rounded projection, which is much more prominent than the lateral dilatation. The second segment is short. The third segment is fully four times as long as the second, and is about equal in length to the furca. The distal end of the furcal ramus is nearly twice as wide as the proximal; the furcae are ciliate on the inner margin.

The antennae are 25-segmented, and in the female extend beyond the tip of the furcae. The right antenna of the male is much swollen anterior to the geniculating joint. The antepenultimate segment bears a recurved, hook-shaped process, which is about one-half the length of the penultimate segment; on the outer surface of this hook, and extending down the segment, is an inconspicuous hyaline lamella.

The first basal segments of the female fifth feet are armed with long and rather slender spines. The lateral hairs of the second basal segment are short and weak. The exopodite consists of three segments. The first segment is more than twice as long as its width. The second segment has a small spine on the outer distal angle; its inner margin is only slightly curved and is finely denticulate. The third segment is distinct and bears two spines, of which the inner is the longer. The endopodite is shorter than the first segment of the exopodite, and is one-segmented, or indistinctly two-segmented; its tip is setose, two of the setae being especially prominent, but hardly large enough to be called spines.

The spines of the first basal segments of the male fifth feet are long and acute. The second basal segment of the right foot is rectangular and longer than broad; the lateral hair is near the distal end of the segment; on the inner margin, about midway of its length, is a prominent hyaline projection with a semi-elliptical outline. The first segment of the exopodite is short, its length being to its breadth as one to one and one-half; on the posterior surface is a ridge running from the inner margin to about the middle of the segment. The second segment of the exopodite is slightly longer than the combined length of the second basal segment and the first segment of the exopodite; the outer margin is angular; the lateral spine is stout, slightly sigmoid, and is situated just beyond the angle near the end of the proximal half of the segment; on the posterior surface of the segment, nearly opposite the distal edge of the lateral spine, is a curved transverse ridge extending nearly across the segment. The terminal hook is strongly curved, falciform, slightly longer than the rest of the exopodite and the first basal segment, and is finely denticulate on the inner margin. The endopodite is one-segmented, about twice as long as the first segment of the exopodite, and is setose at the tip.

The left fifth foot reaches to about one-third the length of the second segment of the right exopodite. The second basal segment is trapezoidal, its proximal end being the wider; the lateral hair is near the distal end. The first segment of the exopodite is longer than broad, the inner and outer margins convex, and the inner margin setose. The inner margin of the second segment is a semicircular setose pad; the segment is terminated with a slender digitiform process and a long and slender spine, the two forming a forcipate structure. The endopodite is slender, one-segmented, longer than the first segment of the exopodite, and setose at the tip.

Length of female, 1.39 mm. Length of male, 1.16 mm.

This species was found in collections made by Prof. C. F. Baker at Havana, Cuba.

DIAPTOMUS PURPUREUS sp. nov.

Plate XXV, figs. 4, 7. Plate XXVI, figs. 2, 5.

A large species. The first segment of the cephalothorax equals the three following. The second, third and fourth are about equal in length, the fifth somewhat longer. The lateral expansions of the last cephalothoracic segment are armed on each side with a small, acute spine.

The first segment of the female abdomen is longer than the rest of the abdomen. The lateral dilatations are near the proximal end of the segment, are not marked, and are armed with small, acute spines. The second segment is short, being only about one-quarter the length of the third. The third segment and the furca are nearly equal. The distal ends of the furcal rami are wider than the proximal; the inner margins are ciliate.

The antennae are 25-segmented, and in the female barely reach the end of the first abdominal segment. The right antenna of the male is much swollen anterior to the geniculating joint; the antepenultimate segment bears a recurved, hook-shaped process which is about one-half the length of the penultimate segment. On the outer surface of the hook, and extending down the side of the segment, is an inconspicuous hyaline lamella.

The first basal segments of the female fifth feet are armed with long and stout spines. The lateral hairs of the second basal segments are short and weak. The exopodite consists of three segments; the first segment is stout, its length being to its breadth as four to two and one-half. The second segment has a small spine on its outer distal angle; the inner margin of the hook is concave and armed with prominent teeth. The third segment is distinct and bears two spines, of which the inner is the longer. The endopodite is one-segmented, is more than one-half the length of the first segment of the exopodite, and at the tip is setose and bears two long spines and one small one.

The spines of the first basal segments of the fifth feet of the male are acute and rather small. The second basal segment is trapezoidal in its general outline, longer than broad, its distal end the broader, and is distinctly convex on its inner and outer margins; the lateral hair is small and is near the distal end; on the inner margin, beyond the middle, is a hyaline projection with a rounded outline. The first segment of the exopodite is wider than long, and bears on its posterior face at about two-thirds of its length a transverse ridge. The second segment of the exopodite is a little more than twice as long as wide, and approximately rectangular in form; about midway of the posterior surface is a short, curved ridge; at the middle of the posterior surface, near the outer margin, is a semi-circular hyaline projection; the lateral spine is near the distal end of the segment; the terminal hook is about as long as the rest of the right foot exclusive of the first basal segment, is slender, and bent at near its middle into very nearly a right angle; the denticulations of its inner margin are very fine. The endopodite of the right fifth foot is short and stout, barely exceeding one-half the length of the first segment of the exopodite, and is setose at the tip.

The left foot reaches to one-half the length of the second segment of the right exopodite. The second basal segment is long and rectangular, equaling in length the corresponding segment of the right foot, but is not so wide; the lateral hair is situated not far from the distal end of the segment. The first segment of the exopodite is twice as long as wide, of nearly the same width through its whole length, the inner and outer margins slightly convex, the inner margin setose. The second segment is conical in form, with a rounded ciliate pad on its inner margin; the segment terminates in a blunt digitate process. The endopodite of the left fifth foot is one-segmented and shorter than the first segment of the exopodite; it is setose at the tip.

Length of female, 2.56 mm. Length of male, 2.24 mm.

This was collected by Prof. C. F. Baker in Havana, Cuba, and was found associated with *D. asymmetricus*.

The species is very conspicuous, for, in addition to being of large size, the furcae, the furcal setae and the distal ends of the antennae are colored a deep purple.

DIAPTOMUS SANGUINEUS Forbes.

Plate XXVI, figs. 2, 5.

1876. *Diaptomus sanguineus* Forbes, pp. 15, 16, 23; figs. 24, 28-30.

1882. *Diaptomus sanguineus* Forbes, p. 647; pl. VIII, figs. 1-7, 13.

1884. *Diaptomus sanguineus* Herrick, p. 138; pl. Q, fig. 12.

1884. *Diaptomus minnetonka* Herrick, p. 138; pl. Q, figs. 8-10.

1889. *Diaptomus sanguineus* DeGuerne and Richard, p. 20; figs. 9-11; pl. IV, fig. 24.

1893. *Diaptomus sanguineus* Marsh, p. 195; pl. III, figs. 1-3.

1895. *Diaptomus sanguineus* Herrick and Turner, p. 71; pl. V, figs. 8, 9; pl. XIII, fig. 12.

1895. *Diaptomus minnetonka* Herrick and Turner, p. 71; pl. XIII, figs. 8–10.

1897. *Diaptomus sanguineus* Schacht, p. 133; pls. XXIII, XXIV, XXV.
1898. *Diaptomus sanguineus* Brewer, p. 124.
1905. *Diaptomus sanguineus* Pearse, p. 147.

Rather large. The first segment of the cephalothorax is nearly equal in length to the rest of the cephalothorax. The last segment of the cephalothorax is produced laterally, and armed on each side with two rather prominent spines. The fifth cephalothoracic segment of the female has a pronounced dorsal hump.

The first abdominal segment of the female equals the rest of the abdomen including the furca. It is expanded laterally and in front, and bears two pronounced lateral spines. The second segment is about one-half as long as the third. The furcal rami are setose on the inner margin.

The antennae are 25-segmented and somewhat longer than the cephalothorax. The right antenna of the male is much swollen anterior to the geniculating joint. The antepenultimate segment bears at its distal end a short, stout, recurved hook, which is continuous with a lateral hyaline lamella of the segment.

The female fifth feet are rather stout. The spines of the first basal segments are of moderate size. The lateral hairs of the second basal segments are commonly long, reaching nearly to the end of the first segment of the exopodite. The first segment of the exopodite is twice as long as broad. The second segment is produced into the customary hook, which is dentate on the inner margin. The third segment is represented by two spines, of which the outer is the shorter. The endopodite is slender, variable in length, but commonly much shorter than the first segment of the exopodite. It is setose at tip, and armed with two rather long spines.

In the male fifth feet, the spines of the first basal segments are rather small. The second basal segment of the right foot is trapezoidal in form, wider at the distal end. Its length is about twice its average width. The outer distal angle is prolonged into a blunt or acute spine; the lateral hair is near the distal end. The first segment of the exopodite is small and quadrate. The second segment has about the same width as the first, and its length is about that of the second basal seg ment. Its outer margin is convex and its inner sinuous. The lateral spine is situated at about two-thirds the length of the segment, and is commonly straight and rather weak. The terminal hook is falciform with a regular curve, is denticulate on the inner margin, and is about equal in length to the second segment of the exopodite. The right endopodite is short and stout, much shorter than the first segment of the exopodite, setose at tip. Frequently the joint between it and the second basal segment disappears, and the endopodite appears simply as a prolongation of the inner distal angle of the second basal segment.

The left fifth foot reaches to the end of the second basal segment of the right foot. The second basal segment is quadrate, its inner margin strongly convex. The lateral hair is situated at the outer distal angle, is stout and plumose. The first segment of the exopodite is small and trapezoidal, widest at the base. The second segment is twice the length of the first, armed on its inner surface with a hemispherical setose pad. It terminates in two curved spines forming a forcipate structure. The inner spine is movable, bears a small tubercle on the inner side of its base, and is setose. The endopodite is about three times as long as broad, longer than the first segment of the exopodite, and is setose at tip.

Length of female, 1.4 to 2.12 mm. Length of male, 1 to 2 mm. (Schacht).

Occurs only in the early spring in stagnant pools. It is found quite generally in the Mississippi valley. It has been found as far east as New York, as far north as Wisconsin and Minnesota, as far west as Nebraska, and as far south as Alabama.

D. sanguineus is a very variable species. Some of these variations have been discussed in some detail by Schacht. The variations do not seem to be so great, however, as necessarily to raise any question as to specific identity. Inasmuch as there is a succession of forms in some pools in the spring, Herrick has maintained a heterogenetic character of this species, but his conclusions have not been verified by other authors. The exigencies of the life of the species may explain its variability. From the fact that its life is so short, we might expect some localization of species, inasmuch as there is hardly time for dispersion in the ordinary ways, and it is very possible that extended study will show that there are very definite local varieties.

Schacht considers *D. armatus* Herrick a variety of *D. sanguineus.* While I think this identification is probably correct, I have not ventured to include this among the list of synonyms, for Herrick's description is so very meager that it is impossible to know what form he had before him.

DIAPTOMUS EISENI Lilljeborg.

Plate XXV, fig. 3. Plate XXVI, figs. 6, 8.

1889. *Diaptomus Eiseni* DeGuerne and Richard, p. 44; pl. I, figs. 19, 29, 33.

1895. *Diaptomus Eiseni* Herrick and Turner, p. 58; pl. X, fig. 11.

1897. *Diaptomus Eiseni* Schacht, p. 162.

1898. *Diaptomus Eiseni* Brewer, p. 128; pl. VII, figs. 9-12.

Among the largest of the genus. The cephalothorax is widest at the posterior part of the head. The first segment does not equal in length the rest of the cephalothorax. The last two thoracic segments are commonly confluent above, or indistinctly separated. The lateral lobes of the last segment, seen from above, are, in the female, short, the anterior and posterior angles somewhat acute, and the lateral obtuse. The lateral spines of the last segment are short and thick.

The first abdominal segment of the female equals or exceeds in length the rest of the abdomen including the furca. It is swollen laterally and in front, and bears on the lateral expansions rather large spines which project backwards. The second segment is very short, and the third and the furca are nearly equal in length. The furcal rami are ciliate on both inner and outer margins.

The antennae are 25-segmented, and in the female reach the lateral processes of the first abdominal segment. The antepenultimate segment of the right male antenna has a long, recurved, acuminate process, which reaches about to the end of the antenna.

In the fifth foot of the female, the first segment of the exopodite is twice as long as wide. The second segment is prolonged into the customary hook. This segment bears a spine at its outer angle and is denticulate on its inner margin. The third segment is distinct and bears two strong spines, of which the inner is longer and is serrate on its margins.

The endopodite nearly equals in length the first segment of the exopodite, is indistinctly two-segmented, is setose at tip, and bears two rather long spines.

In the fifth feet of the male, the spines of the first basal segments are rather small. The second basal segment of the right foot is wider than long, has a peculiar rugose expansion of the inner margin, and bears the lateral hair at about two-thirds of its length. The first segment of the exopodite is short, its length being less than its breadth. It is produced on the outer distal angle, and bears a small tubercle on the inner margin near the distal end. The second segment is twice as long as broad, convex on the outer margin, and concave on the inner. The lateral spine is placed near the outer distal angle and is serrate on the inner side. The terminal hook is about as long as the whole right foot exclusive of the first basal segment; it is abruptly bent at somewhat less than half its length, making very nearly a right angle. The inner margin is dentate. The endopodite is slender, indistinctly two-segmented, and once and a half as long as the first segment of the exopodite. The left foot reaches nearly to one-half the length of the second segment of the right exopodite. The second basal segment is as long as wide, with the lateral hair placed near the distal end. The first segment of the exopodite is twice as long as wide, convex on both inner and outer margins, and with the inner margin setose. The second segment is slightly longer than the first, and armed with two setose pads on its inner margin. It terminates in a blunt digitiform process, and from the inner margin projects an acuminate, curved spine. The endopodite is slender, indistinctly two-segmented, reaches about one-half the length of the second segment of the exopodite, and is setose at tip.

Length of female, 4 mm. Length of male, 3.5 mm.

The original description was from material found in Fresno, California. It was later reported by Brewer from Lincoln, Nebraska. These are thus far the only localities for the species, but doubtless it will be found at intermediate points.

The description, as given above, is largely a compilation from DeGuerne and Richard and Brewer, with such modificacations as a very limited personal acquaintance with the species has permitted.

In the plate, the figures of the antenna and female fifth foot are from DeGuerne and Richard, the male fifth foot from a preparation kindly loaned by Professor H. B. Ward.

DIAPTOMUS NOVAMEXICANUS Herrick.

Plate XXVI, figs. 9, 10.

1895. *Diaptomus novamexicanus* Herrick, p. 46, figs. 27-29.
1895. *Diaptomus novamexicanus* Herrick and Turner, p. 70; pl. VI, figs. 7-10.
1897. *Diaptomus novamexicanus* Schacht, p. 149.

"A small species of robust form. Cephalothorax widest in front of the middle. The first segment equals in length the rest of the cephalothorax. The last segment is armed on each side with a minute spine.

"The first abdominal segment of the female exceeds in length the rest of the abdomen. It is dilated laterally, and armed on each side with a small spine. The second segment is very short. The furcal rami equal in length the preceding segment. The furcal setae are short.

"The antennae are 25-segmented and reach the furca, or sometimes the end of the furca. The right antenna of the male is swollen anterior to the geniculating joint; the antepenultimate segment has a lateral lamina which is prolonged at the end of the segment into a hook which barely reaches the end of the penultimate segment.

"In the female fifth foot, the spines of the first basal segments are large. The second segment of the exopodite has a strongly curved hook, which is denticulate on the inner margin. The third segment of the exopodite is distinct, and bears two spines. The endopodite is one-segmented, hardly equaling in length the first segment of the exopodite; the tip is armed with two spines and is setose.

"In the male fifth feet, the spines of the first basal segments are large. The second basal segment of the right foot is quadrate, rather longer than broad. The first segment of the exopodite is quadrate and shorter than the second basal segment. The second segment of the exopodite is three times as long as broad, convex on the outer margin and concave on the inner. The lateral spine is at about two-thirds its length, and is rather short. The terminal hook is symmetrically curved and nearly equal to the combined length of the rest of the exopodite and of the second basal segment. The right endopodite is one-segmented, setose at tip, and equal in length to the first segment of the exopodite.

"The left fifth foot of the male reaches the end of the first segment of the right exopodite. The first segment of the exopodite is oval. The second segment is nearly equal in length to the first; it terminates in two strong spines, and has a setose lamina at its base on the inner margin. The endopodite is one-segmented, setose at tip, and reaches to the middle of the second segment of the exopodite. The animal is for the most part colorless, but sometimes is blue or red.

"Length of female, 1.1 to 1.2 mm."

Locality, the tank of the city works at Albuquerque, New Mexico.

The above is the description of Herrick, and the figures of the plates are copies from his paper. I have been unable to obtain any material in order to verify the description.

LIST OF PAPERS QUOTED.

Beardsley, A. E., '02: Notes on Colorado Entomostraca. *Trans. Amer. Micr. Soc.*, xxiii: 41-48.

Brewer, A. D., '98: A study of the Copepoda found in the vicinity of Lincoln, Nebraska. *Jour. Cincinnati Soc. Nat. Hist.*, xix: 119-146.

DeGuerne, J., and Richard, J., '89: Révision de Calanides d' eau douce. *Mem. Soc. Zool. de France*, ii.

——, '92: Sur la Faune des eau douces de l' Islande. *Bull. Soc. Ent. Fr.*, 8 fev., 1892.

Forbes, S. A., '82: On some Entomostraca of Lake Michigan and adjacent waters. *Amer. Nat.*, xvi: 537-542, 640-649.

——, '91: On some Lake Superior Entomostraca. *Rept. U. S. Fish Com.*, 1887, pp. 701-718.

——, '93: A preliminary report on the aquatic invertebrate fauna of the Yellowstone National park, Wyoming, and of the Flathead region of Montana. *Bull. U. S. Fish Com.*, 1891, pp. 207-258.

Herrick, C. L., '79: Microscopic Entomostraca. *Ann. Rept. Regents Univ. Minn.*, 1878, pp. 81-123.

——, '82: Papers on the Crustacea of the fresh waters of Minnesota. *Ann. Rept. Geol. and Nat. Hist. Survey Minn.*, x: 221-254 +i-ii.

——, '83: Heterogenetic development in *Diaptomus*. *Amer. Nat.*, xvii: 381-389, 499-505.

——, '84: A final report on the Crustacea of Minnesota included in the orders Cladocera and Copepoda. *Ann. Rept. Geol. and Nat. Hist. Survey Minn.*, xii.

——, '95: Micro-Crustacea from New Mexico. *Zool. Anz.*, xviii: 40-47.

Herrick, C. L., and Turner, C. H., '95: Synopsis of the Entomostraca of Minnesota. *Geol. and Nat. Hist. Survey Minn.*, 2nd Rept. State Zoologist.

Juday, C., '03: The plankton of Winona lake. *Ind. Univ. Bull.,* i: 120-133.

Marsh, C. D., '91: On the deep-water Crustacea of Green lake. *Trans. Wis. Acad.,* viii: 211-213.

——, '93: On the Cyclopidæ and Calanidæ of Central Wisconsin. *Trans. Wis. Acad.,* ix: 189-224.

——, '94: On two new species of *Diaptomus. Trans. Wis. Acad.,* ix: 15-17.

——, '95: On the Cyclopidæ and Calanidæ of Lake St. Clair, Lake Michigan, and certain of the inland lakes of Michigan. *Bull. Mich. Fish Com.,* no. 5.

——, '97: The limnetic Crustacea of Green lake. *Trans. Wis. Acad.,* xi: 189-224.

——, '03: The plankton of Lake Winnebago and Green lake. *Wis. Geol. and Nat. Hist. Survey, Bull.* xii.

——, '04: Report on Copepoda, in "A biological reconnoissance of some elevated lakes in the Sierras and Rockies," by Henry B. Ward. *Studies from Zool. Lab., Univ. Neb.,* no. 60: 146-149.

Pearse, A. S., '04: A new species of *Diaptomus* from Mexico. *Amer. Nat.,* xxxviii: 889-891.

——, '05: Contributions to the Copepod fauna of Nebraska and other states. *Studies from Zool. Lab., Univ. Neb.,* no. 65: 145-160.

——, '06: Fresh water Copepoda of Massachusetts. *Amer. Nat.,* xl: 241-251.

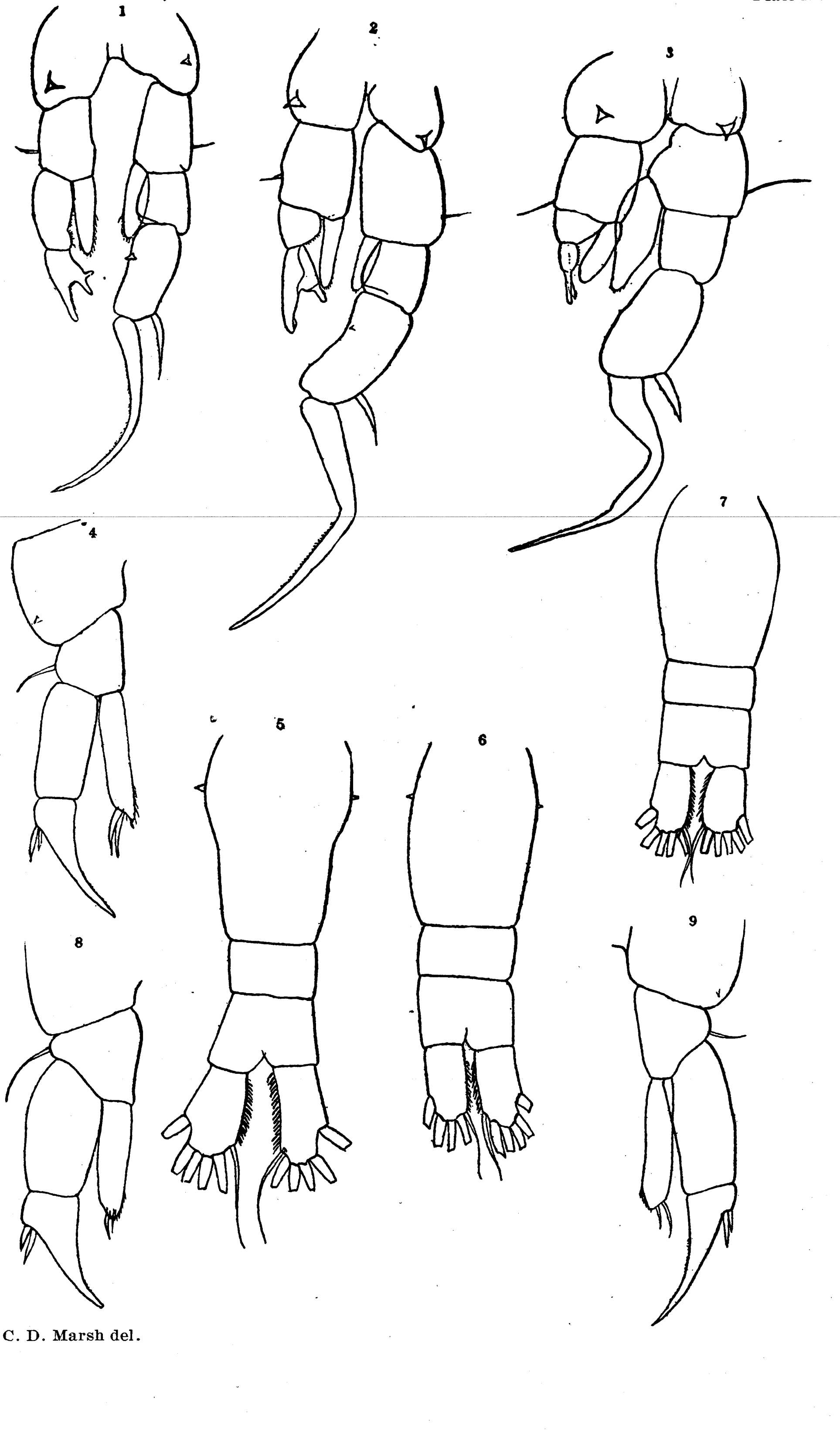
Poppe, S. A., '88: Diagnoses de deux espèces nouvelles du genre *Diaptomus* Westwood. *Bull. Soc. Zool. Fr.,* xiii: 159.

Schacht, F. W., '97: The North American species of *Diaptomus. Bull. Ill. State Lab. Nat. Hist.,* v, art. 3.

PLATE XV.

EXPLANATION OF PLATE XV.

Fig. 1. *Diaptomus oregonensis:* fifth feet of male (× 290).
Fig. 2. *Diaptomus Reighardi:* fifth feet of male (× 290).
Fig. 3. *Diaptomus mississippiensis:* fifth feet of male (× 290).
Fig. 4. *Diaptomus oregonensis:* fifth feet of female (× 375).
Fig. 5. *Diaptomus mississippiensis:* abdomen of female (× 165).
Fig. 6. *Diaptomus Reighardi:* abdomen of female (× 290).
Fig. 7. *Diaptomus oregonensis:* abdomen of female (× 165).
Fig. 8. *Diaptomus mississippiensis:* fifth feet of female (× 290).
Fig. 9. *Diaptomus Reighardi:* fifth feet of female (× 375).



C. D. Marsh del.

PLATE XVI.

EXPLANATION OF PLATE XVI.

Fig. 1. *Diaptomus pallidus:* fifth feet of male (× 190).

Fig. 2. *Diaptomus pallidus:* abdomen of female (× 165).

Fig. 3. *Diaptomus pallidus:* fifth feet of female (× 290).

Fig. 4. *Diaptomus Bakeri:* abdomen of female (× 155).

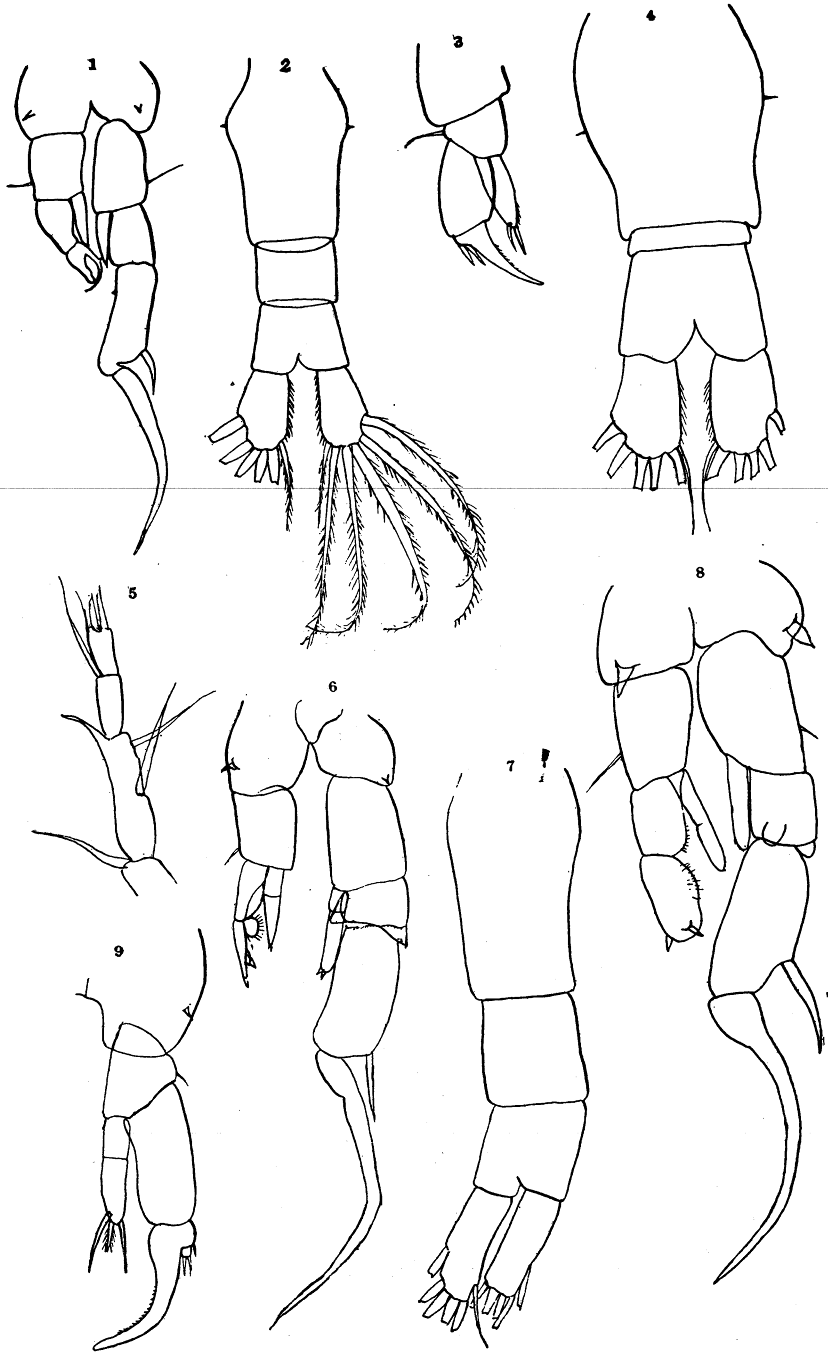
Fig. 5. *Diaptomus Bakeri:* terminal segments of right antenna of male (× 155).

Fig. 6. *Diaptomus Bakeri:* fifth feet of male (× 165).

Fig. 7. *Diaptomus tenuicaudatus:* abdomen of female (× 165).

Fig. 8. *Diaptomus tenuicaudatus:* fifth feet of male (× 290).

Fig. 9. *Diaptomus Bakeri:* fifth feet of female (× 290).



C. D. Marsh del.

PLATE XVII.

EXPLANATION OF PLATE XVII.

Fig. 1. *Diaptomus sicilis:* fifth feet of male (× 290).

Fig. 2. *Diaptomus tenuicaudatus:* fifth feet of female (× 290).

Fig. 3. *Diaptomus tenuicaudatus:* terminal segments of right antenna of male (× 290).

Fig. 4. *Diaptomus sicilis:* terminal segments of right antenna of male (× 290).

Fig. 5. *Diaptomus sicilis:* fifth foot of female (× 290).

Fig. 6. *Diaptomus Ashlandi:* fifth foot of female (× 375).

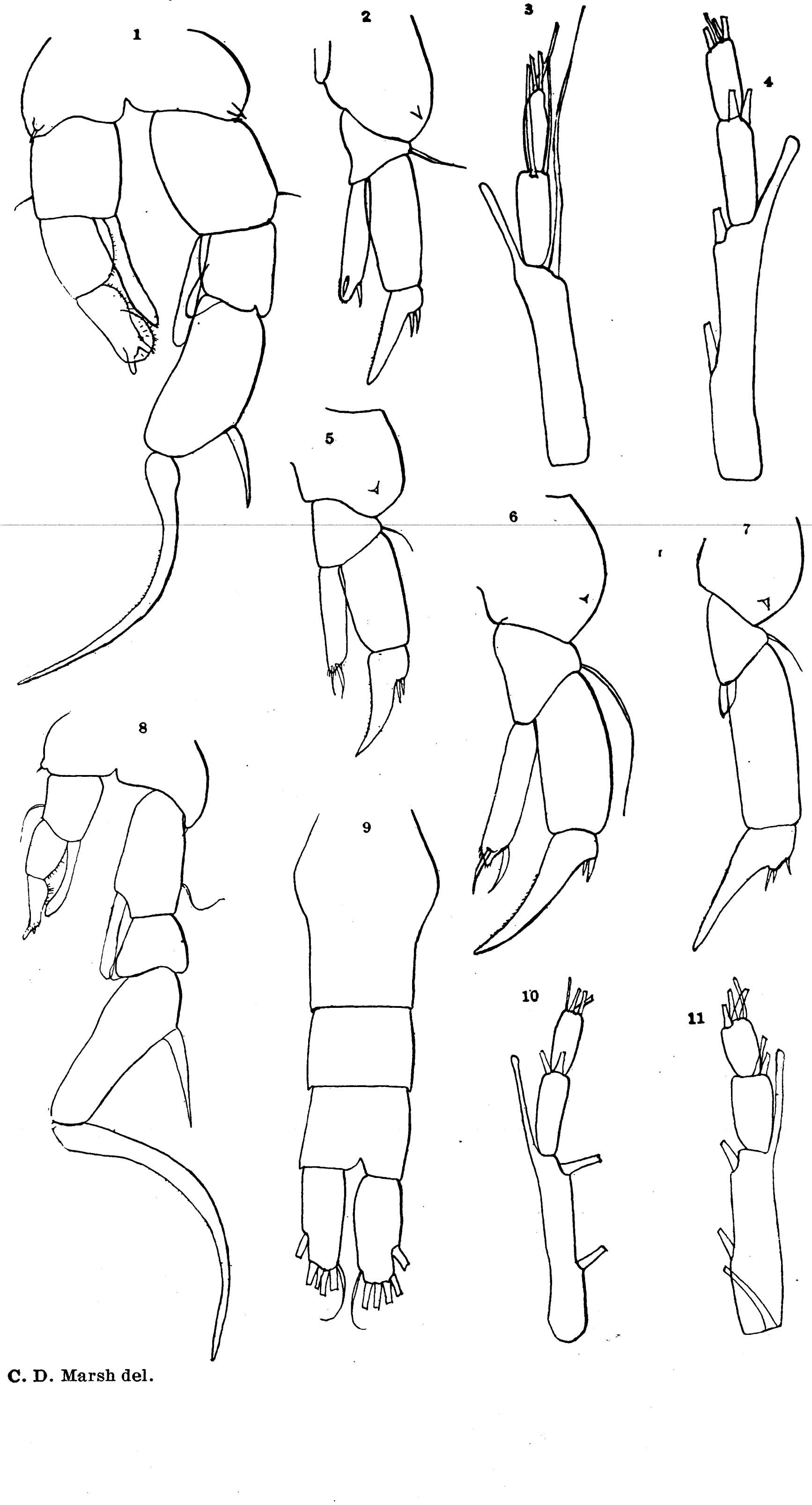
Fig. 7. *Diaptomus minutus:* fifth foot of female (× 375).

Fig. 8. *Diaptomus Ashlandi:* fifth feet of male (× 290).

Fig. 9. *Diaptomus sicilis:* abdomen of female (× 165).

Fig. 10. *Diaptomus Ashlandi:* terminal segments of right antenna of male (× 290).

Fig. 11. *Diaptomus minutus:* terminal segments of right antenna of male (× 290).



C. D. Marsh del.

PLATE XVIII.

EXPLANATION OF PLATE XVIII.

Fig. 1. *Diaptomus minutus:* abdomen of female (× 165).

Fig. 2. *Diaptomus shoshone:* fifth feet of male (× 108).

Fig. 3. *Diaptomus shoshone:* abdomen of female (× 68).

Fig. 4. *Diaptomus shoshone:* terminal segments of right antenna of male (× 180).

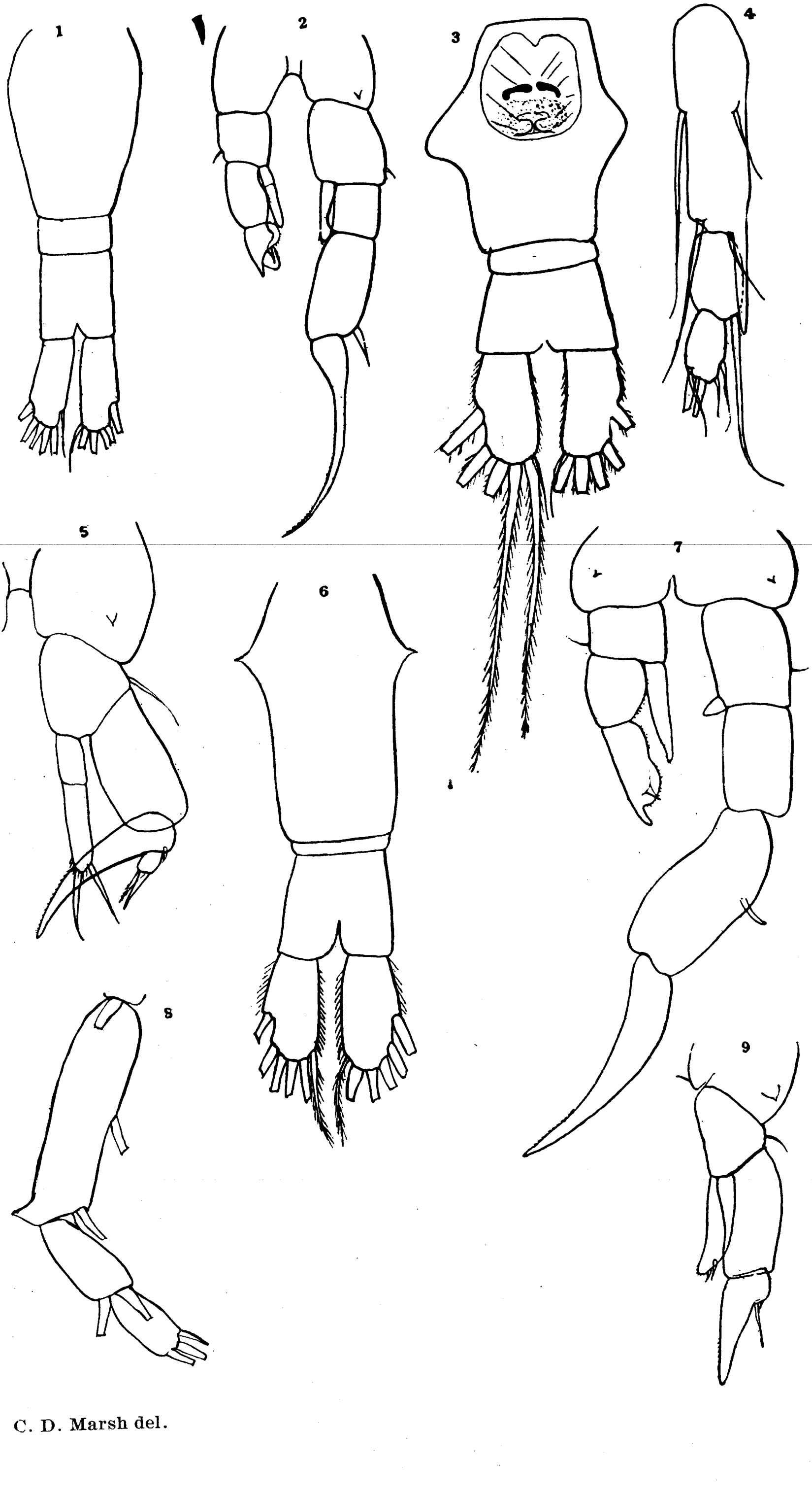
Fig. 5. *Diaptomus shoshone:* fifth foot of female (× 108).

Fig. 6. *Diaptomus Birgei:* abdomen of female (× 165).

Fig. 7. *Diaptomus minutus:* fifth feet of male (× 290).

Fig. 8. *Diaptomus Birgei:* terminal segments of male antenna (× 290).

Fig. 9. *Diaptomus siciloides:* fifth foot of female (× 290).



C. D. Marsh del.

PLATE XIX.

EXPLANATION OF PLATE XIX.

Fig. 1. *Diaptomus Birgei:* fifth foot of female (× 290).

Fig. 2. *Diaptomus Tyrelli:* abdomen of female (× 156).

Fig. 3. *Diaptomus Tyrelli:* fifth feet of male (× 190).

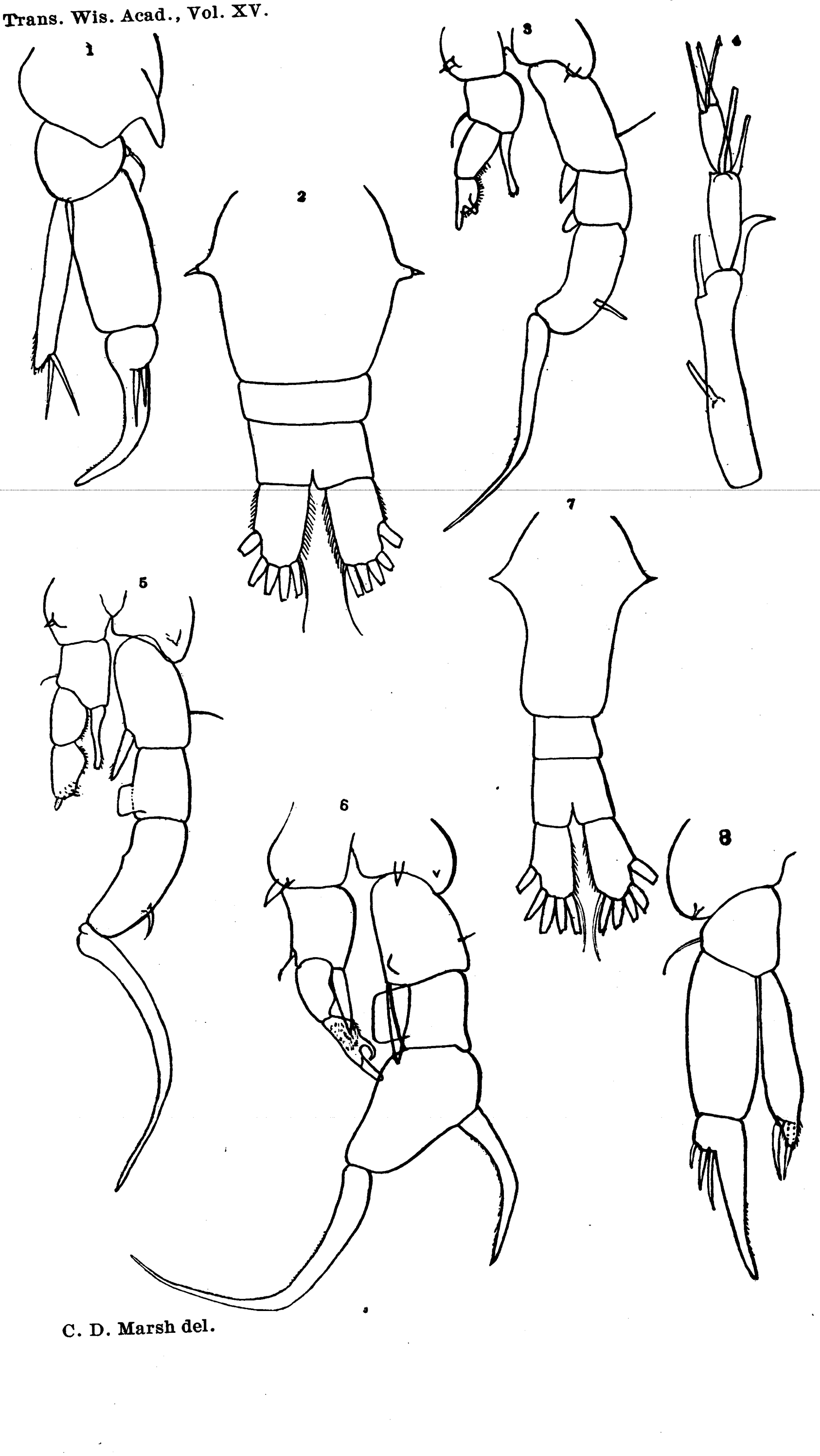
Fig. 4. *Diaptomus siciloides:* terminal segments of right antenna of male (× 290).

Fig. 5. *Diaptomus siciloides:* fifth feet of male (× 190).

Fig. 6. *Diaptomus Birgei:* fifth feet of male (× 190).

Fig. 7. *Diaptomus siciloides:* abdomen of female (× 165).

Fig. 8. *Diaptomus Tyrelli:* fifth foot of female (× 290).

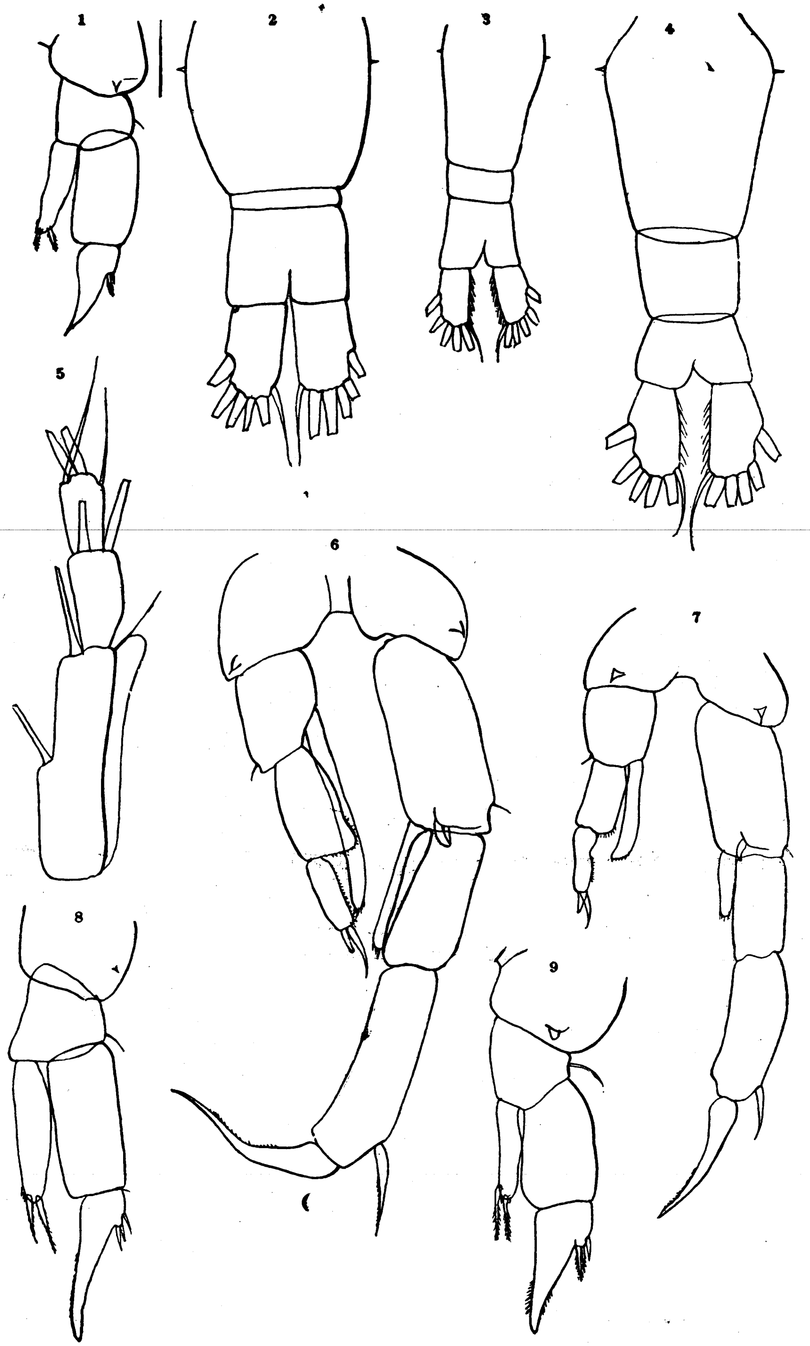


C. D. Marsh del.

PLATE XX.

EXPLANATION OF PLATE XX.

Fig. 1. *Diaptomus leptopus:* fifth foot of female (× 190).
Fig. 2. *Diaptomus leptopus:* abdomen of female (× 158).
Fig. 3. *Diaptomus leptopus* var. *piscinæ:* abdomen of female (× 76).
Fig. 4. *Diaptomus conipedatus:* abdomen of female (× 185).
Fig. 5. *Diaptomus leptopus:* terminal segments of right antenna of male (× 290).
Fig. 6. *Diaptomus leptopus* var. *piscinæ:* fifth feet of male (× 165).
Fig. 7. *Diaptomus leptopus:* fifth feet of male (× 256).
Fig. 8. *Diaptomus leptopus* var. *piscinæ:* fifth foot of female (× 165).
Fig. 9. *Diaptomus clavipes:* fifth foot of female (× 165).



C. D. Marsh del.

PLATE XXI.

EXPLANATION OF PLATE XXI.

Fig. 1. *Diaptomus clavipes:* abdomen of female (× 190).

Fig. 2. *Diaptomus conipedatus:* fifth feet of male (× 190).

Fig. 3. *Diaptomus conipedatus;* terminal segments of right antenna of male (× 290).

Fig. 4. *Diaptomus conipedatus:* fifth foot of female (× 290).

Fig. 5. *Diaptomus clavipes:* fifth feet of male (× 114).

Fig. 6. *Diaptomus clavipes:* terminal segments of right antenna of male (× 190).

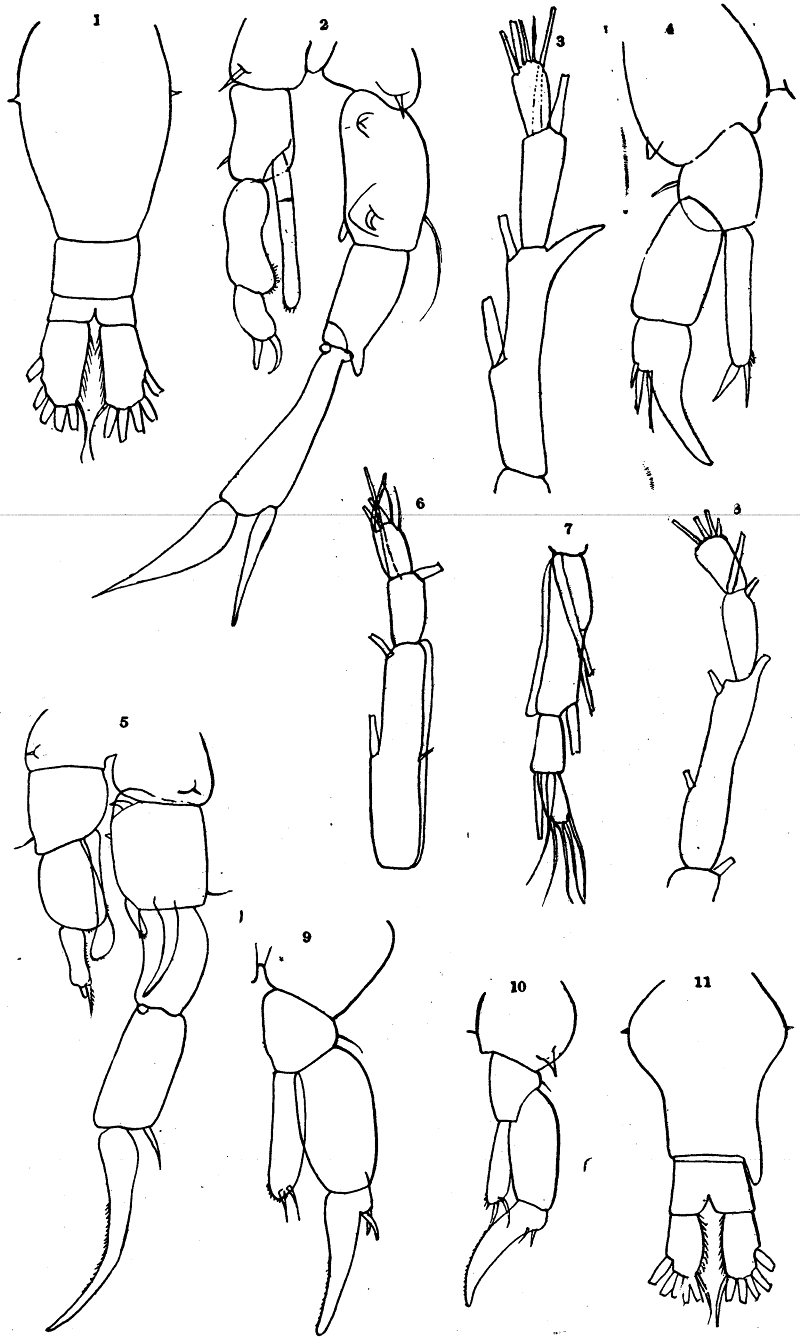
Fig. 7. *Diaptomus leptopus* var. *piscinæ:* terminal segments of right antenna of male (× 165).

Fig. 8. *Diaptomus signicauda:* terminal segments of right antenna of male (× 290).

Fig. 9. *Diaptomus nudus:* fifth foot of female (× 267).

Fig. 10. *Diaptomus signicauda:* fifth foot of female (× 165).

Fig. 11. *Diaptomus signicauda:* abdomen of female (× 165).



C. D. Marsh del.

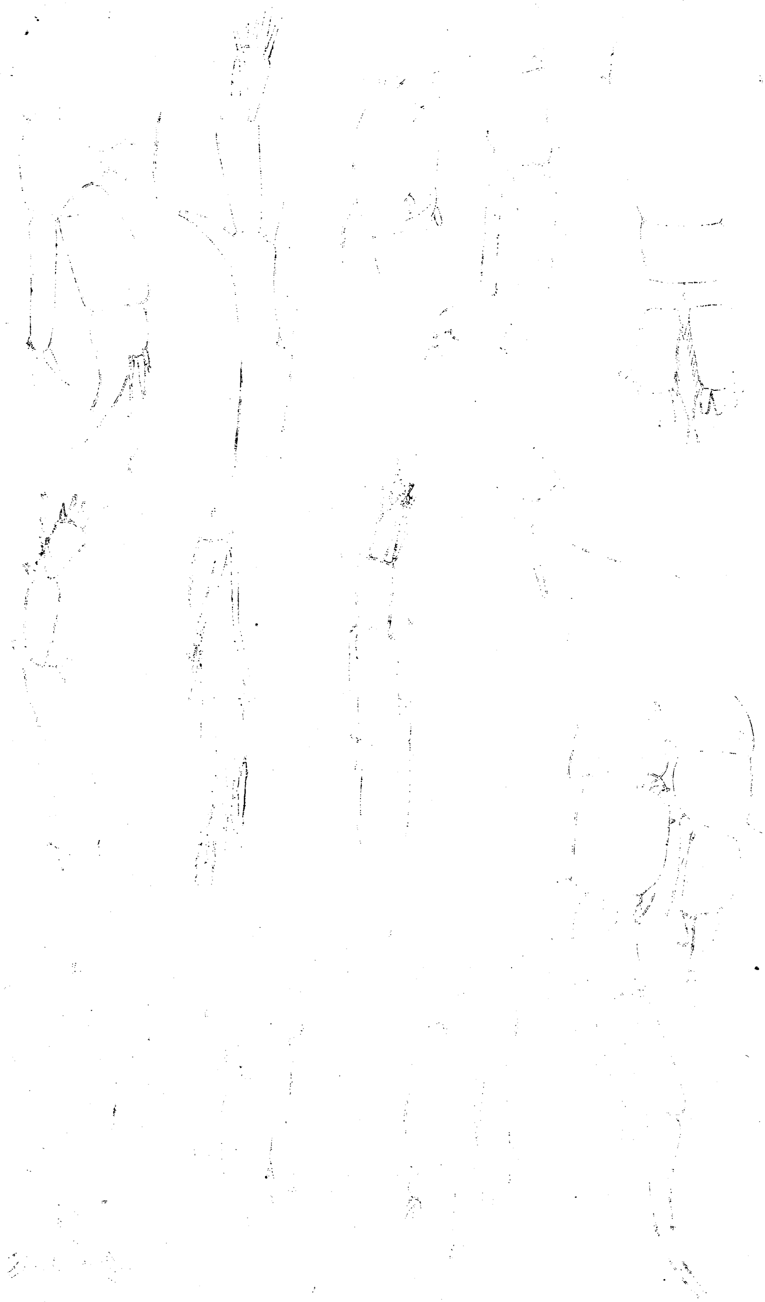


PLATE XXII.

EXPLANATION OF PLATE XXII.

Fig. 1. *Diaptomus nudus:* fifth feet of male (× 158).

Fig. 2. *Diaptomus nudus:* abdomen of female (× 158).

Fig. 3. *Diaptomus signicauda:* fifth feet of male (× 290).

Fig. 4. *Diaptomus Judayi:* terminal segments of right antenna of male (× 290).

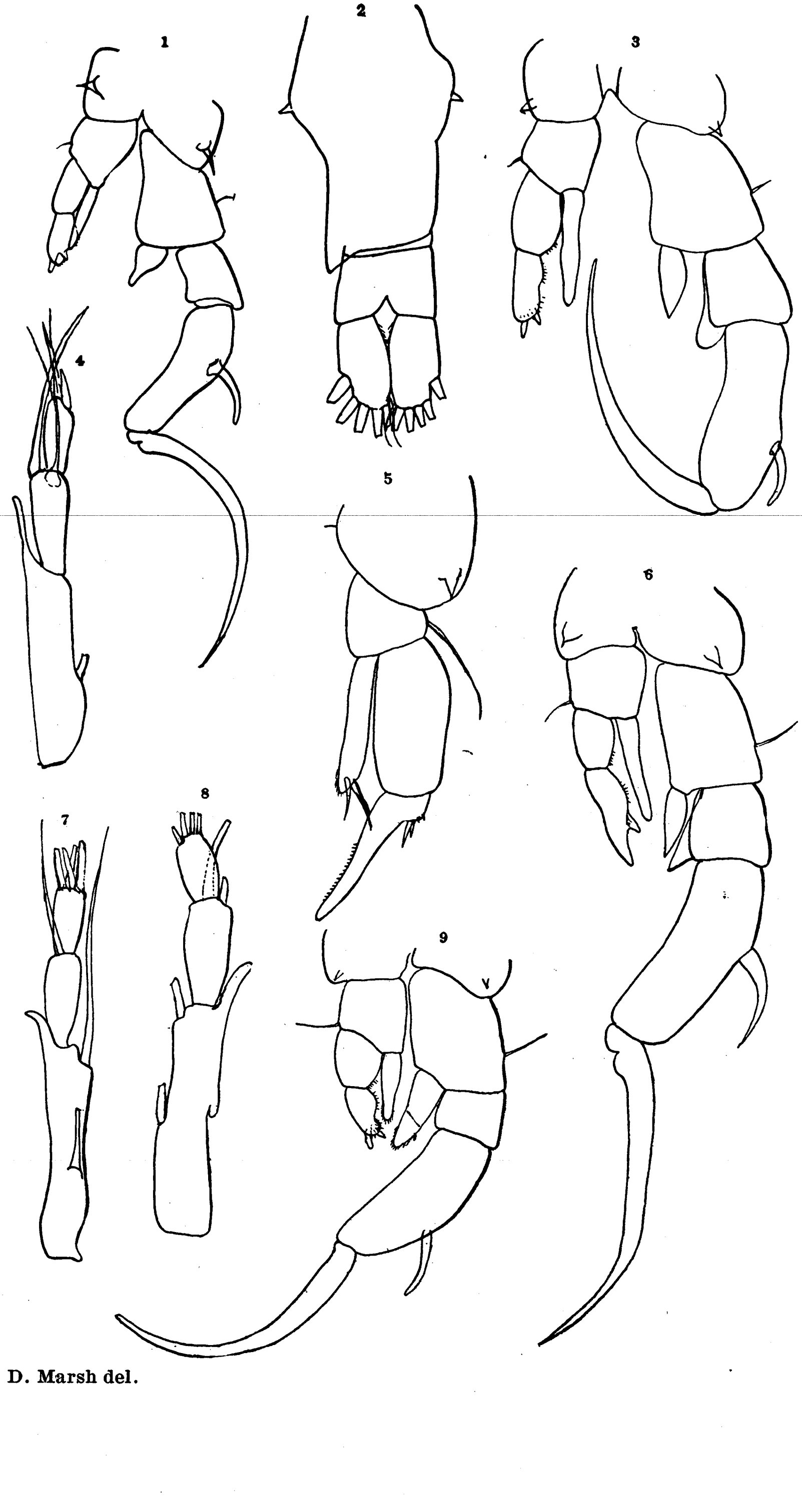
Fig. 5. *Diaptomus washingtonensis:* fifth foot of female (× 290).

Fig. 6. *Diaptomus Judayi:* fifth feet of male (× 290).

Fig. 7. *Diaptomus nudus:* terminal segments of right antenna of male (× 267).

Fig. 8. *Diaptomus washingtonensis:* terminal segments of right antenna of male (× 290).

Fig. 9. *Diaptomus washingtonensis:* fifth feet of male (× 190).



C. D. Marsh del.

PLATE XXIII.

EXPLANATION OF PLATE XXIII.

Fig. 1. *Diaptomus Judayi:* abdomen of female (× 165).

Fig. 2. *Diaptomus washingtonensis:* abdomen of female (× 165).

Fig. 3. *Diaptomus signicauda:* abdomen of female (× 165).

Fig. 4. *Diaptomus saltillinus:* terminal segments of right antenna of male (× 290).

Fig. 5. *Diaptomus Judayi:* fifth foot of female (× 290).

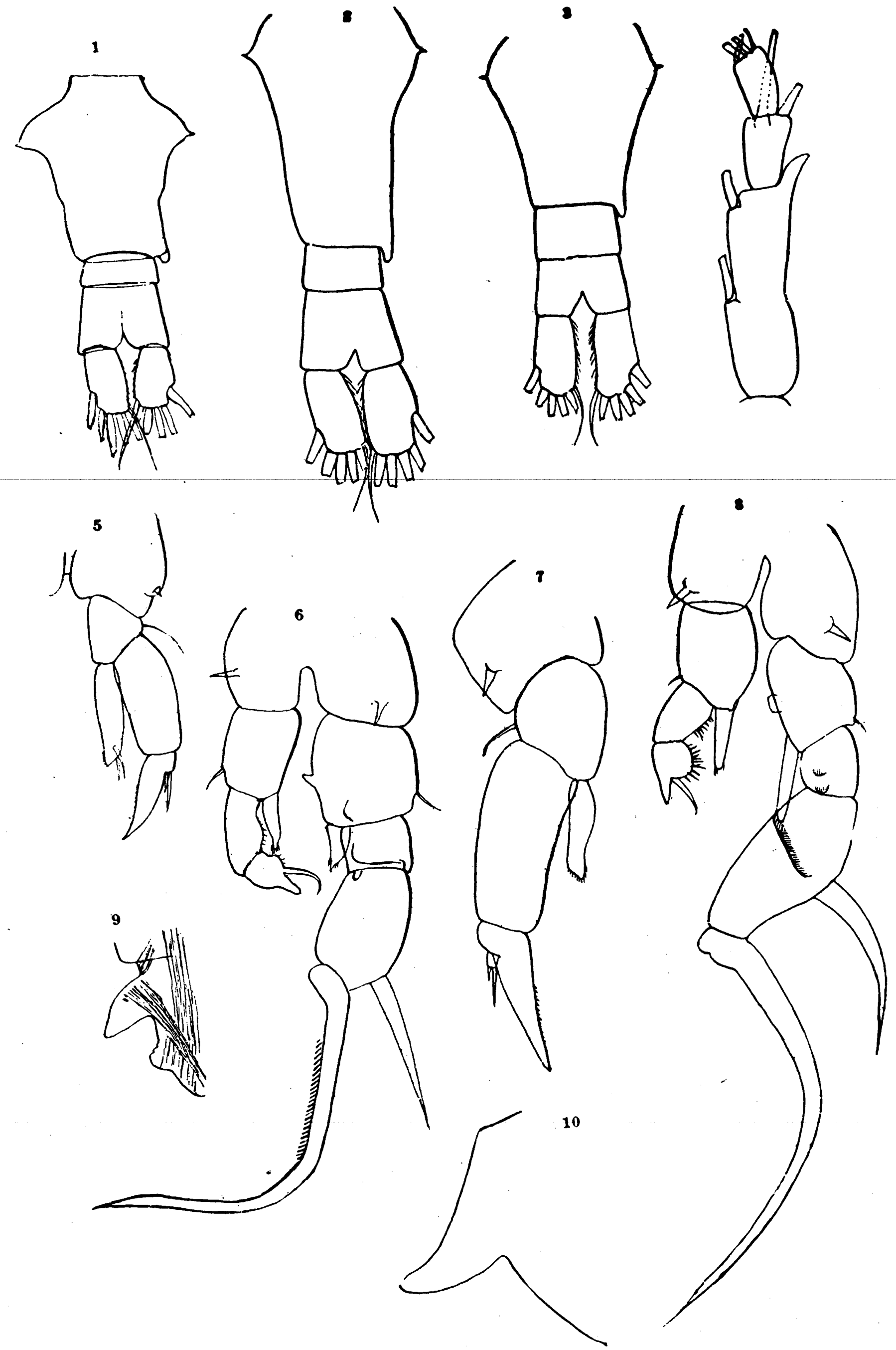
Fig. 6. *Diaptomus saltillinus:* fifth feet of male (× 190).

Fig. 7. *Diaptomus saltillinus:* fifth foot of female (× 290).

Fig. 8. *Diaptomus dorsalis:* fifth foot of male (× 290).

Fig. 9. *Diaptomus dorsalis:* profile of last cephalothoracic segment of female (× 165).

Fig. 10. *Diaptomus saltillinus:* dorsal process of last cephalothoracic segment of female (× 290).



C. D. Marsh del.

PLATE XXIV.

EXPLANATION OF PLATE XXIV.

Fig. 1. *Diaptomus saltillinus:* abdomen of female (× 165).

Fig. 2. *Diaptomus dorsalis:* abdomen of female (× 165).

Fig. 3. *Diaptomus dorsalis:* profile of cephalothorax of female (× 76).

Fig. 4. *Diaptomus albuquerquensis:* abdomen of female (× 100).

Fig. 5. *Diaptomus dorsalis:* terminal segments of right antenna of male (× 290).

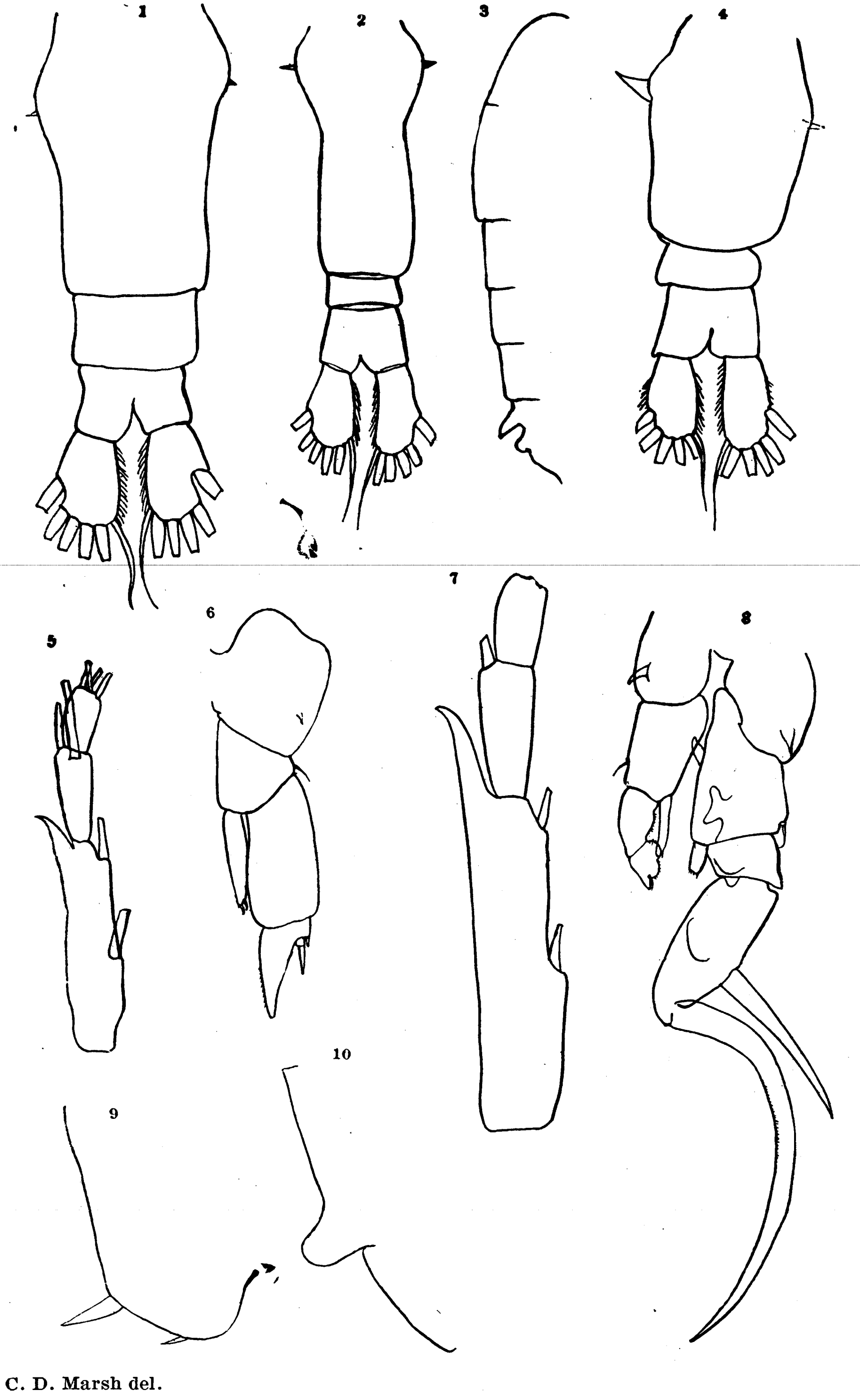
Fig. 6. *Diaptomus dorsalis:* fifth foot of female (× 290).

Fig. 7. *Diaptomus albuquerquensis:* terminal segments of right antenna of male (× 172).

Fig. 8. *Diaptomus albuquerquensis:* fifth feet of male (× 75).

Fig. 9. *Diaptomus albuquerquensis:* spines of left side of last cephalothoracic segment of female (× 180).

Fig. 10. *Diaptomus albuquerquensis:* dorsal process of last cephalothoracic segment of female (× 180).



C. D. Marsh del.

PLATE XXV.

EXPLANATION OF PLATE XXV.

Fig. 1. *Diaptomus albuquerquensis:* fifth foot of female (× 180).

Fig. 2. *Diaptomus sanguineus:* terminal segments of right antenna of male (× 290).

Fig. 3. *Diaptomus Eiseni:* fifth feet of male (× 76).

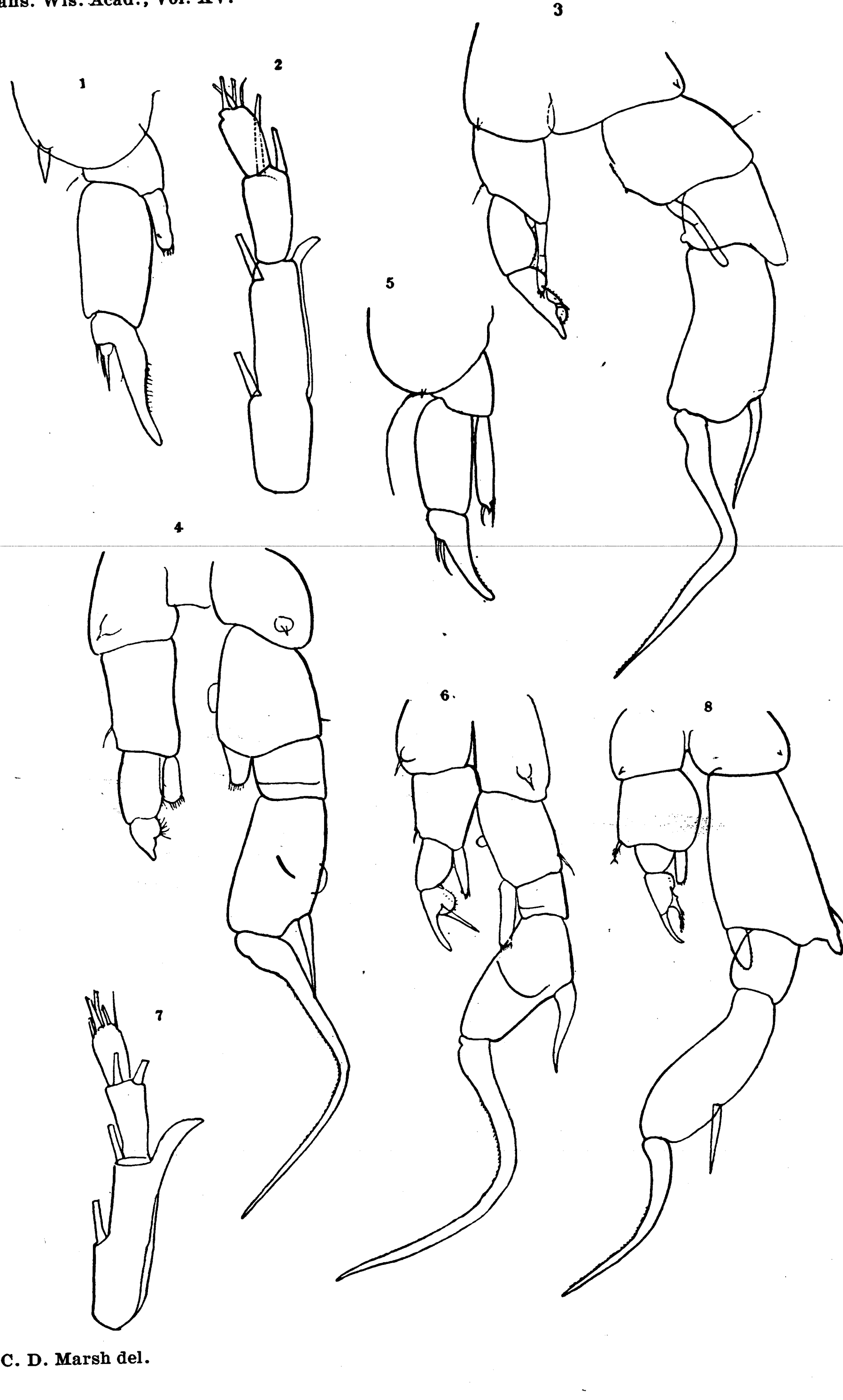
Fig. 4. *Diaptomus purpureus:* fifth feet of male (× 108).

Fig. 5. *Diaptomus sanguineus:* fifth foot of female (× 165).

Fig. 6. *Diaptomus asymmetricus:* fifth feet of male (× 205).

Fig. 7. *Diaptomus purpureus:* terminal segments of right antenna of male (× 180).

Fig. 8. *Diaptomus sanguineus:* fifth feet of male (× 165).



C. D. Marsh del.

PLATE XXVI.

EXPLANATION OF PLATE XXVI.

Fig. 1. *Diaptomus asymmetricus:* terminal segments of right antenna of male (× 267).

Fig. 2. *Diaptomus purpureus:* fifth foot of female (× 180).

Fig. 3. *Diaptomus asymmetricus:* fifth foot of female (× 267).

Fig. 4. *Diaptomus asymmetricus:* abdomen of female (× 158).

Fig. 5. *Diaptomus purpureus:* abdomen of female (× 69).

Fig. 6. *Diaptomus Eiseni:* fifth foot of female. After DeGuerne and Richard.

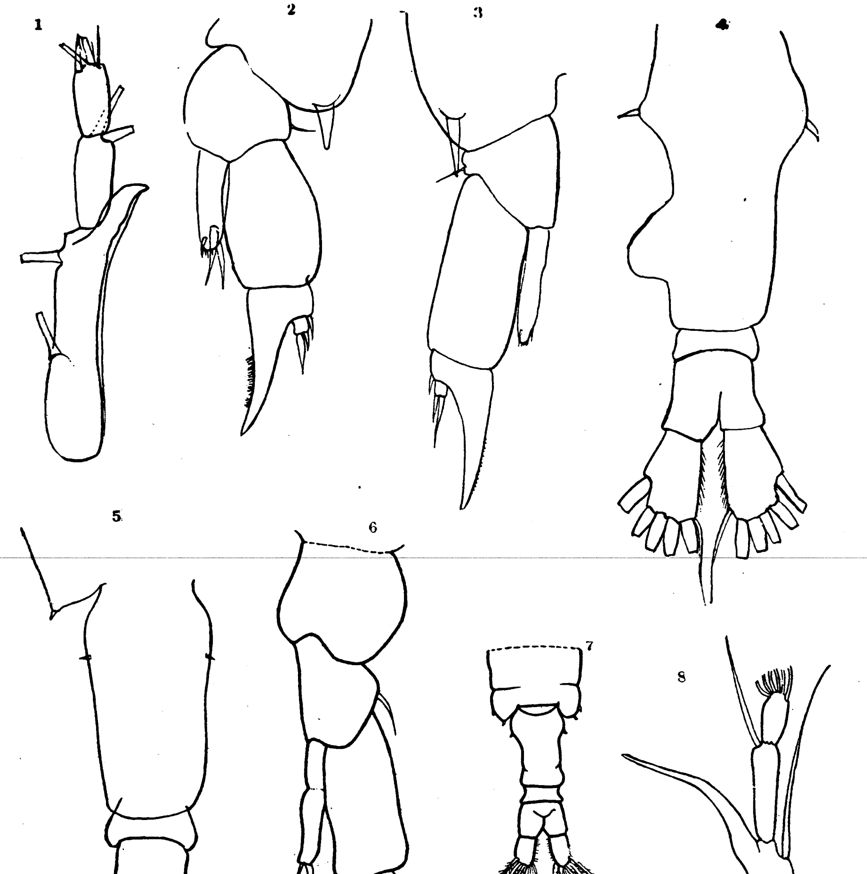
Fig. 7. *Diaptomus franciscanus:* abdomen of female. After DeGuerne and Richard.

Fig. 8. *Diaptomus Eiseni:* terminal segments of right antenna of male. After DeGuerne and Richard.

Fig. 9. *Diaptomus novamexicanus:* fifth feet of male. After Herrick and Turner.

Fig. 10. *Diaptomus novamexicanus:* fifth foot of female. After Herrick and Turner.

Fig. 11. *Diaptomus franciscanus:* terminal segments of right antenna of male. After DeGuerne and Richard.



C. D. Marsh del.

PLATE XXVII.

EXPLANATION OF PLATE XXVII.

Fig. 1. *Diaptomus franciscanus:* fifth foot of female. After DeGuerne and Richard.

Fig. 2. *Diaptomus franciscanus:* fifth feet of male. After DeGuerne and Richard.

Fig. 3. *Diaptomus stagnalis:* fifth foot of female. After Forbes.

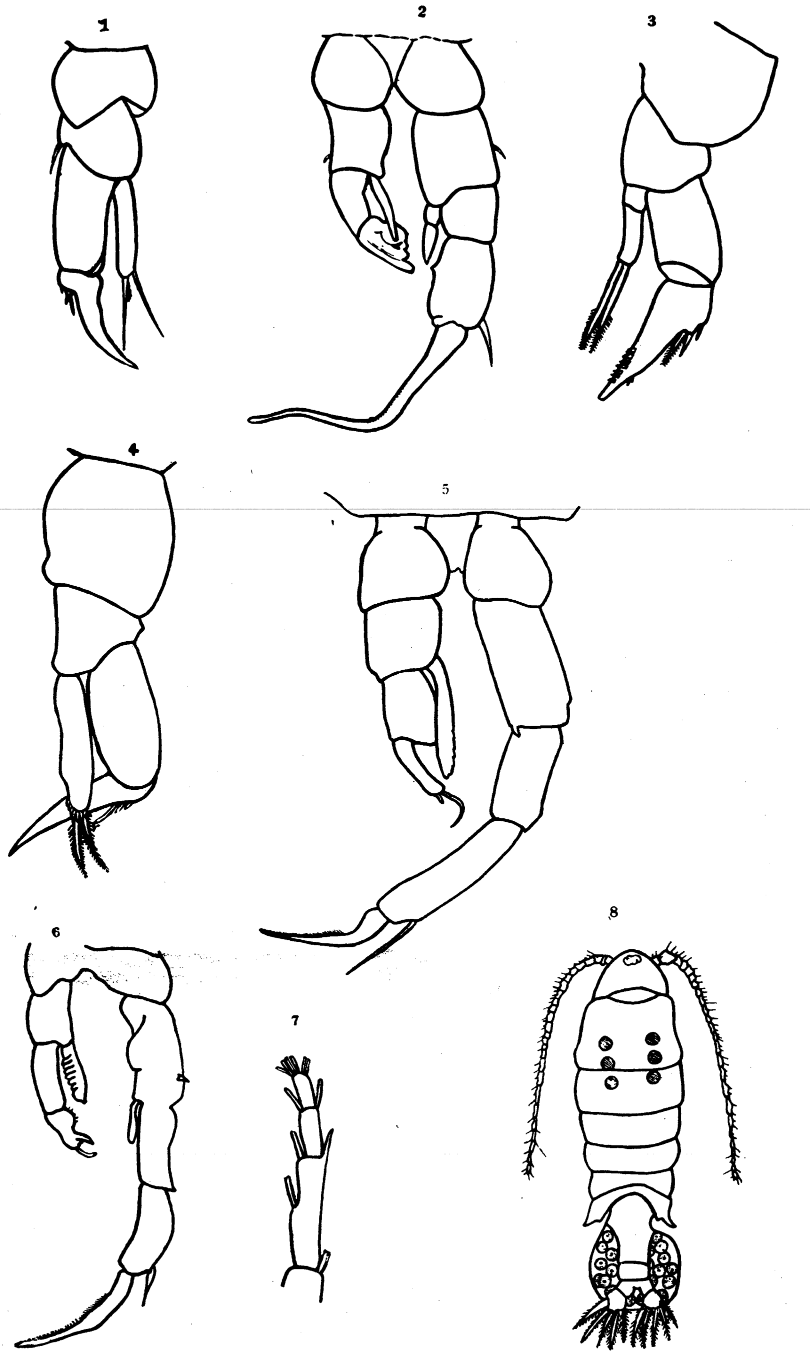
Fig. 4. *Diaptomus Lintoni:* fifth foot of female. After Forbes.

Fig. 5. *Diaptomus Lintoni:* fifth feet of male. After Forbes.

Fig. 6. *Diaptomus stagnalis:* fifth feet of male. After Herrick and Turner.

Fig. 7. *Diaptomus Lintoni:* terminal segments of right antenna of male After Forbes.

Fig. 8. *Diaptomus stagnalis:* female. After Herrick and Turner.



C. D. Marsh del.

PLATE XXVIII.

EXPLANATION OF PLATE XXVIII.

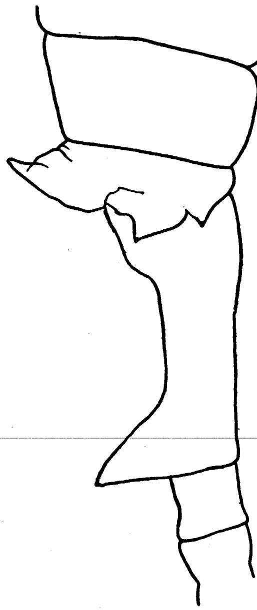
Fig. 1. *Diaptomus Trybomi:* abdomen of female. After DeGuerne and Richard.

Fig. 2. *Diaptomus Trybomi:* fifth feet of male. After DeGuerne and Richard.

Fig. 3. *Diaptomus Trybomi:* 23d and 24th segments of right antenna of male. After DeGuerne and Richard.

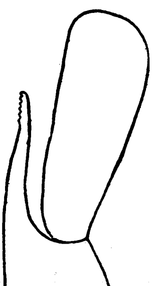
Fig. 4. *Diaptomus Trybomi:* fifth foot of female. After DeGuerne and Richard.

1



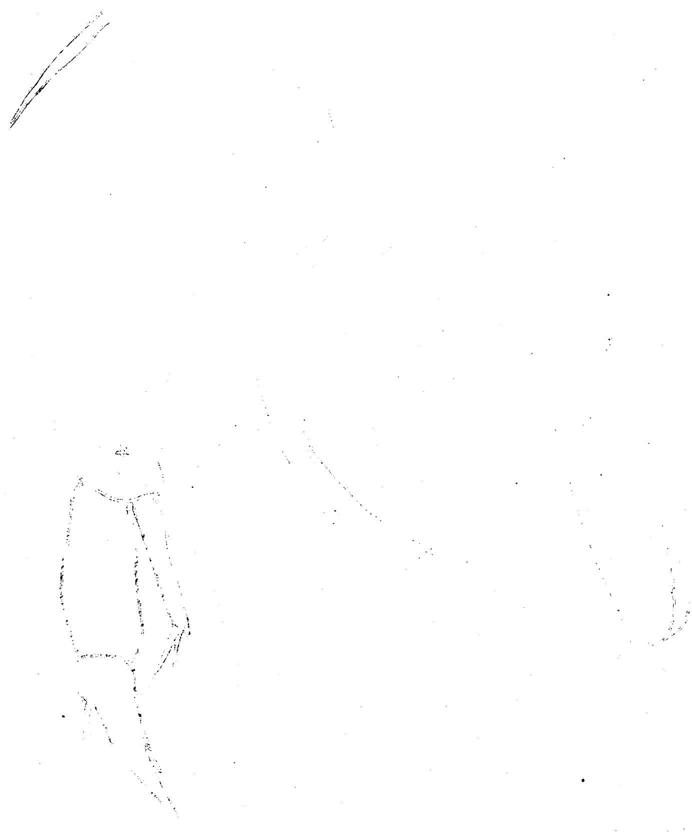
2

3



4

C. D. Marsh del.



INDEX.

THE NATURE AND DEVELOPMENT OF THE PRIMARY UREDOSPORE.

A. H. CHRISTMAN.

(With Plate XXIX)

The true interpretation of the peculiar fertilization phases in the life cycle of certain of the rusts as discovered by Blackman (1) and the author (3) will certainly not be reached without the study of a great number of forms, including especially those species with an abbreviated life cycle. The studies described here are intended as a further contribution in this line, taking up the special case of the development of the so-called primary uredospore.

Phragmidium potentillae canadensis Diet. is a form in which the aecidium is commonly supposed to be lacking, and the so-called primary uredospores result from an inoculation with sporidia from the teleutospores, while the secondary uredospores occur later as a result of infections from primary uredospores.

The hyphae of the primary uredospores differ from those that produce the later uredospores, in that they apparently also produce spermatia while those of the secondary uredospores do not. In structure, too, there is a difference. Those hyphae associated with the spermatia, in every case that I have observed, are composed of uninucleated cells, while the mycelial cells of stages unaccompanied by spermatia have regularly two more compact and smaller nuclei.

I am indebted again to Prof. Arthur for my material and its identification. Portions of the host (*Potentilla canadensis*) bearing the rust were put into Flemming's strong fixing fluid at Lafayette, Indiana, and mailed to the author at Menomonie, Wisconsin. The subsequent treatment, including the staining, was the same as that described in a previous paper (3).

In the formation of the primary uredospores, the hyphae mass beneath the epidermis of the host. Certain cells, which may nearly always be shown to be end cells of longer or shorter branches, assume a position perpendicular to the epidermis, and, by elongating, separate it from the tissue beneath. These cells now enlarge greatly, and divide unequally into a smaller distal cell and a larger one just beneath it, which is of about three times its size (Pl. XXIX, fig. 1).

The cytoplasm of the two cells is at first similar. The nucleus of the smaller cell is also small, and, in general, appears as if it had never fully organized after the preceding nuclear division. The nucleole is not to be seen, and the nuclear membrane is very imperfect. This whole distal cell now dwindles and disappears.

In the meantime, the larger cell beneath it grows somewhat, and comes to lie in close contact with the neighboring cells. At the point of contact between each pair of cells the walls disappear, and the two nuclei come to lie in a common cell (fig. 2).

Up to this point, the process is identical with that described in my previous work on *Phragmidium speciosum* Fr. and *Caeoma nitens* S. It seems that the walls separating the two fusing cells are generally more completely dissolved away in the case of *P. potentillae canadensis* Diet. than in the case of either of the other two forms just mentioned, since in later stages one does not so commonly find the condition which I have described and figured, in which the basal portion of the fusion cell is divided by the remnant of the gamete walls. The cells fusing are, as far as can be seen, *equal,* and the process is, at least apparently, a *fusion of equal gametes,* rather than the fertilization of an egg by the entrance of a nucleus from some other cell.

The fusion cell is a zygospore functionally, however we may interpret its phylogeny, and becomes in its germination, as we shall see, a basal cell for a series of uredospores.

The upper region of this cell now enlarges, and the nuclei come to lie high up in the protoplast rather than to occupy the bases of the original gamete cells. This condition, as I have previously described (3), is also found in *Uromyces caladii* Farl. A prominence is now formed at the apex of the basal cell, which, in general appearance, is not unlike a bud. I have not been able to observe the nuclear divisions which supply this bud with nuclei, but they are probably similar to those occurring later. At any rate, two nuclei come to lie in the bud, and two are left in the basal cell. The bud is now separated from the basal cell by a wall, and thus forms the first uredospore-mother-cell (fig. 3). A nuclear division (fig. 4), which seems in every respect to be a true conjugate division, now follows within the uredospore-mother-cell, and a daughter nucleus from each spindle comes to lie in the upper region, which is destined to become a spore. The other two nuclei are cut off by a cell wall in the lower elongated region of the uredospore-mother-cell (fig. 5). We see thus very clearly that the stalk cell so formed is directly comparable to the intercalary cell of the aecidium. In this case, it merely elongates to form a stalk upon which the uredospore is borne.

About the time that the processes of nuclear and cell division are complete in the first mother-cell, the basal cell is pushing out a second bud beside the base of the first stalk cell (fig. 6). Early in the process of budding, the two nuclei of the basal cell are seen to lie near the base of the protuberance. When the second spore-mother-cell is about half grown, the division of the nuclei occurs. This division does not occur in the central region of the fusion cell, but rather in the basal region of the bud (fig. 7). While the two nuclei divide simultaneously, it is not a conjugate division in the sense that the spindles are closely parallel during the division. The position of the spindles would indicate that in this case the division occurs while the nuclei are being carried into the base of the mother-cell by a flow of cytoplasm. The narrowness of the cell in this region necessitates that one nucleus precede the other, and we find the spindles thus arranged the one somewhat above the other. From analogy we may conclude with tolerable certainly that each cell in the division which follows will receive one daughter nucleus from each spindle. Still, with the spindles arranged as shown in Figure 7, it is possible that such is not to be the case here. Another interesting feature in this figure is the utter abandonment of the two nucleoles by the remainder of the karyokinetic figure. In all other nuclear divisions which I have observed in the rusts, the nucleole lies at no great distance from, and to one side of, the spindle. It would appear in this case that the nucleoles could never be of further use to the nuclei in the process of reconstruction.

Two of the daughter nuclei from this simultaneous division come to lie in the hyphal bud, and two return to the basal cell (fig. 8). By processes similar to those described for the formation of the first spore, this second outgrowth is formed into a uredospore and a stalk cell (fig. 9).

How many times this process can be repeated it is difficult to say, since two branches are all that can well appear in one section. I have followed the process as far as to the formation of the third bud. The later stages are rendered difficult of study by a lateral crowding produced by the pushing of the newer spores between those already formed. This distorts the basal structures and loosens the older spores, so that the original arrangement and connections of the cells are not easily to be made out.

If we compare the spore formation as described here with the process in *Phragmidium speciosum,* we find that, in the formation of the gametes and in their fusion, the two fungi follow a common method. This fact is, of course, of the greatest significance, since it shows that a process of conjugation, fundamentally similar to that which occurs in the aecidium as an origin for each row of aecidiospores, may be transferred in the life cycle to the uredospore sorus, and lead to the formation of what appear to be ordinary uredospores. This condition of things, taken together with the fact that, as is well known for this form at least, the spermagonia accompany the formation of these so-called primary uredospores, suggests a possible close morphological relationship of aecidiospores and uredospores in general. I have given no figures of the spermagonia, but my sections show that they are similar in every way to those accompanying ordinary aecidia, except that they are frequently expanded laterally almost to the extent of forming crust-like masses. The further fact that the stalk cell of the primary uredospores is plainly, as described above, an elongated intercalary cell strengthens the above conclusion very materially.

Richards' account (4) of the development of the aecidium in *Uromyces caladii* shows that in this form a large, well-nourished hyphal branch, the "carpogonial branch," is present as an initial structure in the formation of each aecidium. This structure is interpreted to be a remnant of a former spore-producing organ, which may have developed from a fertilized egg. We have no evidence that such a fertilization as this occurs in any form at the present time, and it is quite possible that these large hyphae are purely vegetative. I have been unable to confirm Richards' observations on my own material of *Uromyces caladii.* Still, the study of the initial stages of aecidium formation is not easy, and I am not certain that such a carpogonial hypha may not be present. Certainly no such structure is present in pustules of the caeoma type, unless, perhaps, it is comparable to the mass of hyphae which accumulate beneath the epidermis just before the gametes are formed. The discovery of such a carpogone would facilitate very much our interpretation of the aecidium. If Richards' account be correct, the conclusion is easy that the old process of fertilization by trichogyne and spermatia has been lost, and the new fertilizations described by Blackman and myself have come to take its place.

In a more recent work, Blackman and Fraser (2) have investigated a number of rusts, and find that nuclear migration, like that found in *Phragmidium violaceum,* occurs also in *Uromyces poae* Raben. and *Puccinia poarum* Niels. In *Puccinia* *malvacearum* Mont., *Puccinia adoxae* D C., *Uromyces scillarum* Wint., and *Uromyces ficariae* Lév., they were unable to determine the origin of the binucleated phase. It was found that binucleated vegetative cells were present in the mycelium. These were found at some distance from the place of spore formation in the case of *Puccinia adoxae* and *Uromyces scillarum.* In the case of *Melampsora rostrupi* Wagn., no nuclear migration was observed, but definite evidence was obtained that the binucleated condition had its origin in the fusion of apparently equal fertile cells, as I have described for *Phragmidium speciosum, Caeoma nitens* and *Uromyces caladii.*

Blackman and Fraser thus accept the existence of two kinds of fertilization processes in the rusts, and believe that in both cases the large fertile cells are egg cells which were formerly fertilized by male cells (spermatia). This fertilization having been abandoned, the egg is fertilized in the one case by the nucleus of a vegetative cell and in the other by fusing with another egg cell. They regard as of little significance Richards' suggestion that the true egg was originally, at least, a single deep-lying cell, with a long trichogyne, which grew after fertilization into the carpogonial branch. Still it is quite possible that the uncertainties of such a fertilization might result first in parthenogenesis, and then in the development of a new method of fertilization by a fusion of carpogonial cells. The fusion of equal cells would then probably be the more primitive process, and the migration of nuclei from vegetative to fertile cells would be a later development in such cases as, for example, *Uromyces poae,* where the fertile cells are in less regular order than in the caeoma, and perhaps in closer proximity to vegetative cells than to one another. On the other hand, the nuclear migrations might have constituted a step in the development of a true fusion of carpogonial cells. The difficulty with all such reasoning is that the evidence for the existence of Richards' carpogonial branch is hardly satisfactory. Blackman's assumption that the "sterile cell" is a reduced trichogyne is hardly more convincing. The persistence and apparently normal development of the spermatia is also a fact to be reckoned with by those who assume that these are at present functionless.

Further data must be had before these difficulties can be cleared up, and meanwhile it is clear that in their general character the fusions found in the development of the aecidiospores of *Phragmidium speciosum, Caeoma nitens, Uromyces caladii* and *Melampsora rostrupi,* and in the development of the primary uredospores of *Phragmidium potentillae canadensis* are strikingly similar to the unions of equal gametes as found in the lower fungi. I am inclined to believe also that the nuclear migrations described for a long series of forms studied by Blackman (1) and by Blackman and Fraser (2) are to be interpreted in the light of this resemblance. Distortions of the vegetative structure of the fungus might lead, as noted above, to the substitution of such nuclear migrations for the original cell fusions.

Blackman has used the term "basal cell" to indicate that structure from which the aecidiospores arise, whether it be the product of the fusion of two equal cells or the result of a migration fertilization. There are obvious objections to this usage which become more marked in such forms as *Puccinia adoxae,* where the nuclear migrations may be several cell generations removed from the base of the aecidium pustule. I shall refer to the product of the fusion of the two equal gametes as the "fusion cell," and use the term "basal cell" for the direct product of this fusion cell in its germination.

It is, however, my chief purpose at this time to bring out the resemblance between the true aecidium and the primary uredo. That the spores in the two cases are in every way morphological equivalents cannot be doubted. Whatever the function of the intercalary cell may be, there can be no question that, as Sappin-Trouffy has pointed out, though misinterpreting the fusion cell, it is the morphological equivalent of the stalk of the primary uredospore, even though it serves a different mechanical purpose in the latter case. The fact that the two bases of the fusion cell do not remain so distinct here as they do in *Phragmidium speciosum* is not of great moment.

The bases of the two original gametes may nearly always be traced to the budding of the second spore. (See figs. 2, 3 and 4.)

In the light of the above facts as to the primary uredo, it is of the utmost importance that still further forms with the abbreviated life cycle be carefully worked out.

Madison, Wis., May 1906.

LIST OF PAPERS.

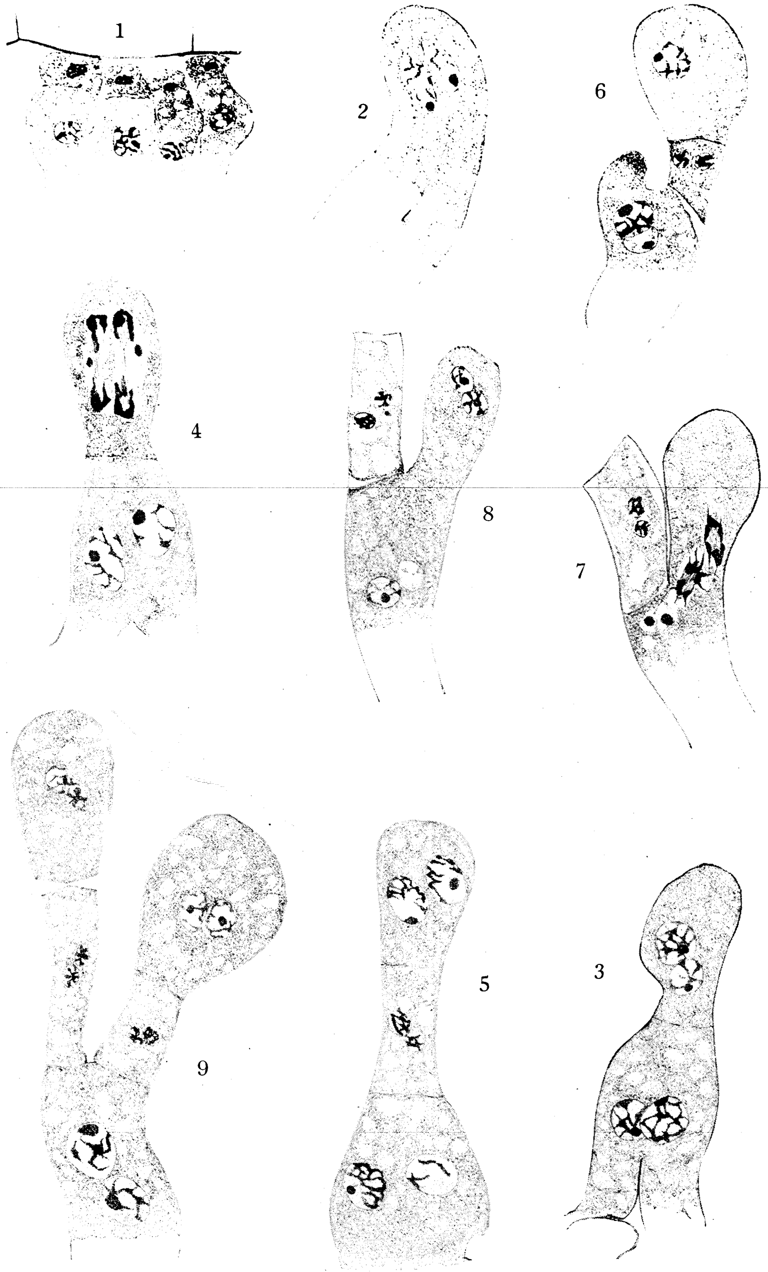
1. Blackman, V. H.: On the fertilization, alternation of generations, and general cytology of the Uredineae. *Ann. Bot.*, xviii: 323.—1904.
2. Blackman, V. H., and Fraser, H. C. I.: Further studies on the sexuality of the Uredineae. *Ann. Bot.*, xx: 35.—1906.
3. Christman, A. H.: Sexual reproduction in the rusts. *Bot. Gaz.*, xix: 267.—1905.
4. Richards, H. M.: On some points in the development of aecidia. *Proc. Amer. Acad. Arts and Sci.*, xxxi: 255.—1896.

PLATE XXIX.

EXPLANATION OF PLATE XXIX.

The figures were drawn with the help of the camera lucida, using the one-half inch eyepiece and the one-twelfth oil objective. The tube length was 150 mm.

Fig. 1. A series of gametes just after throwing off the sterile cells.
Fig. 2. The fusion of two gametes.
Fig. 3. A stage showing the first spore-mother-cell fully formed.
Fig. 4. Simultaneous nuclear division preceding the division of the spore-mother-cell.
Fig. 5. A later stage in which the spore-mother-cell has divided to form the spore and the stalk cell.
Fig. 6. The second bud forming with the nuclei of the basal cell near its base.
Fig. 7. Nuclear division preceding the formation of the second spore-mother-cell. The spindles are not parallel and the nucleoles are left behind within the fusion-cell.
Fig. 8. A stage showing two nuclei in the bud and two in the fusion-cell. In figs. 7 and 8 the first spore is omitted. The stalk cell is present.
Fig. 9. Two fully formed spores on a single basal cell.



A. H. Christman del.

INFECTION EXPERIMENTS WITH THE MILDEW ON CUCURBITS, ERYSIPHE CICHORACEARUM DC.

GEORGE M. REED.

All the recent work on the so-called physiological species of the mildews has tended to show that each genus and, in many cases, each species of host plant has its own particular specialized form. So far as investigated, the mildew from one host plant is not able to infect a species belonging to another genus. Marchal (15), it is true, asserts that the same special form occurs on both oats (*Avena sativa*) and *Arrhenatherum elatius*. Salmon's (24) results, however, contradict those of Marchal on this point.

Neger (20) has further found that conidia of *Erysiphe cichoracearum* DC. taken from *Artemisia vulgaris* will not infect *A. absinthium*, although both are reported as host plants of this species of mildew. A similar result has been obtained by Salmon (24) with the mildew of the clover, *Erysiphe polygoni* DC. He found that conidia taken from *Trifolium pratense* will not infect any other species of this genus, although plants of this species are readily infected. My work (22) with the grass mildew, *E. graminis* DC., upon rye (*Secale cereale*) and blue grass (*Poa pratensis*) in general confirm these results.

The degree of the specialization of *Erysiphe graminis* DC. within the genus *Hordeum*, has also been investigated by Salmon (26). He found (1) that conidia from barley (*Hordeum vulgare*) readily infected barley, *H. distichum, H. zeocriton, H. intermedium* and *H. hexastichum;* (2) that conidia from barley caused only a slight infection ("subinfection") on *H. bulbosum* and *H. maritimum;* (3) that conidia from barley did not infect *H. jubatum, H. sylvaticum, H. murinum* and *H. secalinum.*

He explains the infection of *H. bulbosum* and *H. maritimum* as due to the fact that many conidia were sown at one place upon the leaves, and when these germinated a great number of haustoria attacked each of the epidermal cells in that region. This is supposed to have had the result that the enzyme assumed to inhibit the growth of the barley mildew on these plants was incapable of preventing the growth of so many haustoria, and thus some secured a foothold and a mycelium was formed which was able to develop and produce a few conidiophores with conidia.

In his experiments with *H. secalinum, H. murinum* and *H. sylvaticum,* no immediate infection followed inoculation. A few weeks later, however, several of the plants were found infected. As these plants were kept in a hot, ill-ventilated room, Salmon concludes that their vitality was lowered to such an extent that they could no longer resist the attack of the mildew of *H. vulgare* which was abundant around them.

It has further been found that the *Oidium* on *Euonymus japonicus* is also limited in its capacity for infecting species of this genus, some species being infected while others are not. It is not known to what species of mildew this conidial stage belongs. Arcangeli (1, 2) has determined the fungus as the conidial stage of *Sphaerotheca pannosa* (Wallr.) Lév. Salmon (31), however, thinks the fungus is the conidial stage of some species of *Erysiphe* or *Microsphaera.* As a result of infection experiments, Salmon has found that the *Oidium* on *Euonymus japonicus* will infect *E. japonicus* var. *aureus,* var. *ovatus aureus,* var. *microphyllus,* var. *albo-marginatus,* var. President Gunter, *E. radicans* var. *microphyllus,* var. Silver Gem, but not *E. radicans* var. *carrierei, E. nanus, E. europaeus, E. chinensis, E. americanus* var. *angustifolius, Celastrus scandens, C. articulatus, C. orixa,* and *Prunus laurocerasus* var. *latifolia.* With two exceptions, the negative results rest upon only one experiment. According to my observations, this is not sufficient to prove that these hosts are immune to the fungus.

Salmon (28, 30) has also obtained some interesting results by injuring host plants in various ways and then inoculating them with conidia which would not infect them when uninjured. He has found that if barley leaves are mechanically injured in any way, or if treated with ether, chloroform or alcohol, or if heated in water to about 50 degrees C., and then inoculated with conidia from wheat (*Triticum vulgare*), they lose their power of resistance to the wheat mildew and become infected, although healthy normal leaves of barley cannot be infected. However, the conidia produced on the barley leaves as a result of these methods of treatment are not capable of causing infection on uninjured barley leaves, but they do infect normal wheat leaves, the host from which the conidia were first taken.

It has also been found by Salmon (32) that the mildew on wheat will infect young leaves of *Hordeum sylvaticum*. He has cultivated the mildew on *H. sylvaticum* for five generations, but the conidia produced on the new host never lost the power to infect the wheat from which the fungus was originally taken. Furthermore, it did not acquire the power to infect the hosts, such as barley, which the mildew found in nature on *H. sylvaticum* possesses. We thus see that the fungus is not changed in any way as a result of living on this unusual host.

It has further been shown that a fungus can get a start on a host plant although it may not be able to cause complete infection. Salmon (33) finds that if the mildew from wheat, for example, is sown upon barley, the fungus may penetrate the cells of the barley and in some cases form fully developed haustoria. More commonly the haustoria are arrested in their development, remaining as more or less rounded refractive bodies in the cells, which soon completely disorganize. Salmon concludes from these facts that the susceptibility or immunity of a host plant does not depend on the presence or the absence of a chemotactic substance in the cells of the host, but "on the capacity or the incapacity for maintaining certain working relations between the haustorium and the host cell." Salmon further attempts to explain immunity by supposing that "a power is possessed by the host plant of preventing by means of certain physiological processes the attainment of that balance whereby these working relations are brought about and maintained." What he thinks these "physiological processes" are, is not stated. I am of the opinion that, for all evidence given, they may be chemotactic as well as anything else. It may well be that in the cases cited the haustoria of the fungus push into the host cells in spite of substances formed by the cells to prevent their entrance. Such chemical substances which tend to kill the haustoria may not be in sufficient quantity to prevent their entrance, but may be, none the less, sufficient to prevent their complete development.

In all cases investigated the ascospores are limited in their infection capacity in the same way and to the same extent as conidia from the same host. Marchal (16) states that ascospores of *Erysiphe graminis* DC. from rye will infect this host but not wheat, oats, barley, or *Agropyrum caninum;* ascospores from wheat will infect only wheat; and ascospores from barley will infect barley (*Hordeum vulgare*), *H. distichum, H. zeocriton* and *H. trifurcatum*. These results have been partly verified by Salmon (25), who used ascospores from barley. He has further found (32) that ascospores from *Bromus commutatus* will infect this species and *B. hordeaceus,* but not *B. racemosus*. Voglino (37) states that ascospores of *Phyllactinia corylea* taken from *Carpinus* will not infect *Fagus* but will infect *Carpinus* and, conversely, ascospores from *Fagus* will not infect *Carpinus* but will infect *Fagus*.

In this connection it is interesting to note that Salmon (34) has described three distinct morphological varieties of *Phyllactinia corylea* (Pers.) Karst. based upon the characters of the conidia and conidiophores. The variety *angulata* has conidia varying in size between 45 and 55μ long and between 22 and 26μ wide; they may be rounded, truncate or bluntly apiculate at one or both ends, and more or less constricted in the middle. It occurs on several species of *Quercus, Castanea* *sativa, Ulmus alata* and *Fagus ferruginea* in North America, on *Hippophaë rhamnoides* in Europe, and on *Adesmia* sp. in Argentine. A second variety, called *rigida,* instead of the typical thin-walled, flaccid conidiophore, has a rigid, thick-walled conidiophore. It occurs on *Parmentiera alata* from Mexico. The third variety, *subspiralis,* has a conidiophore which is especially twisted in its basal portion and is found on *Dalbergia Sissoo* from India. It still remains to be determined whether each of these morphological varieties constitutes a single physiological species, or whether they are split up into forms limited to definite hosts.

All of these results indicate that these various physiological species of mildews have definitely limited powers of infection. Under normal conditions they are restricted to certain definite hosts. If a host plant is injured in any way, it loses its power of resistance to other specialized forms and so becomes infected. This infection is not due to any variation in the infecting power of the mildew, but to a change in the capacity of the host to resist infection. The immunity which it naturally enjoys is destroyed. Furthermore, although the fungus can develop upon an unusual host which is injured, it does not change in its power of infection. It does not acquire the capacity of infecting healthy plants like the injured one, nor does it lose its power of infecting its original host.

During the past year I have carried on infection experiments with the mildew on the cucurbits in order to determine whether specialization has also occurred in this mildew. Early in October 1904, plants of the Hubbard squash were found infected with mildew. Some of the infected leaves were brought into the greenhouse and placed in a moist chamber. In a short time conidia were produced abundantly. These were used to inoculate leaves of various cucurbits growing in the greenhouse. About ten days later numerous patches of mycelium producing conidia abundantly were observed on one vine. The mildew spread rapidly over this plant, immense quantities of conidia being produced. The vine subsequently fruited and was thus proved to be a Hubbard squash.

Late in December, about two months after it was first brought into the greenhouse, the mildew began to spread over other cucurbit plants, mainly vines of various cultivated gourds. At first the mycelium was very scanty on these vines and very few conidia were produced. Later, however, the mycelium spread rapidly, forming conidia abundantly.

By growing at intervals young cucurbit plants, mainly squashes, and inoculating them, the mildew has been kept growing in the greenhouse since its first introduction.

Various species of mildews have been reported as occurring on cucurbits. *Sphaerotheca castagnei* Lév. has been reported upon *Cucumis sativus* by Beck (3), Fuckel (7, 8), Von Thümen (36), and Voss (38); upon *Cucurbita maxima* by Cavara (6); upon *C. Pepo* by Beck, Von Thümen and Wettstein (39); upon *Cucurbita* sp. indet., by Brunaud (5), Jaczewski (11), Lambotte (12), Léveillé (13), and Passerini (21). *Erysiphe polygoni* DC. has been reported upon *Cucumis sativus* by Magnus (14) and Schroeter (35), and upon *Cucurbita* sp. indet. by Berlese and Peglion (4). *Erysiphe cichoracearum* DC. has been reported upon *Cucumis sativus* by Humphrey (10), and upon *Cucurbita pepo* by Salmon (23). The latter says: "It is, of course, possible that more than one species of *Erysiphe* occurs on these host plants [various cucurbits], but in this case it seems more probable that the fungus has been named constantly *Sphaerotheca castagnei* merely because this species was originally recorded on these host plants, and it would be very interesting to know if any example with perithecia of *Sphaerotheca* really exists."

Although the conidial stage of the mildew, known as *Oidium erysiphoides,* is very common upon cucurbits, especially in greenhouses, apparently perithecia are rarely formed. The vines where the mildew was first found were carefully examined, but no perithecia were observed. The infected plants in the greenhouse were also closely observed for the sexual fruits of the mildew. None were found, however, until November 6, 1905, over a year after the first introduction of the mildew into the greenhouse. At that time perithecia were observed on infected cotyledons of the squash, pumpkin and cucumber. They were formed on plants which were under observation by students in plant pathology. These plants were inoculated on October 12th, and infection was first observed October 18th. Twenty days later the perithecia were first observed. A study of these showed that the mildew is *Erysiphe cichoracearum* DC.

The methods used in the experiments described below were essentially the same as I have described for the grass mildew in a previous paper (22). The plants were grown in three- to five-inch pots. Usually they were inoculated after one or more foliage leaves had developed and expanded; in other cases only the cotyledons were inoculated, the first leaf being still small and not yet expanded.

The parts inoculated were first moistened with water, and then conidia were applied by means of a scalpel. Control plants were kept in nearly every experiment. The plants were then placed under a bell-jar; in this way a moist atmosphere was secured. The bell-jar was usually removed a few days after inoculation. Infection was regularly first observed from three to five days after inoculation, when minute flecks of mycelium could be seen. A few days later conidia were formed abundantly.

The experiments were extended to a considerable number of varieties of squashes, pumpkins, cucumbers and gourds, representing the standard sorts in common cultivation. Every possible cross infection was tested in order to determine whether the mildew on any one cucurbit would pass over to any other member of the family. The results of these experiments are given in the following tables.

In classifying these different varieties of cucurbits I have followed Gray's "Field, Forest and Garden Botany," and also Bailey's "Encyclopedia of Horticulture." In some cases I am uncertain to what morphological species a given variety belongs. Some of these varieties are probably hybrids between species of *Cucurbita*.

The seed was obtained from J. M. Thorburn & Co., New York, and Henry A. Dreer, Philadelphia.

TABLE I.—VARIETIES OF SQUASH (*Cucurbita maxima* Duchesne).

No. of Exp.	Date.	Age of plants—days.	Plant used as host.	Source of conidia.	No. of plants inoculated.	Part inoculated.		No. of controls.	Observations.		
						Cotyledons.	Leaves.		Date.	Inoc. plants.	Controls.
5	Jan. 12	21	Hubbard squash	Hubbard squash	1	2	1	1	Jan. 21	+	—
6	Jan. 21	30	Hubbard squash	Boston Marrow squash.	1	2	1	...	Jan. 28	—	....
8	Jan. 21	19	Hubbard squash	Hubbard squash	1	2	1	1	Jan. 28	+	—
9	Jan. 28	26	Hubbard squash	White Spine Improved cucumber.	1	2	1	1	Feb. 13	+	+
10	Jan. 28	26	Hubbard squash	Hubbard squash	2	4	2	1	Feb. 13	+	—
13	Jan. 28	15	Hubbard squash	Hubbard squash	2	4	....	2	Feb. 13	+	—
18	Apr. 15	15	Hubbard squash	Large Cheese pumpkin.	1	2	....	....	Apr. 22	+	....
18a	Apr. 25	25	Hubbard squash	Hubbard squash	1	...	1	....	May 6	+[1]	....
42	Dec. 21	15	Hubbard squash	Bottle gourd.	2	4	....	1	Dec. 29	+	—
44	Dec. 29	23	Hubbard squash	Bottle gourd.	1	1	1	....	Jan. 8	+	....
46	Jan. 2	16	Hubbard squash	Bottle gourd.	2	4	...	2	Jan. 11	+	—
51	Jan. 12	36	Hubbard squash	Bottle gourd.	2	4	....	2	Jan. 18	+	—
57	Feb. 12	32	Hubbard squash	Mammoth King pumpkin.	1	1	1	....	Feb. 22	+	....
69	Mar. 7	21	Hubbard squash	Dipper gourd.	1	2	1	1	Mar. 14	+	—
2	Dec. 28	25	Boston Marrow squash.	Hubbard squash	1	1	1	....	Jan. 10	+	....
24	Apr. 29	29	Boston Marrow squash.	Princess cucumber.	1	1	1	....	May 8	+	....
25	Apr. 29	29	Fordhook squash.	Princess cucumber.	1	2	2	1	May 8	+[2]	—
27	May 12	16	Fordhook squash.	Boston Marrow squash.	1	2	....	1	May 18	+	—
34	June 13	11	Fordhook squash.	Fordhook squash.	2	4	...	2	June 21	+[3]	—
68	Mar. 3	51	Fordhook squash.	Hubbard squash	2	4	2	1	Mar. 9	+	—
26	May 12	16	Turban squash.	Boston Marrow squash	1	2	1	1	May 18	+	—
56	Feb. 12	32	Turban squash.	Mammoth King pumpkin.	2	4	2	2	Feb. 22	+	—
39	Dec. 7	24	Golden Brough squash.	Egg-shaped gourd.	1	2	....	1	Dec. 14	+	—
38	Dec. 5	22	Perfect Gem squash.	Turban squash	2	4	....	1	Dec. 11	+	—

[1]A leaf of the plant of experiment 18 was inoculated with conidia from the cotyledons of the same plant.
[2]Leaves only infected, cotyledons dead.
[3]One plant only infected.

TABLE II.—VARIETIES OF CUCURBITA MOSCHATA DUCHESNE.

No. of Exp.	Date.	Age of plants—days.	Plant used as host.	Source of conidia.	No. of plants inoculated.	Part inoculated. Cotyledons.	Part inoculated. Leaves.	No. of controls.	Observations. Date.	Observations. Inoc. plants.	Observations. Controls.
7	Jan. 21	30	Large Cheese pumpkin.	Hubbard squash	2	4	3	3	Jan. 28	+[1]	—
12	Jan. 28	26	Large Cheese pumpkin.	Hubbard squash	2	4	2	2	Feb. 13	+	—
61	Feb. 14	34	Large Cheese pumpkin.	Hubbard squash	2	4	....	1	Feb. 28	+[2]	—
70	Mar. 7	55	Large Cheese pumpkin.	Golden Brough squash.	1	2	3	....	Mar. 14	+[3]	....
71	Mar. 20	24	Winter Crook-neck squash.	Hubbard squash	1	1	1	1	Apr. 4	+[4]	—
72	Apr. 11	42	Winter Crook-neck squash.	Hubbard squash	1	....	2	1	Apr. 18	+	—
75	May 4	25	Winter Crook-neck squash.	Apple-shaped gourd.	1	2	2	2	May 14	+	—

[1] One inoculated leaf infected: cotyledons yellow.
[2] One inoculated plant infected.
[3] Only one leaf and only one cotyledon infected.
[4] Only cotyledon infected.

TABLE III.—VARIETIES OF PUMPKIN AND ORNAMENTAL GOURD (*Cucurbita Pepo* Linn.)

No. of Exp.	Date.	Age of plants—days.	Plant used as host.	Source of conidia.	No. of plants inoculated.	Part inoculated.		No. of controls.	Observations.		
						Cotyledons.	Leaves.		Date.	Inoc. plants.	Controls.
1	Nov. 12	23	Pumpkin	Hubbard squash	1	2	3	2	Dec. 3	+[1]	—
3	Dec. 28	25	Pumpkin	Hubbard squash	2	4	2	2	Jan. 10	+	—
11	Jan. 28	15	Connecticut Field pumpkin.	Hubbard squash	2	4	1	2	Feb. 13	+	—
33	May 26	14	Connecticut Field pumpkin.	Golden Bush squash.	1	2	....	1	June 2	+	—
17	Apr. 15	15	Calhoun pumpkin.	Large Cheese pumpkin.	2	4	....	2	Apr. 22	+	—
17a	Apr. 25	25	Calhoun pumpkin.	Calhoun pumpkin.	2	....	2	2	May 6	+[3]	—
19	Apr. 15	15	Mammoth King pumpkin.	Large Cheese pumpkin.	1	2	...	1	Apr. 22	+	—
19a	Apr. 25	25	Mammoth King pumpkin.	Mammoth King pumpkin.	1	....	1	1	May 6	+[3]	—
23	Apr. 26	26	Mock Orange gourd.	Princess cucumber.	1	2	2	1	May 6	+	—
29	May 12	16	Mock Orange gourd.	Boston Marrow squash.	1	2	1	1	May 30	+	—
36	June 13	11	Mock Orange gourd.	Mock Orange gourd.	2	4	....	1	June 21	+	—
53	Jan. 26	50	Mock Orange gourd.	Hubbard squash	1	1	1	....	Feb. 2	+[4]	..
58	Feb. 12	32	Mock Orange gourd.	Mammoth King pumpkin.	1	2	1	1	Feb. 22	+	—
60	Feb. 14	43	Mock Orange gourd.	Hubbard squash	1	2	1	1	Feb. 28	+[4]	—
63	Feb. 24	44	Mock Orange gourd.	Hubbard squash	2	2	4	1	Mar. 5	+[4]	—
48	Oct. 12	....	Egg-shaped gourd.	Hubbard squash	1	1	...	....	Oct. 22	+	..
49	Nov. 22	....	Egg-shaped gourd.	Hubbard squash	1	2	....	...	Dec. 5	+	..
67	Mar. 3	46	Egg-shaped gourd.	Golden Bush squash.	1	2	2	1	Mar. 9	+	—
45	Jan. 2	16	Apple-shaped gourd.	Bottle gourd....	2	4	....	3	Jan. 11	+	—
50	Jan. 12	36	Apple-shaped gourd.	Bottle gourd....	1	2	1	2	Jan. 25	+	—
59	Feb. 12	32	Apple-shaped gourd.	Mammoth King pumpkin.	1	2	1	2	Feb. 22	+	—
64	Feb. 24	44	Apple-shaped gourd.	Hubbard squash	1	2	3	....	Mar. 5	+	..

[1] Leaves only infected.
[2] Two leaves of the plant used in experiment 17 were inoculated with conidia from cotyledons of the same plant.
[3] One leaf of the plant used in experiment 19 was inoculated.
[4] Leaves only infected, cotyledons dying.

TABLE IV.—BOTTLE AND DIPPER GOURDS (*Lagenaria vulgaris* Ser.)

No. of Exp.	Date.	Age of plants—days.	Plant used as host.	Source of conidia.	No. of plants inoculated.	Part inoculated. Cotyledons.	Part inoculated. Leaves.	No. of controls.	Observations. Date.	Observations. Inoc. plants.	Observations. Controls.
22	Apr. 26	26	Bottle gourd.	Princess cucumber.	1	1	1		May 10	+	..
41	Dec. 7		Bottle gourd.	Hubbard squash.	1		3	1	Dec. 18	+	—
43	Dec. 29		Bottle gourd.	Bottle gourd.	1		3		Jan. 8	+[1]	..
73	Apr. 25	36	Bottle gourd.	Winter Crook-neck squash.	1	2	1	1	May 4	+	—
65	Feb. 24	39	Dipper gourd.	Apple-shaped gourd.	1	2	1	1	Mar. 5	+	—
74	Apr. 25	36	Dipper gourd.	Winter Crook-neck squash.	1	1	1		May 4	+	..
76	May 4	45	Dipper gourd.	Apple-shaped gourd.	1	1	2		May 14	+[2]	..

[1] Only one leaf infected.
[2] A small infected area on the control cotyledon also.

TABLE V.—VARIETIES OF CUCUMBER (*Cucumis sativus* Linn.)

No. of Exp.	Date.	Age of plants—days.	Plant used as host.	Source of conidia.	No. of plants inoculated.	Part inoculated.		No. of controls.	Observations.		
						Cotyledons.	Leaves.		Date.	Inoc. plants.	Controls.
4	Jan. 12	21	White Spine Improved cucumber.	Boston Marrow squash.	1	2	1	....	Jan. 21	+[1]	..
15	Apr. 1	46	White Spine Improved cucumber.	Hubbard squash	1	....	2	....	Apr. 12	+	..
14	Apr. 1	46	Thorburn Everbearing cucumber.	Hubbard squash	1	2	1	2	Apr. 12	+	—
16	Apr. 15	15	Cool and Crisp cucumber.	Large Cheese pumpkin.	1	2	....	2	Apr. 22	+	—
16a	Apr. 25	25	Cool and Crisp cucumber.	Cool and Crisp. cucumber.	1	....	2	2	May 6	+[2]	—
20	Apr. 15	15	Princess cucumber.	Large Cheese pumpkin.	3	6	....	2	Apr. 22	+[3]	—
20a	Apr. 25	25	Princess cucumber.	Princess cucumber.	1	...	2	1	May 6	+[4]	—
31	May 22	10	Princess cucumber.	Fordhook squash.	1	2	1	1	May 30	+	—
35	June 13	11	Princess cucumber.	Princess cucumber.	3	6	....	3	June 21	+	—
37	Dec. 5	22	Princess cucumber.	Turban squash.	1	2	....	1	Dec. 11	+	—
47	Jan. 2	16	Princess cucumber.	Bottle gourd.	3	6	....	3	Jan. 11	+[3]	—
52	Jan. 19	43	Princess cucumber.	Hubbard squash	2	4	....	2	Feb. 2	+	—
54	Jan. 26	....	Princess cucumber.	Hubbard squash	1	2	....	....	Feb. 2	+	..
55	Feb. 12	32	Princess cucumber.	Mammoth King pumpkin.	3	6	3	3	Feb. 22	+	—
21	Apr. 26	26	Talby's Hybrid cucumber.	Princess cucumber.	1	2	1	2	May 6	+	—
32	May 26	14	Cumberland cucumber.	Golden Bush squash.	1	2	1	1	June 2	+	—

[1] No infection of leaf.
[2] Two leaves of the plant used in experiment 16 inoculated.
[3] Two plants dead.
[4] Two leaves of the plant used in experiment 20 inoculated.

RESULTS WITH THE SQUASH, CUCURBITA MAXIMA DUCHESNE (TABLE I).

In twelve of these experiments the conidia were taken Boston Marrow and Turban, belong to the species *Cucurbita maxima.* As seen from Table I, twenty-six experiments were performed in which conidia of the mildew were sown upon seven different varieties of these squashes. Thirty-eight different plants were used.

In twelve of these experiments the conidia were taken from varieties of squashes, in three from cucumber plants (*Cucumis sativus*), in five from the bottle and dipper gourds (*Lagenaria vulgaris*), in one from the egg-shaped gourd, and in three from the pumpkin (*Cucurbita pepo*). Infection failed to occur in only one experiment. Some or all of the inoculated parts became infected in the remaining experiments. Out of the nineteen leaves inoculated eighteen became infected, and fifty-four out of sixty of the inoculated cotyledons. Two of the cotyledons died before the mildew had a chance to develop.

These experiments show that the squash can be infected with conidia taken from all the other cucurbits tested. In the one experiment that failed the conidia were taken from another variety of the squash, the Boston Marrow. Conidia from this variety, however, in other experiments, infected squash plants. There was no apparent difference in the readiness with which the different varieties were infected by the mildew. All were susceptible. Nor was there any difference observed in the infecting capacity of conidia from different cucurbits. From whatever plant taken, the conidia caused infection with equal readiness.

RESULTS WITH CUCURBITA MOSCHATA DUCHESNE. (TABLE II).

In Table II are given the results with two varieties of this species, the large cheese pumpkin and the winter crookneck squash being tested. Ten plants were used, seventeen cotyledons and thirteen leaves being inoculated. The conidia were obtained mostly from the Hubbard squash. Infection occurred on ten cotyledons and eight leaves. Conidia obtained from these infected plants produced infection on varieties of *Cucurbita pepo, Cucumis sativus* and *Lagenaria vulgaris.*

RESULTS WITH THE PUMPKIN AND ORNAMENTAL GOURDS, CUCURBITA PEPO LINN. (TABLE III).

Several distinct types of cucurbits, differing mainly in the character of the fruit, belong to this species. It contains the different varieties of the so-called pie pumpkins and also the field pumpkins. The summer crookneck or warty squashes with white or yellow J-shaped fruits, and the ornamental gourds with small, very hard-shelled fruits of many shapes, as the apple-shaped, egg-shaped, etc., are also varieties of this species.

Table III shows that eight experiments were made in which four different varieties of pumpkins were inoculated with conidia from various cucurbits. Nine foliage leaves were inoculated, all of which became infected. Out of eighteen cotyledons inoculated, all but two became infected.

All these varieties of pumpkins seemed to be as susceptible to the mildew as were the squashes and, as is shown, were readily infected by conidia from squashes, the mildew being thus transferred from one species to another.

Several kinds of ornamental gourds belonging to this same species (*C. pepo* Linn.) were also tested as to their capacity for infection. The mock orange gourd was used in seven experiments, fifteen cotyledons and ten leaves being inoculated. All of these became infected, except five cotyledons which died before the mildew had a chance to develop.

The apple-shaped and the egg-shaped gourds were also used, seven experiments being made with these two varieties. All of the inoculated leaves and cotyledons were readily infected.

As conidia from squashes, cucumbers, pumpkins and the bottle gourd were used in these experiments, it is plain that various varieties of both gourds and pumpkins can readily be infected with the mildew from the squash, a different species, and from the cucumber and bottle gourd, which belong to different genera. All of these varieties of *C. pepo,* whatever the source of the conidia, seemed equally susceptible to the mildew.

RESULTS ON THE BOTTLE AND DIPPER GOURDS, LAGENARIA VULGARIS SER. (TABLE IV).

So far as I am aware, no mildew has ever been reported upon this species, although it is very commonly cultivated with other cucurbits on account of its peculiarly shaped fruits. Seven experiments were made to determine whether the mildew from various cucurbits would infect it, the bottle gourd being used in four experiments and the dipper gourd in three. As seen from the table, the plants were inoculated with conidia from cucumbers, squashes, the apple-shaped gourd and the bottle gourd. Twelve leaves and seven cotyledons were inoculated, all of which, except two leaves, became infected. As these two leaves pressed against the bell-jar, dead areas appeared in them and soon the entire leaves turned brown and died.

It is interesting to note that the incubation period was longer in the case of the bottle gourd than with the other cucurbits. For example, plants of the bottle gourd, mock orange gourd, and Talby's Hybrid cucumber were inoculated with conidia from the Princess cucumber on April 26th. On May 6th there were several patches of mycelium producing conidia abundantly on the inoculated parts of the mock orange gourd and the cucumber, while there was no sign of infection on the bottle gourd. Four days later, however, patches of mycelium producing conidia were present on the inoculated parts of the bottle gourd also. This longer incubation period was not observed in connection with the dipper gourd.

RESULTS ON THE CUCUMBER, CUCUMIS SATIVUS LINN. (TABLE V).

Seedlings of cucumbers were used in sixteen experiments, six different varieties being used, as shown in Table V. Fourteen leaves and forty-four cotyledons were inoculated. Thirteen of the leaves and thirty-six of the cotyledons became infected. The remaining cotyledons died before the mildew had time to appear. As conidia were taken from the varieties of squashes, pumpkins and gourds shown in the table, these results indicate clearly that the mildew on the cucumber is the same as that which occurs on the other cucurbits.

In the course of these experiments, twenty-three different varieties of commonly cultivated cucurbits were used. These belonged to five different species representing the three genera *Cucurbita, Cucumis* and *Lagenaria.* Each of these types was readily infected when inoculated with the conidia taken from any other. There was no difference in the infecting power of the mildew on the different species and genera, the fungus readily passing from plants of one genus to plants of either of the others.

The control plants kept in most of the experiments remained entirely free from the mildew except in two experiments. In experiment 9 a small patch of mycelium was observed upon the stem of the control. As one of the cotyledons of the inoculated plant was in contact with the stem of the control at the point of infection, it is likely that some of the conidia placed upon the cotyledon were washed down upon the stem of the control and caused infection. In experiment 76, a small infected area was present on the control cotyledon This was underneath an inoculated leaf, and probably some conidia were washed down upon it.

Young plants were used in all of my experiments, and the question may be raised whether seedlings are not more susceptible to the fungus than mature plants. Interesting collateral evidence, however, was observed on this point. Several vines of cucurbits, especially squashes and ornamental gourds, grew to maturity in the greenhouse, and the mildew spread over all these. It at first spread more slowly on the gourds, but later these also were covered with the white patches of mycelium, producing immense quantities of conidia. In the light of my experiments, there can be no question but that it was the same mildew which attacked all the vines.

These results are in striking contrast to those previously obtained with the mildews on other host plants. In the light of all our previous results, we should expect a specialized form of mildew for each genus of the cucurbits. Nothing of the sort occurs, however. There is no evidence of any specialization in the mildew of this family.

Some experiments, however, indicate that the mildew on the cucurbits is limited to this one family. Conidia from squashes have been sown on species of the golden rod (*Solidago*) and *Aster,* which are reported as host plants of *Erysiphe cichoracearum* DC., without causing infection, and I am carrying on still further experiments in this line.

Why results so different from those reported for the grass mildew, for example, should be obtained with the mildew on the cucurbits is by no means apparent. It is true, of course, that all the cucurbits studied are quite similar in their morphological characters and form a group of plants quite similar also in their ecological relations. They all thrive well under approximately the same conditions of soil, moisture, light, etc.

Comparisons between two such widely separated families as the Gramineae and the Cucurbitaceae are, of course, very difficult, and it is a question whether we can find from this standpoint any light on the question as to why the grass mildew is split up into physiological species while the cucurbit mildew is so entirely adaptable and cosmopolitan. Many species of *Poa,* for example, differ more among themselves ecologically than do *Cucurbita maxima* and *C. pepo,* and this may be a reason for greater specialization among the mildews of the *Poas.* On the other hand, there are no greater ecological differences between wheat, barley and rye than between squashes, pumpkins and bottle gourds. Whether in morphological characters *Triticum* and *Secale* are more different than *Cucurbita* and *Lagenaria* is a difficult question.

Salmon (29) claims to have found four or five physiological species of mildews on species of Brome grasses, and here we certainly do not find differences in structure and habit any more marked than are present in the cucurbits. Salmon asserts, for example, that conidia of *Bromus commutatus* will not infect *B. racemosus,* and vice versa. These two species, however, are essentially the same with reference to their ecological relations, being able to live under the same conditions, and do not differ in their morphological characters any more than do the squashes and the cucumbers.

It is perhaps best at present to regard it as an open question whether any particular fungus which has acquired the parasitic habit first infected one species or a large number of more or less closely related plants. It is possible that the condition found in the mildew of the Brome grasses is the more primitive one, and that the mildew of the cucurbits represents a further step where a particular parasite has become adapted to live on a much wider range of hosts. Or the line of development may have proceeded in the other direction, the fungus at first infecting a large number of hosts and later becoming restricted and specialized to certain definite ones.

Further investigations are needed which shall show whether there are cases where the mildew is even less specialized than it is on the cucurbits, the same form occurring perhaps on plants belonging to different families. It is possible also that we may find other cases where the specialization has proceeded so far that varieties of the same species of host plant may each be infected only by its own particular mildew. Such investigations may also be expected to throw light on the nature and the origin of the parasitic habit. It is interesting to note in this connection that considerable doubt has been cast upon Massee's (17) theory of the chemotropic origin of parasitism by the recent work of Fulton (9). In view of the work of Miyoshi (18, 19) and others, however, we want much more conclusive evidence than has yet been brought forward before abandoning the idea that chemotropism is a factor of very considerable importance in relation to the parasitic habit of fungi.

This work has been done under the direction of Professor R. A. Harper and I am greatly indebted to him for his kindly criticisms and helpful suggestions.

Madison, Wisconsin, May 1906.

BIBLIOGRAPHY.

1. Arcangeli, G. L.: L *Oidium leucoconium* ed un *Cicinnobolus* sulle foglie dell' *Euonymus japonicus. Proc. Verb. Soc. Toscana Sci. Nat.*, xii. 1900.
2. ————: Sopra alcuni funghi e sopra un caso di gigantismo. *Bull. Soc. Bot. Ital.*, 1903, p. 60.
3. Beck, G.: Uebers. der bisher bekannt. Krypt. Niederösterreichs. *Verhandl. K. K. zool.-bot. Gesell. Wien*, xxxvii: 317–320. 1887.
4. Berlese, A. N., and Peglion, V.: Micromiceti Toscani. *Nuov. Giorn. Bot. Ital.*, xxiv: 100–103. 1892.
5. Brunaud, P.: Liste des plantes—à Saintes (Charente—Inférieure). *Actes Soc. Linn. Bordeaux*, xxxii: 155, 156. 1878.
6. Cavara, F.: Mater. de Mycolog. lombarde. *Rev. Mycol.*, 1889, p. 179.
7. Fuckel, L.: Enum. Fung. Nassoviae (56–64). *Annal. Soc. Nass. Nat. Scrut.*, xv. 1861.
8. ————: Symbolae Mycologicae. Beitr. zur Kenntn. der Rheinischen Pilze. *Jahrb. des Nassauisch. Ver. für Naturk.*, xxiii, xxiv: 76–86. 1869–70.
9. Fulton, H. R.: Chemotropism of Fungi. *Bot. Gaz.*, xli: 81–107. 1906.
10. Humphrey, J. E.: The cucumber mildew—*Erysiphe cichoracearum* DC. *9th Ann. Rept. Mass. Agric. Exper. Sta.*, pp. 222–226. 1892.
11. Jaczewski, A de: Monographie des Erysipheés de la Suisse. *Bull. de l'Herbier Boissier*, iv: 721–750. 1896.
12. Lambotte, E.: Flore mycologique Belge, ii: 171–194. 1880. Supplement i: 88–90. 1887.
13. Leveille, J. H.: Organisation et disposition méthodique des espèces qui composent le genre *Erysiphe*. *Ann. Sci. Nat. Bot.*, sér. iii, t. xv: 109–179, 381. 1851.
14. Magnus, P.: Die Erysipheen Tirols. *Bericht. des naturwiss.-med. Ver. Innsbruck*, xxiv: 1–25. 1898.

15. MARCHAL, E.: De la specialisation du parasitisme chez l'*Erysiphe graminis Compt. Rend.*, cxxxv: 210. 1902.

16. ————: De la specialisation du parasitisme chez l'*Erysiphe graminis. Compt. Rend.*, cxxxvi: 1280–1281. 1903.

17. MASSEE, G.: On the origin of parasitism in Fungi. *Phil. Trans. Roy. Soc. London*, B, cxcvii: 7. 1904.

18. MIYOSHI, M.: Ueber Chemotropismus der Pilze. *Bot. Ztg.*, 1894, p. 1.

19. ————: Die Durchbohrung von Membranen durch Pilzfaden. *Pringsh. Jahrb.*, xxviii: 269. 1895.

20. NEGER, F. W.: Beiträge zur Biologie der Erysipheen. *Flora*, xc: 221–272. 1902.

21. PASSERINI, G.: Primo elenco di funghi Parmensi. *Comment. Soc. Crittog. Ital.*, ii: 472–475. 1867.

22. REED, G. M.: Infection Experiments with *Erysiphe graminis* DC. *Trans. Wis. Acad. Sci., Arts, and Letters*, xv: 135–162. 1905.

23. SALMON, E. S.: A monograph of the Erysiphaceae. *Mem. Torr. Bot. Club*, ix: 202. 1900.

24. ————: On specialization of parasitism in the Erysiphaceae. *Beih. zum Bot. Centbl.*, xiv: 261. 1903.

25. ————: Infection powers of ascospores in Erysiphaceae. *Journ. of Bot.*, xli: 159. 1903.

26. ————: Cultural experiments with the barley mildew, *Erysiphe graminis* DC. *Annal. Mycol.*, ii: 70–99. 1904.

27. ————: On specialization of parasitism in the Erysiphaceae. *New Phytologist*, iii: 109–121. 1904.

28. ————: Cultural experiments with biologic forms of the Erysiphaceae. *Phil. Trans. Roy. Soc. London*, B, cxcvii: 107–122. 1904.

29. ————: On *Erysiphe graminis* DC. and its adaptive parasitism within the genus *Bromus*. *Annal. Mycol.*, ii: 255. 1904.

30. ————: Further cultural experiments with biologic forms of the Erysiphaceae. *Ann. Bot.*, xix: 125–148. 1905.

31. ————: Culture experiments with an *Oidium* on *Euonymus japonicus*. *Annal. Mycol.*, iii: 1. 1905.

32. ————: On specialization of parasitism in the Erysiphaceae. *Annal. Mycol.*, iii: 172–184. 1905.

33. ————: On the stages of development reached by certain biologic forms of *Erysiphe* in cases of non-infection. *New Phyt.*, iv: 217–222. 1905.

34. ————: On the variations shown by the conidial stages of *Phyllactinia corylea* (Pers.) Karst. *Annal. Mycol.*, iii: 493–503. 1905.

35. SCHROETER, J.: Cohn's Krypt. Flora von Schlesien, iii: 229–247. 1893.

36. THUEMEN, F. VON: Beiträge zur Pilz-Flora Böhmens. *Verh. K. K. zool.-bot. Gesell. Wien.* xxv: 544. 545. 1875.

37. VOGLINO, P.: Contribuzione allo studio della *Phyllactinia corylea. Nuov. Giorn. Bot. Ital.*, xii: 313–327. 1905.

38. VOSS, W.: Die Brand-, Rost-, und Mehlthau-Pilze der Wiener Gegend. *Verh. K. K. zool.-bot. Gesell. Wien*, xxvi: 133–140. 1876.

39. WETTSTEIN, R. v.: Vorarb. zu einer Pilzfl. Steier-mark. *Verh. K. K. zool-bot. Gesell. Wien,* xxxv: 578–580. 1886.

COMPARATIVE STUDIES IN THE TROPHI OF THE SCARABAEIDAE.

(With Plates XXX–XXXIV.)

C. B. HARDENBERG.

The mouth-parts of the Coleoptera, although known in a general way and to some extent used in classification, have not yet been studied as thoroughly as might be desired; of many species the mouth-parts are tacitly assumed to be in accord with the general shape of those of their nearest allies in the taxonomic division. If we consider, however, that the insect is directly dependent upon its food for its existence, and that the habit of acquiring its nourishment will directly affect the form of its mouth-parts, it becomes evident that a difference in food habits among members of the same natural group will cause a corresponding difference in their mouth-parts.

It was with a view of ascertaining these variations that the present study was begun. One great natural group was selected, the Scarabaeidae, or Lamellicorn beetles, in which are classed together insects of very different food habits,—some living on very soft material, like the dung beetles, others on dry animal matter (skin beetles), others again on leaves (June beetles et al.), and some on pollen (Cetoniae). We may therefore naturally expect to find a considerable amount of variation.

The study was undertaken for the purpose of ascertaining the following data: (1) the general degree of specialization in the order of Scarabaeidae and of departure from the assumed primitive insect type as presented by the Orthoptera;

(2) the influence of the food habits on the variation of the mouth-parts; (3) the amount of these variations and their taxonomic value, if any.[1]

The subject will be divided into four parts:—(1) General discussion of the mouth-parts of Coleoptera; (2) Description of the mouth-parts of *Copris carolina* Linn., as a standard for comparison; (3) Description and discussion of the mouth-parts of representatives of different genera; (4) Summary and conclusions.

The material used was taken from the duplicates of Professor Marshall's collection, supplemented by specimens from my own cabinet. The specimens were boiled in caustic potash solution; the mouth-parts dissected out, and mounted for microscopic examination. Owing to the thickness and peculiar shape of some of the trophi, especially the mandibles, considerable difficulty was at first experienced in making satisfactory preparations. They were for the most part mounted in Canada balsam, without a cover glass; the object was first cemented to the slide with a little balsam, then the slide inverted and allowed to dry under a bell jar, successive drops of balsam being added from day to day until the whole object was covered. In some cases, especially when studying the labial structures, the object was examined in glycerine, and the parts were drawn in situ. The drawings were all made with a camera lucida, but, owing to the minuteness of some parts and the comparatively large size of others, the magnification is not the same in all cases. This is indicated, however, for every figure.

The treatment to which the parts were subjected made any histological examination of sense-organs impossible; the presence or absence of these was judged by general external appearance. Such a thorough examination as would be necessary

---

[1] It was thought at first that the treatment of another interesting subject in connection with this could be attempted, namely, in how far a classification based on the mouth-parts would correspond with the present arrangement of the genera and species in this order; but, although some important data were gained, the number of species examined was too limited to warrant any definite statement for the present.

to settle this question decisively was considered to be outside of the scope of this article, in which only the morphology of the parts is discussed.

THE MOUTH-PARTS OF COLEOPTERA.

The mouth-parts and the legs of insects are homodynamous, both originating as segmental appendages, the former of the head, the latter of the thoracic region. It is in the order of Orthoptera that we find conditions as regards the trophi more nearly approaching those of the original type than in any other order of insects. Next as to primitiveness come the Coleoptera, in most of which the sclerites of the trophi can be directly traced to, and recognized by comparison with, those of the Orthoptera, and in some cases the conditions existing in the former are the more primitive.

In general, the maxillae are the parts which have undergone the least reduction and in which the sclerites are most distinctly visible; the other trophi are generally compared with them.

The mouth-parts consist of three paired and two unpaired pieces: the labrum, with the epipharynx; the mandibles; the maxillae or first maxillae; the labium or second maxillae; the hypopharynx (endo-labium). Of these, the mandibles, maxillae and labium are paired appendages of the head-segments; the labrum with the epipharynx, and the hypopharynx are not paired.

The *labrum* or *upper lip*. This is not a true appendage and is unpaired in origin, arising in the embryo between the two halves of the brain (protocerebrum), while all the true appendages arise on each side of the nervous system (7). It forms the roof of the anterior part of the mouth and is generally movably connected with the clypeus. Kolbe (5) claims a paired origin for the labrum. He says:— "Am Embryo mehrerer Insekten würde das Hervorgehen der Oberlippe aus zwei ursprünglich getrennten, Anhangspaarenähnlichen Gebilden nachgewiesen;" but he neither gives any figures nor cites any literature to support this claim.

The under side of the labrum is covered by a membrane, the epipharynx (Packard, 7), which contains the organs of taste. It corresponds in extent to the clypeus and labrum, posteriorly merging into the dorsal wall of the pharynx; the suture which separates the labrum from the clypeus does not involve the epipharynx (7). This would seem to show that this organ is not merely the under side of the labrum, but has an independent origin; it really is a fold of the membrane which forms the roof of the mouth. Besides the sense-organs, the epipharynx is covered with hairs or setae, which are classified by Packard under two heads:

a. The normal hairs, arising from a definite cell, and which are either simply defensive, guarding the sense-cups of the sensory fields in which the sense-cups are borne, or they are simply tactile hairs.

b. Soft, flattened, often hooked hairs, cylindrical toward the end but arising from a broad, triangular base, comparable to the gathering hairs described by Cheshire on the bee's tongue.

We shall find that the epipharynx is present and recognizable in nearly all of the species of Scarabaeidae which were examined, and that it shows an instructive series of stages in reduction.

Mandibles. These are used for very different purposes, being either adapted for cutting, tearing and crushing the food, or for defense; in *Cetonia* et al., they are used as a brush for collecting pollen. They are usually opposed to each other at the tip, or even crossed, but in the Coprini and in most of the Scarabaeidae the tips are separated and the bases alone are opposed, strongly chitinized and ridged, the right one being convex, the left one concave, and the two fitting accurately into each other. Although the mandible is generally a strongly chitinized single piece, it really consists of four (possibly more) sclerites which are well shown in some of the Scarabaeidae. In some species of Coleoptera (*Passalus cornutus*) we find a movable piece at the base of the mandible. This is the *prostheca* of Kirby and Spence (4), and is considered homologous with the lacinia of the maxilla. The mandibles are primarily three-lobed appendages like the maxillae (7).

Maxillae (first maxillae of Packard). These probably represent the primary form of buccal appendage of insects, and are composed of three basal pieces with three variously modified distal lobes or divisions; the mandibles and the labium are modifications of this type. The parts of which the maxillae are composed, and which generally can easily be distinguished, are: cardo, stipes, palpifer, lacinia, sub-galea, galea and palpus.

The *cardo* or *hinge* is generally a more or less triangular piece, wedged in between the sub-mentum and the mandibles, but in many cases it becomes elongated and club-shaped. It forms the articulation of the maxilla, and allows a free motion of the latter upon the mentum. The cardo is, however, not the only place of attachment, for muscles extend directly to the sub-galea without passing through the cardo.

The *stipes* or *foot-stalk* is usually triangular, bounded on its base by the cardo, on its outer side by the palpifer, and on its inner side by the sub-galea. The stipes may become united to the palpifer and the sub-galea without any trace of suture, but in all species of Scarabaeidae I have found it present as a distinct sclerite.

The *palpifer* or *palpus-bearer* is situated on the outer side of the stipes; it is generally quite large and convex and more greatly developed on the dorsal than on the ventral surface of the maxillae.

The *palpus* or *feeler* is long and slender, usually four-jointed, the terminal joints bearing in most cases tactile and olfactory sense-organs.

The *sub-galea* or *helmet-bearer* is generally the largest and most conspicuous sclerite of the maxillae. It is in most cases somewhat quadrangular, and in the Scarabaeidae its inner posterior corner generally projects beyond the lacinia and receives muscles directly from the mentum.

The *galea* or *helmet* (outer lobe, superior lobe) is prominent in Coleoptera and is in Scarabaeidae usually helmet-shaped or spatulate. It is composed of two segments, but this condition is obscured in most of the Scarabaeidae.

The *lacinia* or *blade* (inner lobe, inferior lobe) is borne on the inner margin of the sub-galea. It is claimed to be the cutting part of the maxilla (1), but it is generally its weakest point and can be only secondary in importance for the above mentioned purpose, since it follows the galea in its chitinization. In Scarabaeidae it is often provided with a hairy fringe at the tip, the hairs being used as stiff brushes in the pollen-eating forms.

Sometimes the lacinia bears at its distal end a small appendage, the *digitus,* which in some cases has the form of an articulated claw, as in Cicindelidae. It was found only in a few species of Scarabaeidae.

The function of the mandibles seems to be two-fold, viz.: they act as accessory jaws in grinding and cutting the food, and they are also used for seizing and retaining the food in the mouth whereby the palpi act as fingers. Whether or not the palpi contain organs of smell has not yet been settled decisively (7).

The *labium* or *under-lip* (second maxillae of Packard). This organ is formed by fusion at the basal portion of separate embryonic appendages, which arise in the same manner as the first maxillae, as appendages of the last or occipital segment of the head. The parts, although fused to a considerable extent, can be homologized with the parts of the maxillae. The labium consists of gula, sub-mentum, mentum, palpigers with the palpi, ligula and paraglossae; on its upper side we find the hypopharynx.

There is a great diversity of opinion among different authors about the homologies of these parts, and the terminology is very confusing. In the typical labium we find, starting from the posterior end, the gula (supposed to be the ventral plate of the occipital segment of the head), the sub-mentum and the mentum with its palpi and lobes. The mentum is often so small that it is concealed by the sub-mentum; on account of this it has been entirely overlooked by some authors, who have applied the name "mentum" to the sub-mentum, and called the true mentum the "hypoglottis" (Leconte and Horn, 6). The remaining parts of the labium except the palpi are called the ligula by Comstock (1), and this author divides it into a central part, the *glossa,* and "two parts, usually small membranous projections, one on each side of the base of the glossa, the *paraglossae.*"

There is great confusion concerning the homologies of the parts of the labium, some contending that "the sub-mentum and the mentum, or the mentum when no sub-mentum is differentiated (with the gula when present), appear to be collectively homologous with the cardines of the first maxillae, together with the palpifers and stipites" (7). The lobes of the labium are generally admitted to be the homologues of the galea and lacinia of the maxilla. Otokar Kadic (3) considers the sub-mentum and mentum together as the sub-mentum, and thinks that the mentum proper, with its appendages, the palpigers (squamae palpigerae), the glossae and the paraglossae, has grown inward over the sub-mentum. I am inclined to accept his view for some cases; the correctness of this notion I hope to show subsequently.

The *hypopharynx* arises as a fold from the floor of the mouth and is an unpaired membranous structure like the epipharynx. It is continuous with and forms the anterior part or fold of the base of the second maxilla. It does not seem to represent a pair of appendages. Kolbe (5) considers the hypopharynx a third pair of maxillae, calling it the endolabium, and claims that it can be recognized as such in *Hemimerus talpoides* (a roach-like form from West Africa), and that it bears palpi. He further claims that the hypopharynx originates as a third pair of jaws from a special primitive head-segment, but says: "Dieses Organ ist bei den bisher untersuchten Embryonen selbst nicht in elementarer Form gesehen, während doch die zu Mandibeln, Maxillen und zur Unterlippe sich ausbildenden Anhänge in den meisten Fällen deutlich angelegt sind;" and further: "Indes muss es befremden, das sich das zugehörige Ursegment am Embryo nicht findet: wir dürfen doch nicht für eine Tatsache halten, was wir nicht gesehen haben."

At the present stage of our knowledge it is impossible definitely to settle the question of the origin of the hypopharynx, but it probably represents a fold of the membranous floor of the mouth, just as the epipharynx originates as a fold of the roof of the mouth.

According to Comstock (1), the epipharynx and hypopharynx are rarely both developed in the same insect, except in Hymenoptera; in the species of Scarabaeidae, however, they are for the most part either both present or both wanting, but the hypopharynx is never conspicuous.

The Mouth-Parts of Copris Carolina Linn.

Smith (8) was the first to study the mouth-parts of this insect and to attempt to homologize the parts of the mandibles with those of the maxillae. His statements, though mainly correct, proved to be erroneous in some points, as I hope subsequently to show.

In this insect (and in the whole group of dung-beetles in general), we find a very peculiar development of the mouth-parts, which accords with its food habit. Functionally they are very much specialized, while morphologically they represent a low stage in the evolutionary scale.

The *epipharynx* (Pl. XXX, Fig. 1) consists of a large membrane forming the roof of the mouth. Two lateral areas are separated from the median part by a row of stiff, bristle-like hairs which are continued sparsely on the front margin, while their surfaces are densely covered with short, fine hairs, these also covering the posterior two-thirds of the central portion.

The regular arrangement of these hairs makes it appear as if the lateral parts of the epipharynx were curved inward and downward (as is claimed by Smith to be the case), but no evidence in favor of this view could be found; the hairs are not situated on a free edge, and a transverse section through the epipharynx does not show the conditions which we should expect to find in case such a curving has taken place, even if followed by a fusion at the margin. The median part is made up of a club-shaped chitinized thickening, which bears numerous blade-like hairs, especially crowded at the apex of the club and extending more sparsely over the surrounding membranous area. Posteriorly, this chitinized median strip is continued into a transverse band, which shows two large asymmetrical notches in which are received the molars of the mandibles; it then runs dorsad at the sides and forms a supporting arch over the epipharynx. The epipharynx does not lie loosely in the roof of the mouth, but is connected to the labrum by means of a membrane which extends along the sides and the caudal margin of the supporting arch.

The epipharynx is a hollow structure consisting of a double membrane. The upper membrane contains the supporting arch, from the caudal edge of which it is turned back and connected with the membranous lining of labrum and clypeus; this shows that the origin of the epipharynx is in a fold of the upper lining of the mouth. The lower membrane contains the sense papillae and fuses with the dorsal wall of the pharynx.

Toward the caudal end of the epipharynx, where the median chitinized strip fuses with the transverse band, we find a row of papillae, broadening out laterally, decidedly different in appearance from the chitinous hairs which are scattered over the median part of the epipharynx. These papillae may be gustatory, the hairs just mentioned being probably tactile in function.

The great extension of the epipharynx and its many sense papillae would seem to indicate a highly developed gustatory sense, the need of which, however, does not seem clear in these animals which live on excrementitious matter.

Mandibles (Pl. XXX, Fig. 2). These present a great deviation from the type we should expect in insects with biting mouth-parts, and show that they are originally composed of many segments. As Smith (8) was the first to call attention to these facts, and as he also worked out the homology of the parts, I will here quote his statements, followed by corrections which proved to be necessary.

"At the base, outwardly, is a large corneous sclerite, to which are attached inferiorly most of the muscles and tendons controlling the entire organ. This may be called the *basalis*, or basal piece, and is the homologue of the stipes of the maxillae. There is in some species an intermediate piece between the basalis and the head, which presents the cardo of the maxillae and which I propose to call the *sub-basalis*, or *tendon-bearer;* the former on account of its position, the latter as expressive of its function. The muscular attachment is, however, to the basalis as well as to the sub-basalis, even when the latter is present. Another of the basal pieces united to the basalis and forming the inner inferior part of the entire organ, I propose to call the *molar*, or grinder. I believe it to be homologous with the sub-galea, and the function is expressed by the name. The food is not cut or broken by any other organ, and indeed needs little cutting. But, to get into the gullet, it must pass between those grinders and is there fitted for swallowing. In the present species, the molars are ridged and dissimilar. The one grinding face is convex; the other is concave, the convex surface fitting accurately in the opposite cavity.

"In *Macrodactylus, Cetonia* and some other genera, these molars are much larger proportionately, fitted for scraping as well as for grinding or chewing. Between the molar, which is always well-chitinized in all the forms I have seen, and a flattened, more membranous piece, also attached to the basalis, is a small sclerite, which I have thus far found in *Copris* only, and this I call the *conjunctivus*, or *connecting piece*. It has no other function that I can find and does not seem to occur where there is a greater development of the molar. It most likely represents the basal joint of the galea and is obscured where the molar is largely developed. The flat membranous piece forming most of the inner, and part of the outer, margin of the mandible toward the tip is the homologue of the *galea*, and I have called it the *terebra*, or *piercer*. In this species it is quite closely united to the basalis and is fringed with long, dense and fine hairs.

"In some other species, notably the Cetonii and pollen-feeding forms, it is entirely distinct and separate; much firmer in texture, though also fringed with hair. In those cases the attachment is seen to be much more to the grinder than to the basalis, and the connection between the two is distinctly evident, which is not the case here. It is the piece which, when hardened and united with the other parts, forms the apical acute tooth and justifies the term *terebra.*

"Arising from the same base as this piercer is another small piece, also membranous and fringed with hair, quite closely united to the terebra. This is the *prostheca* of Kirby and Spence, and is homologous to the *lacinia* of the maxillae."

After careful dissection of a number of specimens, I found the following differences:

1. The conjunctivus is the thickened central part of a membrane, which is spread over the basal part of the mandible, on its ventral surface; it *bears the lacinia,* while the underlying basal part of the mandible is wholly chitinized.

2. The conjunctivus shows a very peculiar structure which consists of numerous parallel longitudinal ridges covered with a reticulated membrane and suggesting a special function.

3. The lacinia is blade-shaped, connected by its thickened lateral edge to the galea, and is provided with stiff, comb-like teeth. Underneath it the galea runs through and connects with the chitinized basal part of the mandible, so that between the galea and lacinia a kind of sheath is formed, open toward the inside, in which a needle can be shoved as far as the end of the lacinia. I have been able to dissect out the conjunctivus with the lacinia and part of the galea attached (Pl. XXX, Fig. 3). These relations are still more clearly shown in allied genera (*Phanaeus*).

4. The conjunctivus is *not* found in *Copris* alone, but is present in all genera of the dung-beetles so far examined, and in some is even more prominent.

5. The hairs on the end of the galea are not hairs in the ordinary sense, but are the fringed edge of the blade of the galea. They are blunt, branched, and often curved at the tip (Pl. XXX, Fig. 4).

Maxillae (Pl. XXX, Fig. 5). These do not show any peculiar variation from the regular type already described. All parts are present: the small triangular cardo, the large stipes, and a large convex palpifer, which is provided with a few long, stiff hairs and bears the four-jointed palpus. The sub-galea is large and somewhat quadrangular; the galea, like the smaller lacinia, is a flat, helmet-shaped piece covered with moderately long hairs. Between the sub-galea and the galea we find a fork-shaped chitinous sclerite, which in other genera is more conspicuous than in *Copris;* this is possibly the proximal segment of the galea. As the maxillae show only slight variations, they need not be discussed for every species examined, and reference to them will be made only when they present any striking peculiarity.

Labium (Pl. XXX, Figs. 6, 7). The labial structures are all present, but the arrangement is somewhat confusing and complex, different authors disagreeing as to the homology of some parts. To give a clear idea of the arrangement as I understand it, I have used diagrams wherever necessary or helpful. I am inclined to accept the view of Kadic (3) in regard to the mentum and sub-mentum, believing that the two sclerites, hitherto called mentum and sub-mentum in coleopterological literature, are really together the sub-mentum, which thus consists of a posterior and an anterior part. The mentum proper, in *Copris* and its allies, is folded in over the sub-mentum, and is, for the greater part, membranous; its lateral edge, however, is always chitinized, and appears as a curved chitinous rod, extending from the lateral anterior corner of the sub-mentum to the origin of the inner lobe of the labium. As these outer and inner lobes are homologous with the lobes of the maxillae, I use the same names throughout, calling the outer lobe (lobus externus, paraglossa) the *galea,* and the inner lobe (lobus internus, glossa) the *lacinia.*

That part which I consider the true mentum (and which bears the lobes and the palpifer), has been called by some authors the hypoglottis, and by others the ligula. I will call it the *mentum.*

The diagram (Pl. XXXIV, Fig. 1) shows that in *Copris carolina* the mentum presents a small, somewhat triangular sclerite, which is the remnant of the palpifer, the rest of it having become membranous and allowing free movement of the whole labial structure. In the other species, this palpifer is fused with the chitinized edge of the mentum and is no longer separately visible.

The palpi are three-jointed, their basal segments are very broad, and these and the second segments are clothed with stiff, bristle-like hairs.

Further inward we find the two lobes, galea and lacinia, fused, their separation only indicated by a suture. The galea is chitinized along its outer margin. The lacinia is thickly clothed with short hairs, giving it a velvety appearance. Those of both sides converge posteriorly and end in a chitinized piece which bears strong teeth on its dorsal edge, and underneath these teeth (ventrad) long, saber-shaped hairs are borne. In front of this area we find a somewhat quadrangular unpaired membrane, clothed with fine, long hairs and concave at its anterior edge. This I consider the hypopharynx, for a similar structure in other beetles of this group undoubtedly bears the sense-hairs (Pl. XXX, Fig. 13), although in *Copris* this function has been ceded to the proximal part of the lacinia. Underneath this hypopharynx we often find two thin, chitinous, crescent-shaped plates. These were considered by Smith (l. c.) to constitute a valve for the gullet. As an examination of this so-called "valve" does not fall within the scope of this article, a discussion of it will be omitted. Supporting the hypopharynx and the floor of the mouth we find a peculiar structure, the "fulcrum hypopharyngeum." It is composed of a small chitinous area, usually covered with short, velvety hairs, from which radiate slightly curved chitinous rods, generally four in number; two of these rods are attached to the inner surface of the anterior plate of the sub-mentum, and the other two either to the posterior plate of the sub-mentum or to the gula. These hypopharyngeal structures, with which the above mentioned valve seems to be in some way connected, were not examined in detail.

The velvety area mentioned above, at the junction of the anterior and posterior arms of the hypopharyngeal fulcrum, does *not* represent the hypopharynx, for which it may easily be mistaken in other species in which the true hypopharynx is absent.

THE MOUTH-PARTS OF REPRESENTATIVES OF DIFFERENT GENERA.

Particular attention was paid to the first great group of the Lamellicornia, the dung beetles, on account of their peculiar adaptation, and the considerable amount of specific variation in some of the minor parts, especially the labial structures; also in order to come to a clear understanding of the relations as there represented, and thus to be better able to trace the variations from this type in the other groups.

Copris anaglypticus Say (Pl. XXX, Figs. 9–13).

The *epipharynx* (Fig. 9) shows the same general shape as in *C. carolina,* but the broad, chitinized supporting arch has disappeared, and in its stead we find only a faint line, which indicates the attachment to the under side of the clypeus. We see that already the place of attachment has moved forward.

The *mandibles* (Fig. 10) show only a slight difference from those of *C. carolina.* The attachment of the lacinia to the conjunctivus is, however, more definite.

The *labium* (Fig. 12) shows the galea and lacinia more distinctly separated, the lacinia being clothed with long, fine hairs, and its distal end curved outward.

The *hypopharynx* (Fig. 13) shows peculiar, two-jointed, saber-shaped sense-hairs, most of which are placed along its lateral edge, thus showing a distinct difference from *C. carolina,* in which similar hairs are borne by the proximal part of the lacinia.

Canthon laevis Drury (Pl. XXX, Figs. 14, 15; Pl. XXXI, Fig. 16).

Here we find the *mandibles* (Fig. 15), though of the same general shape, becoming more chitinized and the membranous terminal part correspondingly shorter. The lacinia is here somewhat larger and again distinctly connected with the conjunctivus.

Labium and *labial lobes.* (Pl. XXXI, Fig. 16; Pl. XXXIV, Fig. 2). The anterior part of the sub-mentum is distinctly paired. The mentum is indented in the middle, and the sides of this indentation are fringed with fine hairs. The galea and lacinia are fairly distinct, the lacinia being less thickly clothed with hairs and with its distal part wholly membranous and twisted. Its proximal part is connected with the hypopharynx, which is here triangular and again bears peculiar hairs, principally on its outside edges.

Choeridium histeroides Web.

The *epipharynx* is of the usual type, but the club-shaped, chitinized median thickening is here relatively broad and less prominent, widening posteriorly. We here have the first step toward a disappearance of this thickening.

Labial lobes and *hypopharynx* (Pl. XXXI, Fig. 17). The inner lobe is membranous and fringed with strong, pointed hairs, the outer lobe for the greater part chitinized. Where the lobes join the hypopharynx, their dorsal surface is sparsely covered with numerous short, conical projections; where they meet in the median line they are furnished with three long, blade-shaped hairs, which here, however, are firmly chitinized, and which may be considered intermediate between the sense-hairs as found in other forms and the teeth which we find in *Copris*. The hypopharynx itself is quadrangular and clothed with moderately long, fine hairs.

Pleurophorus caesus Panz.

Epipharynx (Fig. 18). Though still presenting the general appearance found throughout this group, the epipharynx shows some important modifications in structure. The hairs on the incurved lateral margin are broader, stronger and more brush-like. The median club-shaped thickened area with its sense-hairs has entirely disappeared, the field between the lateral areas being furnished instead with a comparatively few short, conical projections.

Mandibles (Fig. 19). These show a more distinct chitinization at the lateral and distal margin. The fringe of hairs at the end of the galea has disappeared, the whole mandible being more compact with its tip no longer membranous. The molar is still well developed and ridged. The lacinia has increased in length, reaching nearly to the tip, and still shows the comb-like teeth. At its base the conjunctivus is still distinctly visible.

Maxillae (Fig. 20). In this species we find that the maxillae have begun to show a variation. The hairy fringe of the galea has disappeared and is replaced by strong, curved, blunt, chitinized teeth, surmounted by a slight fringe of hairs. The lacinia is small and slender, and provided with a number of thin, curved teeth at the end instead of the hairs heretofore found.

Labial structures (Fig. 21). The two lobes of the labium are distinct, the galea being represented by a broad, flattened, slightly chitinized plate, and the lacinia having its distal end greatly differentiated into four peculiarly shaped processes. The palpi are here three-jointed, each segment being smooth and similar to the others. At their junction, the inner lobes pass over directly into the hypopharynx, which is only slightly developed and is recognizable by the fact that its median area is covered with short, conical protuberances. No sense-hairs were found, and the hypopharynx has been so much reduced that it is no longer recognizable as such; it becomes optional to call the area described the hypopharynx, or merely the median confluent part of the inner lobes.

About the habits of this species nothing could be learned; its mouth-parts show, however, that it lives no longer on soft, excrementitious matter, but on more solid food. The mandibles have become more chitinized and the hairs on the maxillar lobes have been transformed into teeth; the gustatory setae have undergone a great reduction. The present species forms a transition from this group to the next (*Geotrupes* et al.).

Phanaeus cornifex Linn.

We find the epipharynx, mandibles and maxillae very much like those of *Copris;* the stipes and palpifer of the maxillae are clothed with long, stiff hairs.

The *labium* (Pl. XXXI, Fig. 22; Pl. XXXIV, Fig. 3) is in its general appearance very *Copris*-like; the proximal end of the inner lobe is also curved inward and connected with the hypopharynx, but instead of being differentiated into chitinized teeth, its surface is covered with low, dome-shaped papillae, giving it the appearance of a cobble-stone pavement. Here also, as in *Copris,* the blade-shaped hairs are borne on the edge of this upturned part of the lobe, and, becoming slightly modified, extend to the distal end.

The *hypopharynx* (Fig. 22) is somewhat quadrangular with a concave distal edge, and is clothed with moderately long, fine hairs.

Onthophagus hecate Panz.

The *epipharynx* (Fig. 23) presents the usual appearance. The *mandibles* (Fig. 24) are also of the *Copris* type, but the lacinia has increased in length, nearly attaining the tip of the galea. With this has gone a corresponding increase in prominence of the conjunctivus, and the molars have begun to decrease in size; the change in the galea is here shown by the fact that the fringe on its tip has become finer and shorter.

The *maxillae* (Fig. 25) show a slight reduction in the lacinia and an increase in the bristles on palpifer, stipes and cardo.

Labial structures (Fig. 26). The lacinia is membranous. The thick, velvety coat of short hairs has disappeared, and in its stead we find long, bristle-like hairs covering the entire blade. The galea is as usual somewhat chitinized along its lateral margin. The proximal end of the lacinia is continued directly into the hypopharynx, the connecting membrane, which shows it, changing gradually from a thickened proximal to a thinner distal part. This structure continues over the triangular hypopharynx proper, which bears along its edges the characteristic saber-shaped hairs.

Aphodius fimetarius Linn.

Epipharynx (Fig. 27). Here the club-shaped thickening begins to disappear, and in its place we find a small median protuberance, with a few pitted hairs at the distal edge, which expands caudad into a broad V-shaped area. This area is slightly chitinized and smooth, and along its edges is pierced by a number of irregular holes of different sizes, which, increasing in number at the posterior part, give to the plate a sieve-like appearance. This feature has been observed only in this one species, and its physiological significance is not clear.

The *mandibles* are short and more thick and compact, but still membranous at the tip; the lacinia is short and the conjunctivus well developed.

The *labium* and *labial lobes* (Fig. 28). Both lobes are membranous, the galea and lacinia fused as usual and but sparsely beset with setae. At the junction of the hypopharynx the lobes are continued into an elongated area, covered with short, blunt, flat, conical papillae. The hypopharynx itself is a thin, membranous plate, convex in front and sparsely covered with thin, soft hairs.

Aphodius granarius Linn.

This second representative of the genus was taken on account of its different food habits. The members of this genus are prevailingly found feeding on cow dung, but *A. granarius* Linn. has become a pest in our granaries, and it was examined to see whether such a comparatively slight deviation would show any effect on the construction of the mouth-parts. This was found to be the case, although the change has not proceeded very far and its modification can be directly traced from *A. fimetarius.*

Epipharynx (Fig. 29). The V-shaped, slightly chitinized area described in the preceding species is here flask-shaped (a direct modification from the dung-feeding *A. fimetarius*), more strongly chitinized and sparsely beset with short papillae. its posterior border being fringed with a row of sense-cups. It does not show the perforations which were found in the preceding species. Its anterior tip shows two blade-shaped chitinous hairs or teeth. An additional row of blade-shaped hairs has appeared on the area between this and the incurved lateral margin of the epipharynx.

Mandibles (Fig 30). These are shorter and more strongly chitinized than in *A. fimetarius.* The lacinia has again become longer and extends to the tip of the mandible where it is fused with the end of the galea; we cannot say where one ends and the other begins, only the comb-like fringe of hairs showing that it is the lacinia with which we have to deal.

Labium (Fig. 31). The inner lobe is sparsely covered with scattered saber-shaped hairs; where it joins the hypopharynx it changes into an oval, cushion-like structure, thickly covered with slender, pointed cones. The hypopharynx is here again a thin plate, broadened in front and covered with fine, soft, moderately long hairs.

We see in this natural group of the dung beetles a great similarity in the mouth-parts, as was to be expected. Summing up the characteristics, we have:

1. A large, membranous epipharynx, with well-developed sensory area.

2. Mandibles which show that they were originally composed of a number of sclerites, the homologies of which can be traced to those of the maxillae; their anterior parts are membranous, with a pair of grinders or molars placed at their posterior ends.

3. A labium in which the mentum is turned in over the sub-mentum, with the labial lobes membranous, and galea and lacinia generally fused; the inner lobes at their junction pass over into the hypopharynx; the latter part and the labial lobes show a great amount of variation in the different species, though individual differences were found to be immaterial. In general we have two types:

a. The hypopharynx is well-developed and bears peculiarly shaped sensory hairs; the inner lobes bear almost exclusively long, slender tactile hairs.

b. The hypopharynx is clothed with long, slender hairs which are here non-sensory, this function being taken over by the median part of the inner lobes, which bear peculiar structures.

4. A loosely developed elastic swallowing apparatus, the fulcrum hypopharyngeum, the structure of which was not, however, examined in detail.

The members of the next group, though generally included among the dung-beetles, show in their mouth-parts a distinct departure from the types just described, being intermediate between these and the skin beetles; they also show in some respects an approach to the predatory type of Coleoptera.

Of the habits of the species examined nothing could be learned, excepting as to *Geotrupes*, but in the latter case the information did not account for the changes shown by the trophi.

Bradycinctus ferrugineus Burm.

The *epipharynx* (Pl. XXXI, Fig. 32) forms here the under side of the labrum and is fused with it. Of the gustatory sense-organ, little has remained of the elaborate structure in the *Copris* beetles, though still enough to suggest its descent. Along the median line we find a small elevated area which is club-shaped in appearance; it projects slightly beyond the anterior margin of the labrum and bears numerous sense-papillae. Laterally it also bears a small number of long tactile hairs and towards the posterior end a row of taste-cups.

From the posterior margin a membrane extends backward, which covers the roof of the mouth and shows several rows of thin hairs thickly crowded together.

Mandibles (Fig. 33). The galea has become wholly chitinized, but we still find part of the lacinia present as a fringe of comb-like hairs, extending along the inner edge. No trace of a conjunctivus can be found, the entire basal part of the mandible being chitinized too thoroughly to show any such structure. Below the lacinia, and between it and the molar, we find a whorled mass of fine hairs, which may possibly represent the remnant of the hairs at the end of the conjunctivus.

Maxillae (Fig. 34). A slender, four-segmented palpus is present. The galea ends in a sharp tooth, still retaining somewhat the helmet shape found in the preceding group, but no longer membranous and hairy. The lacinia is also entirely chitinized and ends in a sharp, curved tooth. Above it a second, movable tooth is developed, similar to the digitus of the Carabidae.

Labium (Pl. XXXII, Fig. 35). The labial structures show a decided change and a reduction. The mentum is no longer turned over and lying on top of the sub-mentum, but is now in front of this piece. It is very small, however, and being pushed somewhat back over the sub-mentum, it is easily overlooked. As a result of this change in position, the labial palpi no longer arise above, but distad from the sub-mentum.

The palpi are three-jointed and slender. The lobes are both present; the outer one is a slightly chitinized plate, sparsely covered with stiff hairs; the inner lobe is small and membranous. No hypopharynx could be found; the hairy structure on the membranous floor of the mouth corresponds neither in structure nor in position to a hypopharynx, but is similar to that structure which we find posterior to the epipharynx on the membrane forming the roof of the mouth.

The whole sensory apparatus of this insect has been reduced, and those hairy, slightly chitinized parts of the membrane just referred to seem to be the remnant of the large hypopharyngeal structure.

Bolboceras farctus Fab.

The *epipharynx* (Pl. XXXI, Fig. 36) is in general the same as in *Bradycinctus*.

The *mandibles* (Pl. XXXII, Fig. 37) are more strongly chitinized, and the galea has two teeth at the apex. The lacinia bears a divided tooth; at its end and from here inward the usual hairy fringe is present. No trace of a conjunctivus could be made out.

The *maxilla* is similar to that of the preceding species, excepting that the digitus of its lacinia has become longer, more curved and forked at the end. Stipes and palpifer are provided with very long tactile hairs.

Labium (Pl. XXXII, Fig. 38; Pl. XXXIV, Fig 4). The mentum here is similar to that already described for *Bradycinctus ferrugineus*. The labial lobes, however, are thoroughly chitinized, the outer lobes fused, and only rudiments of the inner lobes are visible as slight projections. The fused chitinized outer lobes are very easily mistaken for the mentum, but the intermediate stage, as shown in the preceding species, proves their real homology with the outer lobes of the labium.

Bolboceras lazarus Fab.

Here the *epipharynx* (Pl. XXXII, Fig. 39) is less developed; it is sparsely beset with hairs and forms the under side of the labrum. Laterally the epipharynx is continued into a membrane which is thickly covered with tactile hairs. No taste-cups of any kind could be seen.

Mandibles (Fig. 40). These are in general like those of *B. farctus,* still showing a junction between the large galea and smaller lacinia. The latter part is chitinized, bearing the characteristic hairs along its margin and showing at its base a striated portion with which it is continuous. This basal portion, which lies adjacent to the molar, is doubtless a remnant of the conjunctivus, which here, as in other species of this group, is no longer recognizable as a distinct piece.

Labium. This is very much reduced. The lobes are membranous, the inner one rudimentary. No trace of a hypopharynx remains, and no sense-cups of any kind could be found.

Geotrupes egeriei Germ. (Pl. XXXII, Figs. 41-45).

Epipharynx (Fig. 41). Here we find the epipharynx occupying as usual the under side of the labrum, no longer as a distinct membrane but connected with it all along its anterior and lateral margins. The arrangement of the hairs still shows a strong resemblance to that found in the beetles of the preceding group.

Mandibles (Fig. 42). The mandibles are chitinized and end in strong teeth, the distal one of which is the horny point of the galea. The lacinia consists of an inner membranous and an outer chitinous part and forms the second tooth of the mandible. That this is the lacinia is shown by its connection with the conjunctivus; this can still be distinguished and shows the remnant of its original structure by the interrupted parallel ridges on its surface.

Labium (Figs. 44-45). Here we find a hypopharynx present in connection with the labial lobes; the hypopharynx is itself covered with fine hairs, while pointed papillae and sense-cups are borne on the proximal part of the inner lobes of the labium.

Cloeotus aphodioides Ill. (Pl. XXXII, Figs. 46-47, Pl. XXXIV, Fig. 5).

Epipharynx (Fig. 53). The epipharynx has become entirely corneous. The lateral hairs are disappearing, only a few remaining scattered over the surface. A thickened, V-shaped median area bears both sense-cups and short papillae.

Mandibles (Fig. 47). The molars are still distinguishable, those of both sides being nearly alike and failing to show the convex and concave surfaces hitherto found. There is only one apical tooth at the end of the galea, and the lacinia, which extends along the inner side of the galea to the base of the tooth, presents the characteristic fringe of hairs. A conjunctivus cannot be made out with certainty.

Maxillae. The palpi are slender, both galea and lacinia well developed.

Labium (Pl. XXXIV, Fig. 5). Only the frontal edge of the mentum is chitinized; the rest of it is membranous. It is here distinctly pushed in over the sub-mentum, and this gives to the palpigers with their three-jointed palpi the appearance of arising above the sub-mentum. The labial lobes are represented by a very thin plate, fringed with long hairs and supported at the proximal part by the hypopharyngeal fulcrum. No true hypopharynx could be distinguished.

Trox scutellaris Say (Pl. XXXII, Figs. 48-51).

The members of this genus, the skin beetles, are generally considered to constitute a group by themselves, and rightly so, for in appearance and habits they differ greatly from any other group in this order. In structure their mouth-parts show an intermediate stage between those of the preceding and those of the following group.

Epipharynx (Fig. 48). The frontal and lateral edges of the labrum appear to have been turned in, and the space thus enclosed is bridged over by a membrane which bears the epipharyngeal structures. These are, however, much reduced, and laterally we find a number of tactile hairs, while the median sense-area bears only a small group of flat, round papillae.

Mandibles (Fig. 49). These are very thoroughly chitinized, so much so that the homology of the parts has become entirely obscured and cannot be traced with any degree of certainty. Their outer surface, as is the case with all the mouthparts of this beetle, is thickly covered with short, thick, stiff hairs, evidently adapted for brushing and scraping.

Maxillae (Fig. 50). Here again the lacinia ends in a tooth and bears a digitus, which is here double-toothed. Stiff hairs are intermingled with these teeth.

Labium (Fig. 51). The sub-mentum has its anterior and lateral margin folded in, and its normally anterior margin bears the mentum with its palpi and lobes. The labial lobes are represented by a thin membrane which bears two rows of hairs. These may indicate the line of fusion of outer and inner lobes. The hypopharynx has almost entirely disappeared. At the posterior end of the lobes there is only one row of sense-cups, and in front of these are two pairs of flat, round papillae.

Hoplia trifasciata Say (Pl. XXXII, Figs. 52-54).

Epipharynx (Fig. 52). This shows in its form and structure a close resemblance to the corresponding organ of *Trox scutellaris;* in fact, nearly all the following species show the lateral and distal edge of the labrum turned in and chitinized, the space enclosed by them being covered with a membrane, the true epipharynx. In this species both the labrum and the epipharynx are very much shortened. The membranous area is furnished with a few sense-cups in the center and is covered laterally with long, stiff hairs.

Mandibles (Fig. 53). These are strongly chitinized and show a well developed molar furnished with strong ridges. The galea forms a single apical tooth; the lacinia is also present and recognizable by its characteristic hairs.

Labial structures (Fig. 54). Here the conditions are different from those previously described. The mentum with its palpi has been pushed in over the distal end of the sub-mentum, and what is seen projecting distad from the sub-mentum (looking at it from the ventral side) is only a part of the mentum. In the case of *Hoplia trifasciata* only a small portion of the mentum is visible from beneath, the greater part of it lying on top of the sub-mentum. The front and lateral edges only are chitinized, and the membranous enclosed area is devoid of sense-cups, but furnished with lateral rows of long, thin hairs which converge posteriorly.

Dichelonycha elongata Fab. (Pl. XXXII, Figs. 55-58).

Epipharynx (Fig. 55). Here this organ is still more reduced and almost entirely corneous; only a few scattered hairs and papillae are left to indicate its original function. The epipharynx is reduced, not only in specialization, but also in extent, and has become very much shortened.

Mandibles (Fig. 56). These are much more chitinized; they are, in fact, almost entirely corneous. The molar has greatly increased in size; the apical tooth of the galea has become broader and the lacinia shorter and much reduced. The large molar, the broad apical expanse of the galea and the heavy chitinization give to the organ a strong, compact appearance.

Maxillae (Fig. 57). The galea is well developed and strongly chitinized, while the lacinia is much reduced, having lost its hairy covering and become a thin, chitinous plate. It forms part of the dorsal surface of the organ and extends to the median edge where it is deflexed and forms the internal margin of the maxilla, so that when viewed from the ventral side the lacinia appears as a thin line along the inner edge of the sub-galea.

The maxillary palpus is very long, and the palpifer bears two conspicuous, long, stiff setae.

Labial structures (Fig. 58). These are similar in position to those of the preceding species, except that the inner lobes of the labium are still distinguishable. They appear as membranes, separated from each other along the median line for a short distance from the distal edge, and are sparsely covered with short, curved hairs. No sense-cups of any kind are apparent. Caudad from these hairs just mentioned is the usual V-shaped hairy area connecting the labial lobes with the hypopharyngeal fulcrum, which is here fairly well developed.

Serica sericea Ill. (Pl. XXXII, Figs. 59-63).

Epipharynx (Figs. 59-60). In this species the epipharynx has undergone a still greater reduction. At first sight the membranous part of the under side of the labrum appears structureless. Upon closer examination, however, we find remnants of the epipharyngeal structure which are here represented by a few sense-pits in the median area, bounded laterally by a row of hairs.

Mandibles (Fig. 61). In this insect, as in *Dichelonycha,* the mandibles have become more compact and strongly chitinized, not by an increase of the galea but by a greater development of the molar. The width of the galea is reduced, and the lacinia, increased correspondingly, ends in a slightly chitinized tooth.

Maxillae (Fig. 62). All the hairs which usually are present on the surface of the galea and the lacinia have disappeared, and the entire organ has become stronger and shorter. The galea ends in five strong chitinized teeth; the lacinia as such is no longer distinct.

Labial structures. Figure 6 (Plate XXXIV) gives a diagrammatic representation of the conditions here. The sub-mentum is large; beyond it, when seen from beneath, the mentum projects as a narrow transverse sclerite. A lateral view shows the mentum moved in over the sub-mentum and bearing the three-segmented palpi on its ventral surface. Lateral notches on the sub-mentum allow the passage of these palpi, which have the appearance of arising from the sub-mentum.

The anterior edge of the mentum is strongly chitinized and is continued posteriorly into a membrane which forms the floor of the mouth. No trace is left of hypopharynx and labial lobes; lateral rows of hairs, converging caudad and enclosing a V-shaped area, may here represent a remnant of the original conditions. The hypopharyngeal fulcrum is still present and fairly well developed.

Macrodactylus subspinosus Fab. (Pl. XXXII, Figs. 64-67). In this insect the trophi are less strongly chitinized and show an approach to those of the pollen-eating beetles (*Euphoria* et al.). This was to be expected, as this species lives on the soft petals of flowers and has no need of strongly chitinized mouth-parts.

Epipharynx (Fig. 64). This shows a better development than in the preceding species; the sensory area is larger, the sense-cups are more numerous, and the arrangement of the hairs and sense-pits reminds us of that in *Hoplia trifasciata*.

Mandibles (Fig. 65). These are less chitinized, both galea and molar having undergone a reduction. The lacinia is again enlarged and much broader, giving the whole mandible a more leaf-like aspect. A remnant of the conjunctivus is here suggested, there being a slight difference in structure in that part of the base of the mandible which adjoins the molar.

Maxillae (Fig. 66). These are noteworthy in that they show that the teeth with which the maxillae are armed in *Serica* and the preceding species are really formed by the galea, and that the lacinia does not take part in their formation. Galea and lacinia are here separate and distinct, the former ending in five strong teeth, the latter having a small tuft of hairs at its end.

Labial structures (Fig. 67). The mentum, which with its appendages has been pushed in over the sub-mentum, is comparatively broad, narrowing toward the posterior end. It bears on its ventral side the short three-segmented palpi, while on its dorsal surface is a small transverse piece which is corneous and projects dorsally. This I consider to be the remnant of the fused inner lobes of the labium. Laterad of this we again find the usual rows of long hairs converging posteriorly. At the place where we should naturally expect the hypopharynx to be, there are only a few sense-pits.

Diplotaxis sordida Say (Pl. XXXII, Figs 68-69; Pl. XXXIV, Fig. 7).

Epipharynx. This organ presents a condition similar to that found in *Serica.* It is much reduced, the sense-papillae no longer being apparent, but the lateral row of hairs is still present. Its sensory function has evidently been lost.

Mandibles. These are strongly chitinized, each bearing a prominent curved tooth forked at its free end; there is a well developed molar. The lacinia is much reduced, its presence being indicated merely by a whorl of hairs at the base of the inner edge of the galea.

Maxillae (Fig. 68). Except for their short, compact appearance and greater amount of chitinization, these do not materially differ from those already described. The teeth of the maxillae (here four in number and prominent) are again shown to be formed by the galea alone, the lacinia ending in a number of strong, stiff hairs.

Labial structures (Pl. XXXII, Fig. 69; Pl. XXXIV, Fig. 7). The short transverse mentum has been moved in over the sub-mentum, but for so short a distance that it seems to be situated directly in front of it. The true relative position of these sclerites is shown in the diagram. The anterior and posterior plates of the sub-mentum are distinct and nearly equal in size, thus differing from the general arrangement which shows the posterior plate to be considerably shorter than the anterior. No sensory structures which would suggest a hypopharynx are apparent, but the lateral rows of hairs are present as usual.

Lachnosterna fusca Fröh. (Pl. XXXII, Fig. 70; Pl. XXXIII, Fig. 71). This is the common species. Other species were examined but did not show any essential differences in the shape or structure of their trophi from the species here described.

Epipharynx (Fig. 70). This organ has almost entirely disappeared, the turned-in front and lateral edges of the labrum extending nearly over its entire under surface. Whether this is the chitinized front and lateral edge of the epipharyngeal membrane, or whether it is part of the labrum, would be hard to decide. No taste-organs of any kind are apparent.

Mandibles. These are strongly chitinized, short and compact, and they present highly developed molars which have numerous sharp, high ridges. The galea is not toothed at the end but terminates in a slightly chitinous, leaf-like expansion.

Labial structures (Fig. 71). Again we find the anterior and posterior plates of the sub-mentum nearly equal in size; the former is convex in front. The mentum is comparatively large and has not been moved in very far over the sub-mentum.

Anomala minuta Burm. (Pl. XXXII, Fig. 72; Pl. XXXIII, Figs. 73-74).

Epipharynx (Fig. 72). This organ is less reduced in this than in the preceding species. It is comparatively large and chitinous, with a fringe of bristle-like hairs along its frontal and lateral edges. A few sense-papillae are present, arranged in a triangular shape; they are bounded by the characteristic lateral row of hairs. I am inclined to believe from their position and appearance that these papillae, here as in other species, are gustatory in function.

The *mandibles* (Fig. 73) and the *maxillae* are similar in appearance to those of *Diplotaxis* and need not be discussed.

Labial structures (Fig. 74). In *Anomala* the anterior plate of the sub-mentum is large, the posterior plate comparatively small and transverse. The mentum is large and is pushed in over the sub-mentum to a considerable extent. Its posterior margin is convex, its anterior edge slightly concave with the lateral angles rounded. It is wider than the anterior part of the sub-mentum, and its front and lateral portions are visible from beneath, protruding over the edges of the sub-mentum. As usual, no hypopharynx is present.

Pelidnota punctata Linn. (Pl. XXXIII, Figs. 75-76; Pl. XXXIV, Fig. 8).

Epipharynx (Fig. 75). This is for the greater part membranous, its anterior edge only being chitinized. It is strongly indented in front, and its lateral portions are furnished with three long rows of strong, moderately long hairs. The velvety, hairy area, which we generally find covering the posterior end of the membranous part of the epipharynx, is in this species situated directly behind its front edge. The whole labrum, with the epipharynx, is pushed far back under the clypeus, so that this velvety area is really in its normal position in regard to the gullet of the insect.

Mandibles (Fig. 76). These are large, prominent and strongly chitinized. The molar is well developed and is furnished with numerous high ridges; the galea forms the greater part of the mandible and ends in two sharp, inwardly projecting teeth. The lacinia has also been chitinized, but still shows the characteristic hairs along its inner edge.

Labial structures. The diagram (Pl. XXXIV, Fig 8) shows the existing conditions. The posterior plate of the sub-mentum is short, the anterior plate long with slightly convex sides. The mentum is large and nearly quadrangular, somewhat narrowed posteriorly, and has been pushed in far over the sub-mentum so that in a ventral view only a small portion of it can be seen projecting in front. No sensory apparatus suggesting a hypopharynx seems to be present.

Cotalpa lanigera Linn. (Pl. XXXIV, Fig. 9).

Epipharynx. The labrum is deeply indented and is shoved far under the clypeus. The epipharynx is almost entirely corneous; only its median area is membranous and entirely covered with stiff hairs. No sensory structures of any kind could be found. Neither the mandibles nor the maxillae show any striking peculiarity, and they need not be discussed.

Labial structures. The mentum is shorter than in *Anomala;* its position, dorsad from the sub-mentum, is not apparent when examined from beneath. A fusion has evidently taken place here between the mentum and the distal edge of the sub-mentum, not even a suture indicating the place of fusion. A lateral view of the labial structures discloses the true condition of affairs; the separation between mentum and sub-mentum is then plainly shown, and the palpi are seen to arise dorsad from the sub-mentum.

Cyclocephala immaculata Oliv. (Pl. XXXIII, Figs. 77-79; Pl. XXXIV, Fig. 10).

Epipharynx (Fig. 77). This is short, entirely corneous, and does not show any sensory structures. The usual lateral rows of hairs enclosing a V-shaped area are still present. The epipharynx is thus very much reduced and apparently functionless.

Mandibles (Fig. 78). These show a considerable difference in form from those in the preceding species of this group. The molar is small and not strongly chitinized; the galea is narrow and does not as usual end in a tooth, but is flat and thin at its extremity. This gives the whole mandible a somewhat elongated appearance. The lacinia is prominent and thickly covered on its inner edge with moderately long hairs.

Maxillae (Fig. 79). These are elongated and slender. The galea is somewhat quadrangular in shape, covered with numerous thin, long hairs, and its distal edge bears small, irregular teeth. The cardo is no longer triangular as in the preceding species of this group, but has become elongated and club-shaped.

Labial structures (Pl. XXXIV, Fig. 10). The posterior plate of the sub-mentum is short and transverse; the anterior plate is long; its lateral edges are slightly convex and converge anteriorly. The mentum is pushed in for a considerable distance over the sub-mentum, is broader than its distal part, and has its lateral edges converging posteriorly.

Ligyrus gibbosus De G. (Pl. XXXIII, Figs. 80-82; Pl. XXXIV, Fig. 11).

Epipharynx (Fig. 80). At first sight this organ appears totally different from those already described for other species. Its anterior part is entirely corneous, the chitinization extending backward for some distance along the median line. Instead of the usual lateral row of hairs converging posteriorly, we find that in this species the entire lateral portion of the chitinous area is covered with moderately long, pointed hairs which show no definite arrangement. The chitinous portion is followed caudad by a membranous part, which is densely covered with what seem to be short, conical papillae. Whether these are sense-papillae or merely abortive hairs I cannot with certainty decide. The anterior edge of the epipharynx is thickly beset with long, thin, cylindrical hairs.

Mandibles (Fig. 81). These are short and strongly chitinized. The molar is small and smooth and has undergone a great reduction. The galea is broad; its terminal expansion shows a rounded tooth. Below this tooth we find on the inner edge of the galea a tuft of hairs such as is usually found in the lacinia; this seems to indicate that in this species a part of the horny terminal expansion of the mandibles was formed by the lacinia.

Maxillae (Fig. 82). These are similar in shape to those of *Cyclocephala* except that they are somewhat shorter; the galea is more nearly triangular and ends in two short teeth of equal length. The entire organ is covered with moderately long, stiff hairs.

Labial structures (Pl. XXXIV, Fig. 11). The posterior plate of the sub-mentum is small and transverse; the anterior plate is elongated and narrows anteriorly. Its sides are slightly convex; its lateral edges are turned inward, and its front edge is deeply notched. The mentum is pushed in over the sub-mentum for a considerable distance, and, being broader than the anterior part of the sub-mentum, it can be seen projecting over its front and lateral edges. The mentum narrows posteriorly and is forked at its caudal end; these two prongs extend backwards and their lateral edges join the turned-in sides of the sub-mentum; a cavity is thus formed, the opening of which is dorsad; ventrally it is bounded by the sub-mentum, whose turned-in edges also enclose the cavity laterally and in part dorsally. As already mentioned, these turned-in edges of the sub-mentum form the boundary of the opening of the cavity, excepting the anterior margin which is bounded by the mentum; in this space the fulcrum hypopharyngeum is imbedded. No trace of a sensory hypopharynx was found.

Xylorectes satyrus Fab. (Pl. XXXIII, Figs. 83-86).

Epipharynx (Fig. 83). In this species we find the epipharynx as a free fold of the roof of the mouth. It is somewhat triangular in shape with convex sides, and its lateral portions are densely covered with long, sharply pointed hairs; but a median area extending the entire length of the organ is left uncovered, suggesting the presence of a sensory apparatus of some kind on this area. Nothing could be found, however, which might be credited with any sensory function.

Mandibles (Fig. 84). The molar is much reduced; the galea is broad, terminating in two short, blunt teeth, and has a row of stiff, pointed hairs along its outer edge. The lacinia is comparatively large, but in this species there is no indication that it contributes to the formation of the terminal blade of the mandible.

Maxillae (Fig. 85). These are similar in shape to those of *Ligyrus*. The galea has become triangular, the outer of the two apical teeth being much elongated and sharply pointed.

Labial structures (Fig. 86). The posterior and anterior plates of the sub-mentum differ greatly in size, the former being short and transverse, the latter large, broad and greatly narrowed anteriorly. The comparatively small mentum is entirely pushed in over the sub-mentum and is covered with long, pointed hairs similar in shape to those found on the epipharynx. Its relations to the sub-mentum are like those described for *Ligyrus*.

Allorhina nitida Linn. (Pl. XXXIII, Figs. 87-90).

Epipharynx (Fig. 87). This is entirely corneous and shows the characteristic lateral rows of hairs converging posteriorly. Three or four rows have been added to these and cover nearly the entire lateral area. In the enclosed V-shaped median area we find a few sense-papillae and in front of these a tuft of hairs similar to those on the lateral portions of the epipharynx.

Mandibles (Fig. 88). These are very similar to those described for *Cyclocephala;* the molar is small, the galea long, flat and narrow, and the lacinia broad. They show an approach in form to the mandibles found in *Euphoria*.

Maxillae (Fig. 89). These are elongated like the mandibles; the galea is no longer toothed but becomes hairy; the lacinia is more prominent and is furnished at its inner edge with a row of stiff hairs.

Labial structures (Fig. 90). The mentum is larger and broader than the anterior plate of the sub-mentum and is pushed in over it for a considerable distance. Its front and the lateral chitinized edges are turned inward, and the latter bear several lateral rows of hairs, but no sense-cups. An additional tuft of smaller hairs is found on the anterior median area.

Euphoria inda Linn. (Figs. 91-94). This insect may be considered as the type of the pollen-eating forms. Its mouthparts are greatly reduced both in size and in amount of chitinization.

Epipharynx (Fig. 91). This is very similar in structure to that of *Ligyrus,* being entirely chitinous and having its anterior edge beset with long, cylindrical hairs. Its sides are strongly convex; the anterior edge is concave; laterally it is covered with numerous pointed hairs which gradually pass over into short, conical papillae covering the posterior part of the epipharynx. The median area is not entirely smooth as in *Ligyrus,* but bears an isolated tuft of hairs near its anterior edge.

Mandibles (Fig. 92). The galea is long, slender, slightly chitinized and ends in a membranous plate; the lacinia is broad, not at all chitinous, and has a fringe of thickly crowded, soft hairs along its inner margin. A molar can still be distinguished, but it is rudimentary.

Maxillae (Fig. 93). These are long, slender and but slightly chitinized. The four-segmented palpi are short and stout; the terminal joint of each is nearly as long as the other three combined. The most striking feature of the maxillae is the covering of long, stiff, thickly crowded hairs with which the galea and the tip of the lacinia are provided; they are used as brushes for collecting pollen.

Labial structures (Fig. 94). The mentum is pushed in far over the flask-shaped sub-mentum, and being considerably broader than this sclerite, can be seen projecting over its front and lateral edges. The palpi, like those of the maxillae, are comparatively short, with a large, club-shaped terminal segment. The sub-mentum is sparsely clothed with long, pointed hairs, similar ones arising from the inner surface of the mentum. A distinct hypopharynx is not present; only a few sense-papillae are scattered over the mentum.

Osmoderma scabra Beauv. (Fig. 95). The mouth-parts of this insect are remarkably small in comparison with the size of its body and lie entirely concealed under the clypeus. They show a very great resemblance to those of the preceding species, both in actual size and in structure. The epipharynx alone shows a notable difference, approaching in its structure that of *Allorhina nitida.* We find two conspicuous lateral rows of hairs, which, converging posteriorly, enclose a V-shaped area; the posterior portion of this area is covered with sense-cups, and near the anterior edge a tuft of sharply pointed hairs is borne.

Trichius piger Fab. (Pl. XXXIII, Figs. 96-99).

Epipharynx (Fig. 96). This organ has assumed an appearance like that of *Copris;* it is again a free fold of the roof of the mouth, and in the arrangement of its hairs and sense-papillae it reminds one of the epipharynx of the dung-beetles. Thin, slightly curved hairs cover the lateral portions, the sense-papillae being crowded together in a median club-shaped area.

Mandibles (Fig. 97). The galea and the lacinia are of the type common to the pollen-feeding group, but the molar is more strongly developed and ridged.

Maxillae (Fig. 98). These resemble in general the type described for *Euphoria,* but the long, stiff hairs which cover galea and lacinia in that species have been replaced by a short fringe of fine hairs.

Labial structures (Fig. 99). The mentum is comparatively large and has its anterior edge deeply indented. In correlation with a greater development of the sense of taste, as shown by the structure of the epipharynx, we should naturally expect to find a corresponding increase in the sense-organs of the labial structure. This is the case; the entire dorsal surface of the mentum is covered with sense-papillae, and every vestige of hairs has disappeared. The absence of pollen-gathering hairs on the maxilla, the more highly developed sense-organs, and the more prominent molar of the mandibles, all point toward a difference in food habits between this and other members of the same group, this species not living entirely on pollen but in part on the flowers themselves.

Valgus squamiger Beauv. (Pl. XXXIII, Figs. 100-102). Although nothing could be learned about the food-habits of this, the last member of the series, its mouth-parts show that it is a true pollen-eating species.

The *epipharynx* (Fig. 100) shows the long, stiff, pollen-gathering hairs covering its lateral portions, while in the median area posterior to them are situated a small number of sense-cups.

The *mandibles* (Fig. 101) here also show a rudimentary molar, a conspicuous lacinia and a slender, slightly chitinized galea, the tip of which is membranous and is fringed with short, soft hairs.

The *maxillae* (Fig. 102) are shorter than those found in *Euphoria,* with the palpi stronger and more prominent. The galea and the lacinia are very thickly covered with long, stiff hairs for gathering pollen.

The *labial structures* are essentially the same as those described for *Euphoria* and need no special discussion.

Summary and Conclusions.

The present study of the mouth-parts of the Scarabaeidae has brought out many points of interest, some of which may be discussed under the following headings:

I. Division of the order into groups, and the general characteristics of the mouth-parts in each;

II. The evolution shown throughout the order from types which are morphologically lower but which functionally show a higher specialization, to those in which these two conditions are exactly reversed.

I.

The trophi of the Scarabaeidae show a remarkable adaptation even to slight differences in food habits. In no other order of the Coleoptera do we find so great an amount of variation, and even slight, comparatively recent changes in habits, when once established, are followed by a decided modification of the mouth-parts. (Compare *Aphodius fimetarius* and *A. granarius*).

Comstock (2) divides the order into two great groups, the scavengers and the leaf-chafers, each of which is further subdivided. This grouping is based entirely upon habits and general external appearance, and, as might be expected, closely corresponds with a division based upon the form and development of the trophi. The arrangement given by Comstock is as follows:

1. *The Lamellicorn Scavengers*
    - A. The Tumble-bugs
    - B. The Aphodian Dung-beetles
    - C. The Earth-boring Dung-beetles
    - D. The Skin-beetles
2. *The Lamellicorn Leaf-chafers*
    - A. The May-beetles or June-bugs
    - B. The Rose-bugs
    - C. The Shining Leaf-chafers
    - D. The Rhinoceros-beetles
    - E. The Flower-beetles

These may be taken up in the above order.

1. *The Scavengers.* These live either in dung or on decaying animal matter, their mouth-parts showing in general the following characteristics:

a. A well developed gustatory sense, which is represented by the more or less prominent epipharyngeal and hypopharyngeal structures.

b. Mandibles which show distinctly their origin from a number of segments, and are characterized by the presence of a distinct conjunctivus.

c. Maxillae in which the galea is somewhat quadrangular, usually membranous, and thickly clothed with fine hairs.

d. Labial structures which show both the outer and inner lobes present but generally fused, those of the one side separate from and not fused with those of the other side.

e. A mentum which with its palpigers is turned over on the sub-mentum, so that the palpi seem to arise above (dorsad from) the sub-mentum.

f. A sub-mentum, consisting of an anterior, smaller, and a posterior, larger, plate.

The scavengers are sub-divided into four groups:

A. The tumble-bugs (*Canthon, Copris, Choeridium, Onthophagus, Phanaeus*).

B. The Aphodian dung-beetles (*Aphodius*).

C. The earth-boring dung-beetles (*Bradycinctus, Bolboceras, Cloeotes, Geotrupes*).

D. The skin-beetles (*Trox*).

Of these four groups, the Aphodians are not entitled by the shape of their mouth-parts to separate rank, but should be included in the first group with the tumble-bugs.

This group (A and B) would then be characterized by:

a. A large epipharynx which is attached to the under side of the clypeus by a more or less prominent supporting arch, and in which the gustatory area forms a median club-shaped thickening (broadening posteriorly in the Aphodians) bounded laterally by one row of tactile hairs, which fringe the edges of the turned-in lateral parts.

b. Mandibles which show a well developed, ridged molar, a leaf-like membranous galea with fringed edge, a long, membranous lacinia and a conspicuous conjunctivus.

c. Maxillae in which the galea is sub-quadrangular, thickly clothed with fine hairs (as is also the lacinia), and is connected to the sub-galea by a conspicuous, V-shaped, chitinous rod, which may represent the proximal segment of the galea.

d. A distinct hypopharynx with labial lobes, the outer lobe of which is slightly chitinized and fused with the more or less hairy, membranous inner one, the suture being indicated by a conspicuous row of hairs.

C. The earth-boring dung-beetles show a deviation in the following organs:

a. The epipharynx is chitinized and attached to the labrum along its entire anterior and lateral margins; the arrangement of its hairs and sense-papillae is less definite and regular.

b. The mandibles become more chitinized and end in one or more sharp teeth; the proximal one is formed by the lacinia, which is partly chitinized and partly membranous. The conjunctivus, which is still conspicuous in *Geotrupes,* becomes more and more obscured, and has almost entirely disappeared in *Bradycinctus ferrugineus* (compare Figs. 39, 49). The molars are reduced in size.

c. The maxillae show a change in both galea and lacinia; the mass of fine hairs disappears and is replaced by a few stouter ones, the parts becoming slightly more chitinized and toothed.

d. The mentum becomes chitinized at its front edge, and a fusion of the lobes along the median line is here first noticeable. With this fusion goes a reduction of the hypopharynx.

D. The skin-beetles. In this group the entire set of trophi has become more strongly chitinized and armed with stiff hairs adapted for brushing and scraping. The group is represented by one genus, *Trox* (Figs. 48-51).

a. The epipharynx is no longer a separate fold; it shows a distinct reduction in size; the front and lateral edges of the labrum are turned in, enclosing a space which is covered by a membrane, the epipharynx.

b. The mandibles have become so thoroughly chitinized as to obscure their segmentation; the maxillae show a greater development of the teeth on galea and lacinia.

c. The labium shows a decided reduction in hypopharyngeal structures, and the labial lobes have fused along the median line to form one broad plate.

2. *The Leaf-chafers.* These are all herbivorous, and we should naturally not expect to find a great difference in mouthparts between members of the group. Comstock (2) divides

the leaf-chafers into several minor divisions which, though sharply separated by their external appearance, have similar habits, so that the mouth-parts do not show such a distinct division. We can distinguish only two groups, the leaf-chafers proper (A and C), and the pollen-eating forms (D); the rose-bugs (B), which live on the petals of flowers, form an intermediate group.

The leaf-chafers proper (*Hoplia, Dichelonycha, Diplotaxis, Lachnosterna, Anomala, Pelidnota, Cotalpa, Cyclocephala, Ligyrus, Xylorectes*) show in their mouth-parts the following characteristics:

a. The epipharynx shows a considerable modification; in the first members of the group it has a membranous median area, which changes gradually until in the last member it has become entirely chitinized. With this increased chitinization goes a corresponding decrease in the development of the sensory apparatus.

b. The mandibles show a great development of the molar, and the galea usually ends in strongly chitinized teeth. The lacinia is correspondingly reduced and represented by a fringe of hairs, extending from the base of the apical teeth to the molar.

c. The labial structures are decidedly different from those of the scavengers. The mentum is pushed in over the submentum; the inner labial lobes are very much reduced or wanting; the hypopharynx has entirely disappeared, and the anterior and posterior plates of the sub-mentum are nearly equal in size.

In group D, the flower-beetles (*Euphoria, Allorhina, Osmoderma, Trichius, Valgus*), the mouth-parts again become less chitinized and are covered with long, stiff hairs for collecting pollen.

a. The epipharynx becomes more specialized and prominent, and in some species again forms a free fold of the roof of the mouth.

b. The molar is much reduced in the mandible, which has both galea and lacinia long and slender, the former ending in a leaf-like expansion, often membranous; in the last member of the series (*Valgus*), the galea again ends in a hairy fringe. Thus this group, both in the greater development of the epipharynx and in the shape of the mandibles, betrays a similarity to the *Copris*-like forms, a similarity which would seem to indicate a close relationship.

c. In the labial structures, however, there is shown a further development of the relations which exist in the preceding group (the leaf-chafers). The mentum has been pushed in still further over the sub-mentum, and the anterior plate of this sclerite has now become larger than the posterior one.

II.

Tracing the modifications within the order of the various organs in question, the following changes may be noted:

Epipharynx. This organ is conspicuous in the *Copris*-beetles, in which it forms a highly specialized structure clearly showing its origin as a fold of the membranous roof of the mouth. Its attachment is at first far back at the caudal edge of the supporting arch, the latter being a stiff, chitinous structure, which is here necessary to support the large, projecting organ. The place of attachment moves forward, and, as the free, projecting part of the epipharynx becomes shorter and shorter, a strong supporting arch becomes unnecessary and disappears. At last the place of attachment has reached the front edge of the labrum, whose under surface is now formed by the epipharynx. An increase in chitinization now occurs, which, beginning at the front and lateral edges, proceeds inward, making the membranous part smaller and smaller until the whole epipharynx is chitinized (as in the leaf-chafers). With an increased chitinization goes a corresponding decrease in function; the sensory apparatus becomes less and less pronounced, until in the leaf-chafers it has entirely disappeared.

In the flower-beetles we again see an increase in the development of the epipharynx, the reappearance taking place in the reverse order; that is, the sense-papillae, which were the last to disappear, are the first to reappear, followed by a decrease in chitinization until in *Trichius* we again find a free projecting epipharynx which shows in its general shape and the distribution of its sense-papillae and hairs a close resemblance to that of the *Copris*-beetles. That the gustatory sense is here more highly developed than in the typical pollen-eating forms may possibly be explained by the habits of the insect; it is said that it dives deep into the flower and eats the soft inner part; possibly the fact that the nectaries form part of its food may account for the greater development of the gustatory sense in this insect.

Mandibles. In the *Copris*-beetles we find the mandibles composed of a number of sclerites, the molars well developed, that of the left mandible concave, that of the right convex. The galea is membranous with a fringed edge; the lacinia is well developed, with a distinct conjunctivus. At the junction the conjunctivus bears a tuft of hairs, different in shape from those which fringe the edge of the lacinia. Subsequently the lacinia becomes longer until it nearly attains the tip of the galea. The galea now becomes more chitinized, its fringe disappears and is replaced by one or more chitinous teeth. This chitinization also involves the outer margin of the lacinia, and this sclerite, at least in some cases (as in *Geotrupes*), takes part in the formation of the tooth or teeth of the mandible. As chitinization proceeds further, the hairy fringe indicating the position of the lacinia becomes shorter and the conjunctivus less prominent, until at last neither can be distinguished, and there is only a whorl of hairs between the molar and the chitinized, toothed part of the mandible. This whorl of hairs, which is generally conspicuous, indicates the place of junction between the original lacinia and conjunctivus. The lacinia evidently becomes chitinized and fuses with the galea, forming part of the teeth. This is the condition in *Trox* and the leaf-chafers, for here strong mandibles are needed for cutting and grinding tough material. Coming to the flower-beetles, a reduction in chitinization is found; the molars become smaller; the galea becomes long and membranous at the tip, the lacinia broad and entirely membranous. In some cases this membranous lacinia shows a weak tooth differentiated at its apex, which, being of no use, seems to prove that it did form part of the toothed end of the mandible which has now become membranous. In *Trichius,* again, the tip of the galea becomes fringed at the edge. This insect thus shows, in the shape of its mandibles, as in its epipharynx, a resemblance to the *Copris*-beetles; but the absence of a well developed molar and of a conjunctivus shows that it is not closely related to them, belonging rather at the end of the series.

Maxillae. These are merely accessory organs, used for passing the food seized by the mandibles on into the mouth, and also for adjusting it between the molars; acting somewhat like the tongue in vertebrate animals. They do not, therefore, show a great amount of variation, only following the mandibles in a general way in the greater or smaller amount of chitinization and armature. In the pollen-eating forms they are clothed with long, stiff brushes.

Labial structures. These show a very interesting series in development. In the *Copris*-beetles, the mentum is turned back over the sub-mentum, so that the palpigers and lobes arise from its dorsal surface. Normally the appendages arise from the ventral surface of the mentum, the origin of the lobes being in front of the palpigers; but on account of the abnormal relation which is here shown in the position of these parts, the appendages now arise from the dorsal surface; the palpigers are in front of the origin of the lobes. The mentum itself is membranous, and the lobes are comparatively distinct; the galea and lacinia borne by each half of the labium are fused; the structures formed on each side by this fusion are separate except at their posterior ends, at which part the hypopharynx arises as a distinct median organ. The hypopharynx disappears, its function being taken over by the posterior parts of the inner lobes, which begin to fuse along the median line. This fusion advances until the lobes form a single plate (showing in some cases remnants of the inner lobes as a dorsad projection), and the sensory structures, representing the hypopharynx, disappear. This is the condition in *Trox*. In the leaf-chafers appears a new displacement of the mentum; it is at first pushed slightly inward over the sub-mentum, a condition which later becomes more pronounced. This movement may continue so far that in extreme cases the mentum is entirely pushed inward and the sub-mentum projects in front. The hypopharynx has now entirely disappeared, and the mentum consists of one plate formed by the fusion of the labial lobes and the mentum proper. The palpigers and palpi arise from its ventral surface, between the mentum and the sub-mentum. The front and lateral edges of the mentum become chitinized and are turned inward, forming a structure similar to that found in the epipharynx. The lateral edges of the sub-mentum are curved inward and joined to the edges of the mentum. Lastly, the anterior edge of the sub-mentum fuses with the mentum where this overlaps it, and at this stage only a lateral view of the structures shows the true state of affairs. These are the conditions in the leaf-chafers.

In the flower-beetles the sense of taste shows a greater development, and, although the members of this group approach in their epipharyngeal structure to the *Copris* type, their labial structures remain in their relative position practically unchanged. No hypopharynx is developed, but taste-cups appear on the inner surface of the labium.

The *sub-mentum* also shows a progressive series of changes. When in the Coprini both plates are distinct, the anterior is smaller than the posterior. This difference in size becomes less pronounced, until at the beginning of the leaf-chafer series both plates are of equal size. From this point on the anterior plate increases in size, so that in the flower-beetles the original conditions are reversed and the anterior plate is large, tapering toward its distal end, while the posterior plate forms a small transverse sclerite between it and the gula.

Zoological Laboratory, University of
Wisconsin, June 1905.

BIBLIOGRAPHY.

1. Comstock, J. H.: An introduction to entomology.—1888.
2. Comstock, J. H.: A manual for the study of insects.—1888.
3. Kadic, Otokar: Studien über das Labium der Coleopteren.—1901.
4. Kirby, W., and Spence, W.: An introduction to entomology.—1898.
5. Kolbe, H. J.: Einführung in die Kenntniss der Insekten.—1893.
6. Leconte, John L., and Horn, George H.: Classification of the Coleoptera of North America.—1883.
7. Packard, A. S.: A textbook of entomology.
8. Smith, John B.: The mouth-parts of *Copris carolina*, with notes on the homologies of the mandibles. *Trans. Am. Ent. Soc.*, xix: 83—1882.

The bibliography is very incomplete, as I have not had access to a number of papers on the subjects here treated.

EXPLANATION OF PLATES.

ABBREVIATIONS.

ep. .... epipharynx.
s. a. .... supporting arch.
max. .... maxilla.
gal. .... galea.
sub. gal. .... sub-galea.
lac. .... lacinia.
st. .... stipes.
m. .... molar.
conj. .... conjunctivus.
m. p. .... maxillary palp.
l. p. .... labial palp.
p. f. .... palpifer.
p. g. .... palpiger.
ment. .... mentum.
s. m. .... sub-mentum.
a. p. .... anterior plate of the sub-mentum.
p. p. .... posterior plate of the sub-mentum.
g. .... gula.
fulc. hyp. .... fulcrum hypopharyngeum.
hyp. .... hypopharynx.
i. l. .... inner lobe of the labium.
o. l. .... outer lobe of the labium.

PLATE XXX.

EXPLANATION OF PLATE XXX.

Fig. 1. *Copris carolina* Linn.: epipharynx (× 15).

Fig. 2. *Copris carolina* Linn.: mandible (× 15).

Fig. 3. *Copris carolina* Linn.: part of mandible, with lacinia and conjunctivus (and with part of the galea attached), to show their connection (× 15).

Fig. 4. *Copris carolina* Linn.: tip of mandible, showing the fringed edge of the galea (×50).

Fig. 5. *Copris carolina* Linn.: maxilla (× 50).

Fig. 6. *Copris carolina* Linn.: labial structures, ventral view (× 15). The posterior plate of the sub-mentum is not separated from the gula.

Fig. 7. *Copris carolina* Linn.: hypopharynx and proximal part of labial lobes, showing the chitinous teeth (× 50).

Fig. 9. *Copris anaglypticus* Say: epipharynx (× 15).

Fig. 10. *Copris anaglypticus* Say: mandible (×15), showing again distinctly the connection between lacinia and conjunctivus.

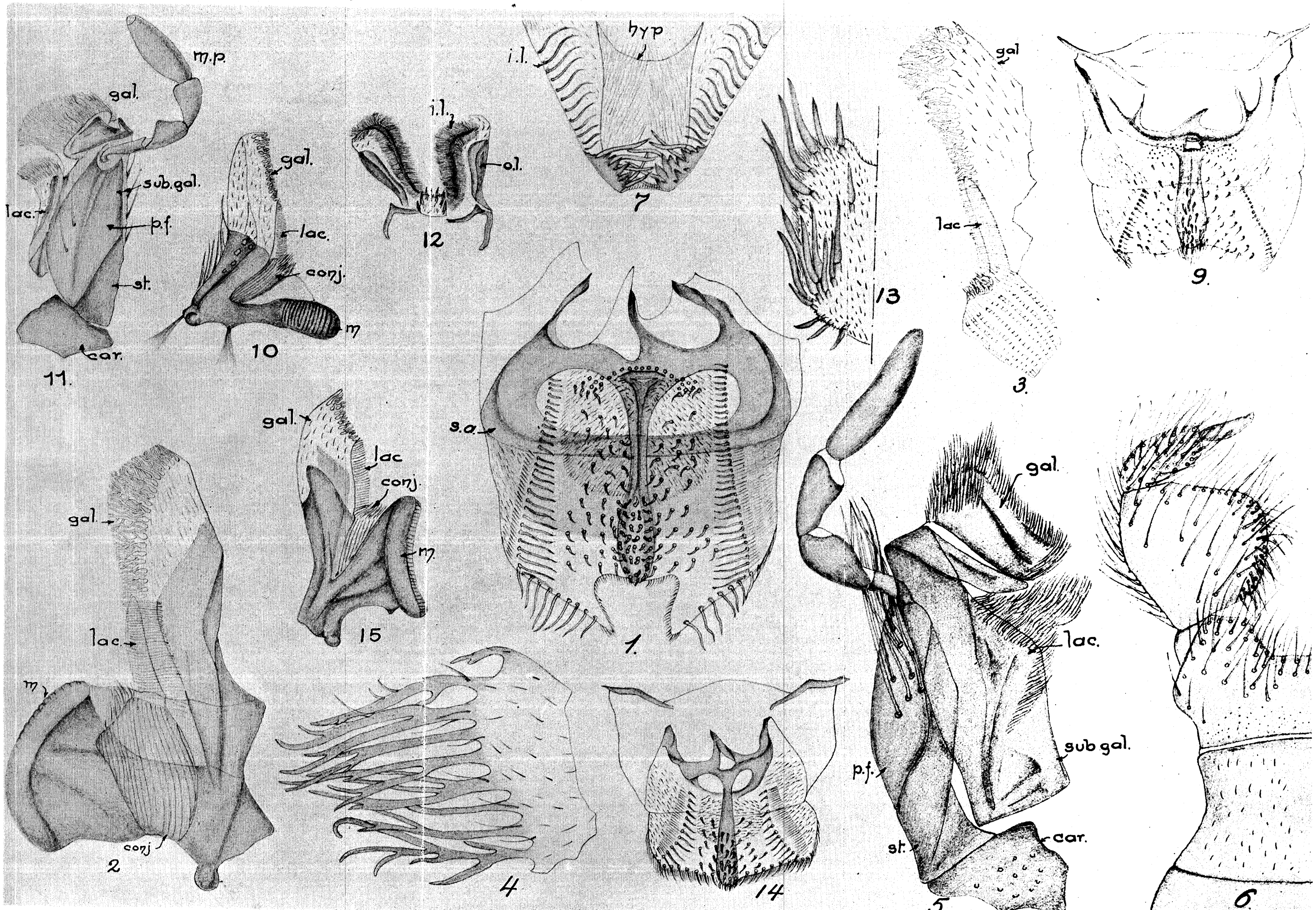
Fig. 11. *Copris anaglypticus* Say: maxilla (× 15).

Fig. 12. *Copris anaglypticus* Say: labial lobes and hypopharynx.

Fig. 13. *Copris anaglypticus* Say: left half of hypopharynx, showing its two-jointed hairs (× 50).

Fig. 14. *Canthon laevis* Drury: epipharynx (× 15).

Fig. 15. *Canthon laevis* Drury: mandibles (× 15).



C. B. Hardenberg del.

PLATE XXXI.

EXPLANATION OF PLATE XXXI.

Fig. 16. *Canthon laevis* Drury: hypopharynx and labial lobes of right side (× 50). The twisted distal end of the inner lobe is peculiar to this genus.

Fig. 17. *Choeridium histeroides* Web.: hypopharynx and proximal end of lobes of right side, showing the three chitinous teeth at the proximal end of the inner lobe (× 150).

Fig. 18. *Pleurophorus caesus* Panz.: ephipharynx (× 208). The median chitinous area has entirely disappeared.

Fig. 19. *Pleurophorus caesus* Panz.: mandible (× 208).

Fig. 20. *Pleurophorus caesus* Panz.: maxilla (× 208), the distal part of the palpus not shown.

Fig. 21. *Pleurophorus caesus* Panz.: labial structures (× 208), showing the peculiar shape of the inner lobes.

Fig. 22. *Phanaeus carnifex* Linn.: hypopharynx and labial lobes of right side (× 50), showing the peculiar armature of the proximal end of the inner lobes.

Fig. 23. *Onthophagus hecate* Panz.; epipharynx (× 50).

Fig. 24. *Onthophagus hecate* Panz.: mandible (× 50).

Fig. 25. *Onthophagus hecate* Panz.: maxilla (× 50). The distal part of the palpus has been omitted.

Fig. 26. *Onthophagus hecate* Panz.: hypopharynx and labial lobes of right side (× 67).

Fig. 27. *Aphodius fimetarius* Linn.: epipharynx (× 50). Notice the broad, chitinized median area.

Fig. 28. *Aphodius fimetarius* Linn.: hypopharynx and labial lobes of right side (× 150).

Fig. 29. *Aphodius granarius* Linn.: epipharynx (× 150).

Fig. 30. *Aphodius granarius* Linn.: mandible (× 150).

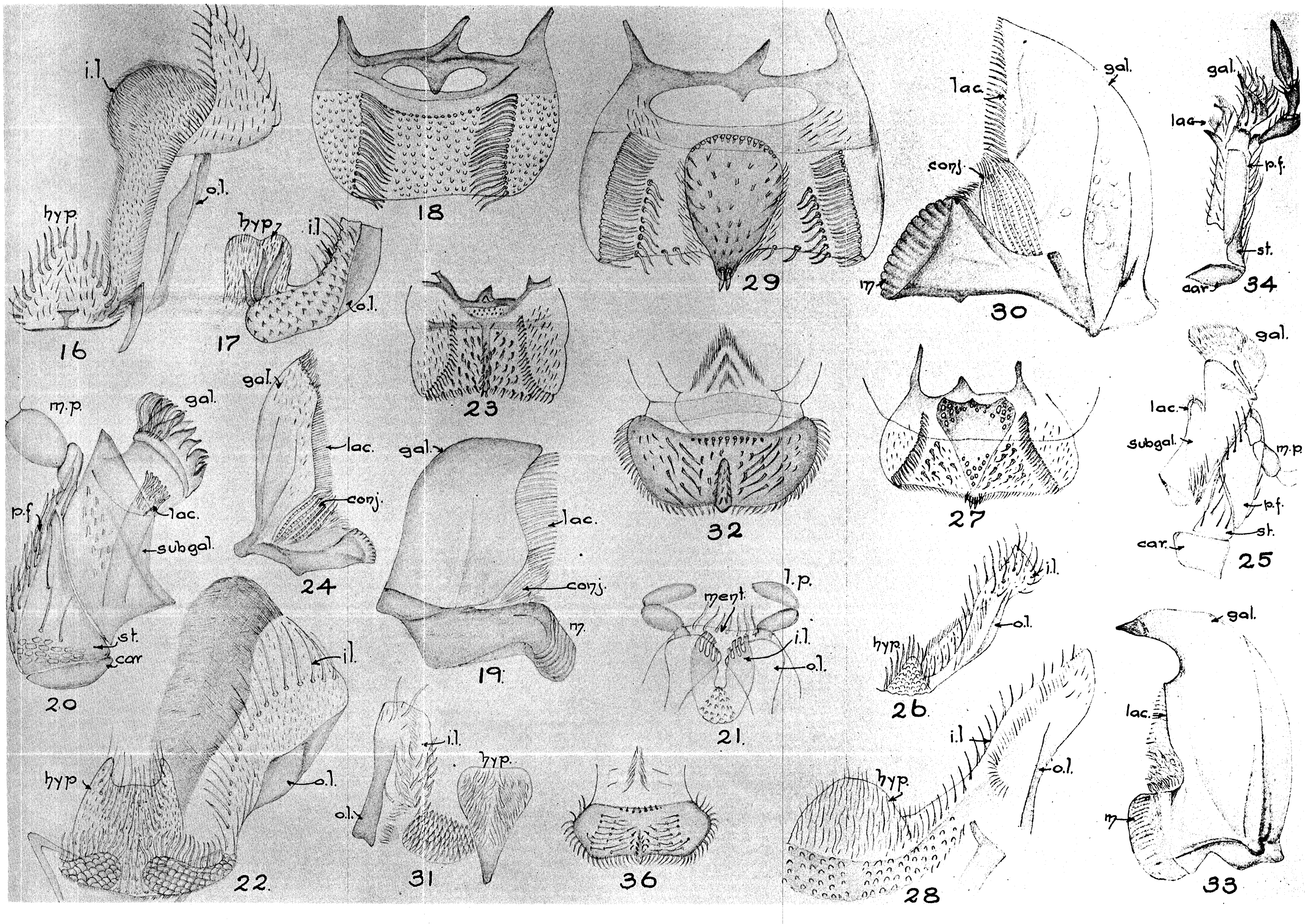
Fig. 31. *Aphodius granarius* Linn.: hypopharynx and labial lobes of left side (× 150).

Fig. 32. *Bradycinctus ferrugineus* Burm.: epipharynx (× 15).

Fig. 33. *Bradycinctus ferrugineus* Burm.: mandible (× 15).

Fig. 34. *Bradycinctus ferrugineus* Burm.: maxilla (× 15), showing the presence of a "digitus" on the lacinia.

Fig. 36. *Bolboceras farctus* Fab.: epipharynx (× 15).



C. B. Hardenberg del.

PLATE XXXII.

EXPLANATION OF PLATE XXXII.

Fig. 35. *Bradycinctus ferrugineus* Burm.: labial structures (× 15).

Fig. 37. *Bolboceras farctus* Fab.: mandible (× 15).

Fig. 38. *Bolboceras farctus* Fab.: labium (× 50), showing the rudiments of the inner lobes.

Fig. 39. *Bolboceras lazarus* Fab.: epipharynx (×15).

Fig. 40. *Bolboceras lazarus* Fab.: mandible (× 15).

Fig. 41. *Geotrupes egeriei* Germ.: epipharynx (× 15).

Fig. 42. *Geotrupes egeriei* Germ.: mandible (× 15), showing the well developed conjunctivus, and the lacinia forming one of the teeth of the mandible.

Fig. 43. *Geotrupes egeriei* Germ.; maxilla (× 15).

Fig. 44. *Geotrupes egeriei* Germ.: hypopharynx and labial lobes (× 15).

Fig. 45. *Geotrupes egeriei* Germ.: hypopharynx and proximal part of inner lobes (× 50).

Fig. 46. *Cloeotes aphodioides* Ill.: epipharynx (× 50).

Fig. 47. *Cloeotes aphodioides* Ill.: mandible (× 50).

Fig. 48. *Trox scutellaris* Say: epipharynx (×15), showing the beginning of chitinization from the edges inward.

Fig. 49. *Trox scutellaris* Say: mandible (× 15); the lacinia greatly reduced, molar absent, and the place of the conjunctivus indicated by a whorl of hairs.

Fig. 50. *Trox scutellaris* Say: maxilla (×15).

Fig. 51. *Trox scutellaris* Say: labial structures (× 50). The hypopharynx has entirely disappeared.

Fig. 52. *Hoplia trifasciata* Say: epipharynx (× 50), showing the progressive chitinization from the edges inward (compare Fig. 48).

Fig. 53. *Hoplia trifasciata* Say: mandible (× 50).

Fig. 54. *Hoplia trifasciata* Say: labial structures (× 50); entire disappearance of hypopharynx and labial lobes; and a beginning of chitinization at the edges, similar to the process going on in the epipharynx.

Fig. 55. *Dichelonycha elongata* Fab.: epipharynx (× 50).

Fig. 56. *Dichelonycha elongata* Fab.: mandible (× 50).

Fig. 57. *Dichelonycha elongata* Fab.: maxilla (× 50). Part of the palpus is not shown.

Fig. 58. *Dichelonycha elongata* Fab.: labial structures (× 50).

Fig. 59. *Serica sericea* Ill.: epipharynx and labrum (× 15).

Fig. 60. *Serica sericea* Ill.: epipharynx (× 50), showing reduced sensory area.

Fig. 61. *Serica sericea* Ill.: mandible (× 15). The tooth is formed entirely by the lacinia.

Fig. 62. *Serica sericea* Ill.: maxilla (× 50).

Fig. 63. *Serica sericea* Ill.: labial structures (× 15).

Fig. 64. *Macrodactylus subspinosus* Fab.: epipharynx (× 50).

Fig. 65. *Macrodactylus subspinosus* Fab.: mandible (× 50).

Fig. 66. *Macrodactylus subspinosus* Fab.: maxilla (× 50).

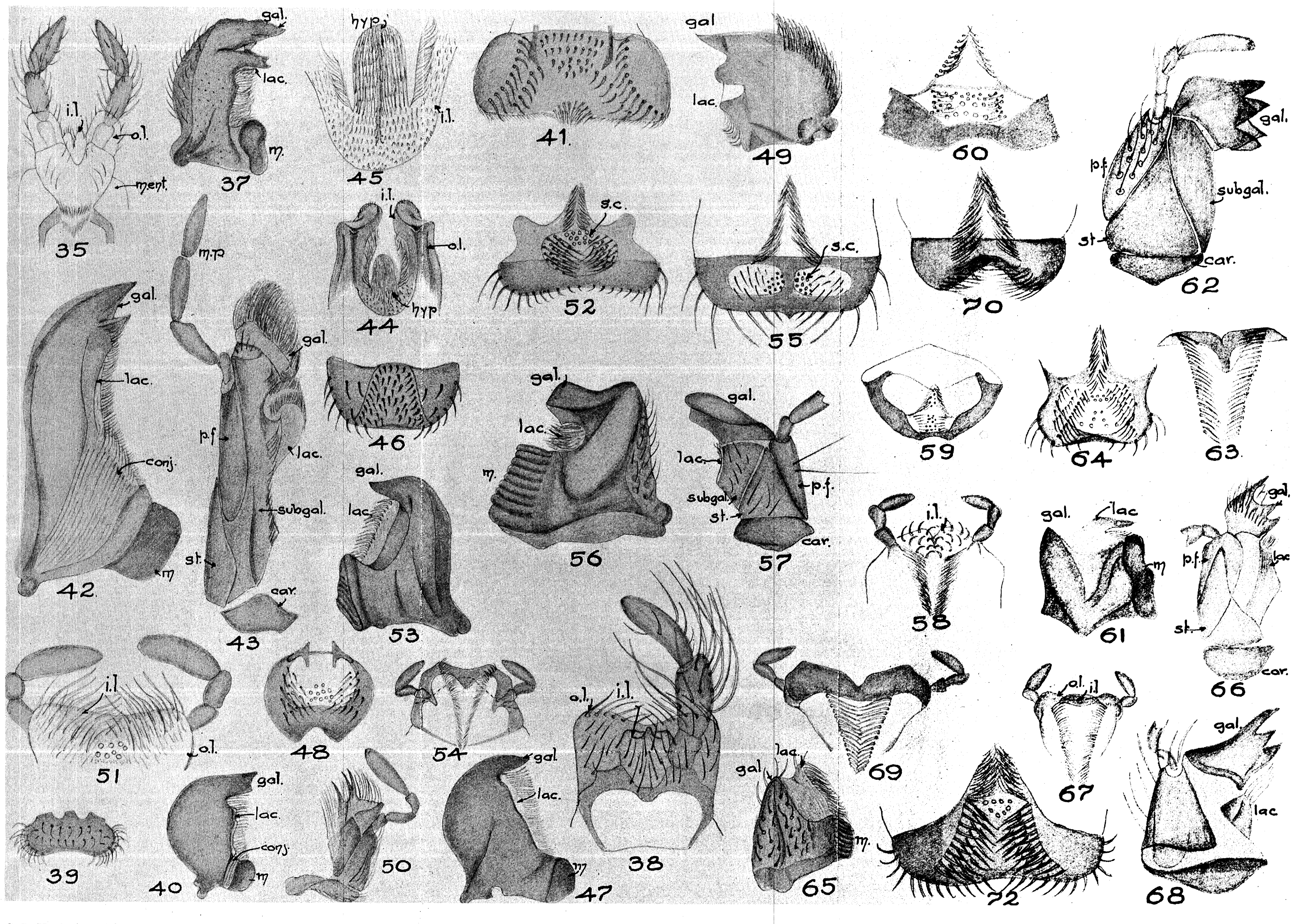
Fig. 67. *Macrodactylus subspinosus* Fab.: labial structures (× 50), showing rudiments of the inner lobes.

Fig. 68. *Diplotaxis sordida* Say: maxilla (× 50).

Fig. 69. *Diplotaxis sordida* Say: labial structures (× 50).

Fig. 70. *Lachnosterna fusca* Fröh.: labrum (× 15), showing rudiments of epipharynx.

Fig. 72. *Anomala minuta* Burm.: epipharynx (× 50).



C. B. Hardenberg del.

PLATE XXXIII.

EXPLANATION OF PLATE XXXIII.

Fig. 71. *Lachnosterna fusca* Fröh.: labial structures (× 15). Anterior and posterior plates of the sub-mentum are of about equal size.

Fig. 73. *Anomala minuta* Burm.: mandible (× 50).

Fig. 74. *Anomala minuta* Burm.: labial structures (× 50); semi-diagrammatic; the anterior plate of the sub-mentum is larger than the posterior plate.

Fig. 75. *Pelidnota punctata* Linn.: labrum-epipharynx (× 15).

Fig. 76. *Pelidnota punctata* Linn.: mandible.

Fig. 77. *Cyclocephala immaculata* Oliv.: labrum-epipharynx (× 15).

Fig. 78. *Cyclocephala immaculata* Oliv.: mandible (× 15).

Fig. 79. *Cyclocephala immaculata* Oliv.: maxilla (× 15).

Fig. 80. *Ligyrus gibbosus* De G.: labrum-epipharynx (× 50).

Fig. 81. *Ligyrus gibbosus* De G.: mandible (× 15).

Fig. 82. *Ligyrus gibbosus* De G.: maxilla (× 15).

Fig. 83. *Xylorectes satyrus* Fab.: epipharynx (× 15).

Fig. 84. *Xylorectes satyrus* Fab.: mandible (× 15).

Fig. 85. *Xylorectes satyrus* Fab.: maxilla (× 15).

Fig. 86. *Xylorectes satyrus* Fab.: labial structures, dorsal view (× 15), showing the small mentum pushed entirely in over the sub-mentum. The anterior plate of the sub-mentum is very much larger than the posterior plate.

Fig. 87. *Allorhina nitida* Linn.: labrum-epipharynx (× 15).

Fig. 88. *Allorhina nitida* Linn.: mandible (× 15).

Fig. 89. *Allorhina nitida* Linn.: maxilla (× 15).

Fig. 90. *Allorhina nitida* Linn.: labial structures, dorsal view.

Fig. 91. *Euphoria inda* Linn.: labrum-epipharynx (× 50).

Fig. 92. *Euphoria inda* Linn.: mandible (× 50).

Fig. 93. *Euphoria inda* Linn.: maxilla (× 15).

Fig. 94. *Euphoria inda* Linn.: labial structures, ventral view (× 15).

Fig. 95. *Osmoderma scabra* Beauv.: labrum-epipharynx (× 15).

Fig. 96. *Trichius piger* Fab.: labrum-epipharynx (× 15).

Fig. 97. *Trichius piger* Fab.: mandible (× 50).

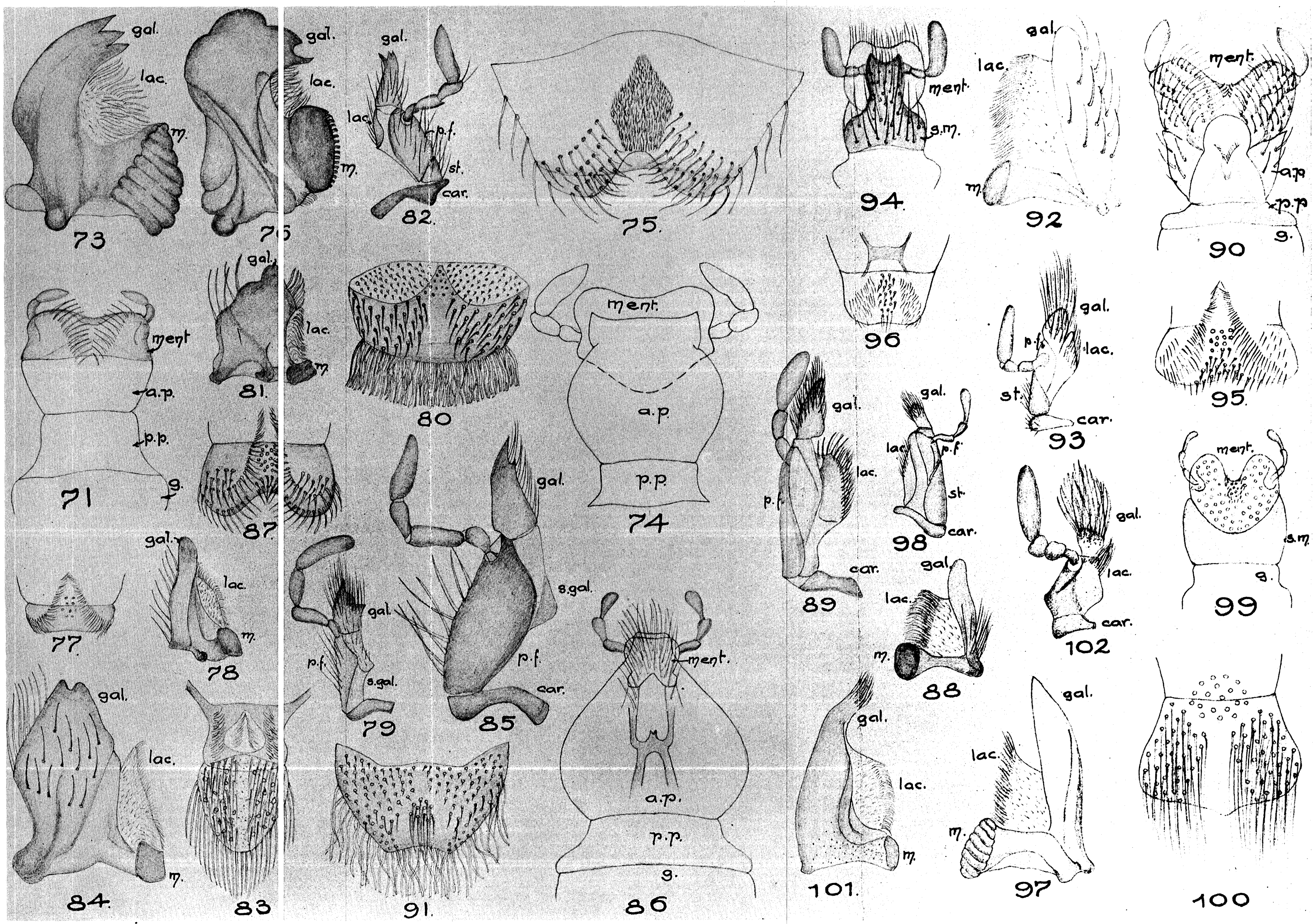
Fig. 98. *Trichius piger* Fab.: maxilla (× 15).

Fig. 99. *Trichius piger* Fab.: labial structures, dorsal view (× 15).

Fig. 100. *Valgus squamiger* Beauv.: labrum-epipharynx (× 150).

Fig. 101. *Valgus squamiger* Beauv.: mandible (× 150).

Fig. 102. *Valgus squamiger* Beauv.: maxilla (× 50).

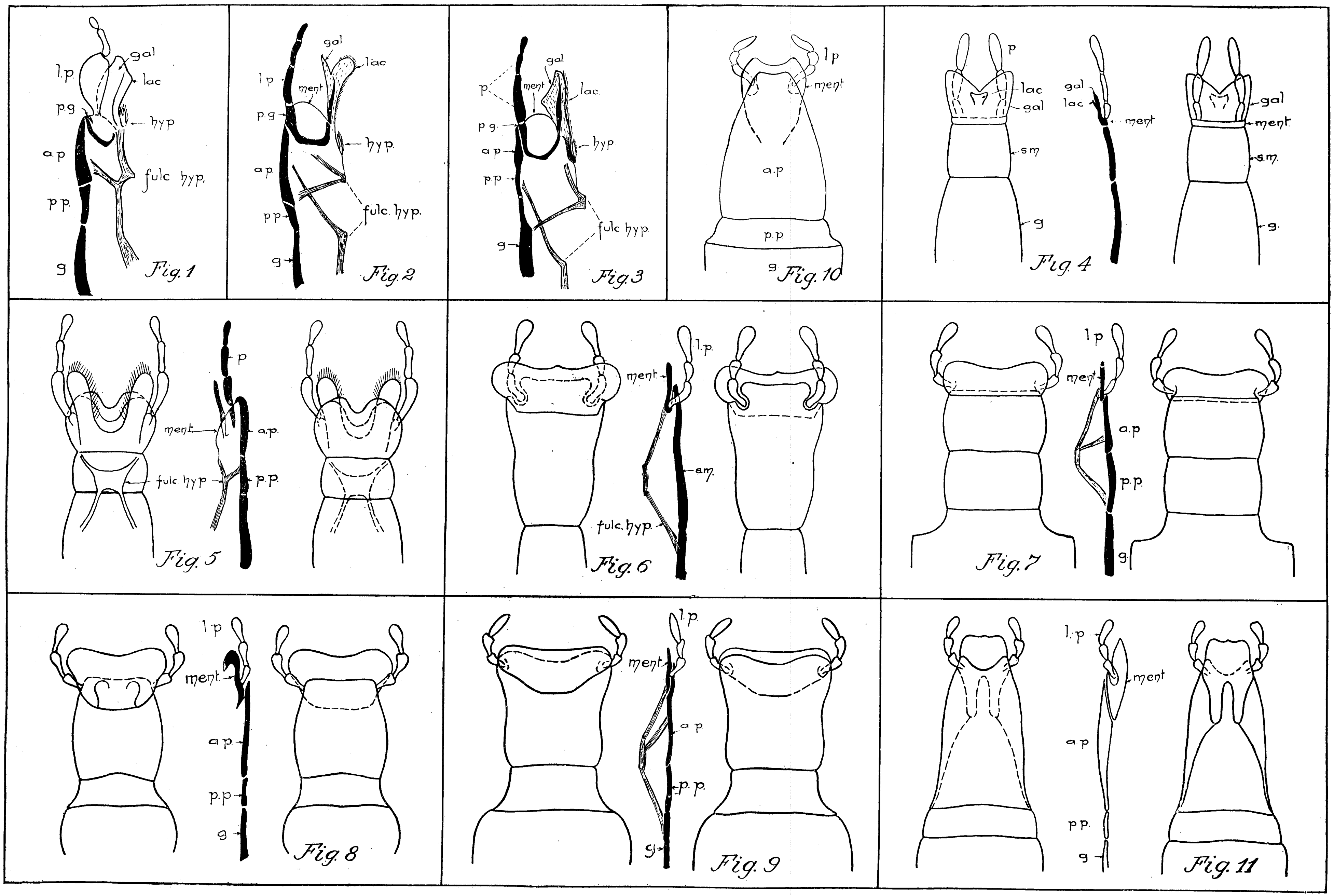


C. B. Hardenberg del.

PLATE XXXIV.

EXPLANATION OF PLATE XXXIV.

Fig. 1. *Copris carolina* Linn.: diagram of labial structures.
Fig. 2. *Canthon laevis* Drury.
Fig. 3. *Phanaeus carnifex* Linn.
Fig. 4. *Bolboceras farctus* Fab.
Fig. 5. *Cloeotes aphodioides* Ill.
Fig. 6. *Serica sericea* Ill.
Fig. 7. *Diplotaxis sordida* Say.
Fig. 8. *Pelidnota punctata* Linn.
Fig. 9. *Cotalpa lanigera* Linn.
Fig. 10. *Cyclocephala immaculata* Oliv.
Fig. 11. *Ligyrus gibbosus* De G.



C. B. Hardenberg del.

THE ATTIDAE OF BORNEO.

GEORGE W. PECKHAM AND ELIZABETH G. PECKHAM.

We owe the opportunity of seeing the Attidae here described to the kindness of Mr. R. Shelford, formerly curator of the Museum of Sarawak, by whom most of them were collected. A few species from our own collection have been included. Where other localities are not mentioned, the spiders were collected in the neighborhood of Sarawak.

We have followed the classification of Simon, based upon the dentition of the falces, which gives us the three groups, Pluridentati, Fissidentati and Unidentati.

PLURIDENTATI.

Myrmarachne Shelfordii sp. nov.

♂. Length 5 mm., exclusive of falces. Falx 2 mm. Legs 4132, all slender.

A yellowish-brown species with a wide, dark, transverse band on the abdomen.

The cephalic part is on a little higher plane than the thoracic, from which it is separated by a slight constriction. The quadrangle of the eyes occupies half of the cephalothorax, is one-fourth wider than long, and is wider behind than in front. The first row is slightly curved downward, with the eyes close together and all large, the middle not twice the lateral. The second row is about halfway between the others, and the third row is as wide as the cephalothorax. The falces are long and horizontal, flattened above and below, with a stout spine on the upper edge at the distal end, opposite the insertion of the fang, which is nearly as long as the falx. Both margins have numerous teeth, those on the upper being longer. The sternum is long, pointed behind and truncated in front. The first coxæ are separated by a little less than the width of the labium, which is very long, plainly longer than wide. The maxillæ are long and narrow, and are excavated, the wider distal end being connected with the base by a neck. The legs are all slender, the third and fourth pairs unarmed. There are six pairs of long spines under the tibia of the first and three pairs of short ones under the tibia of the second, while both legs have two pairs under the metatarsus and are provided with lateral spines. The patella of the first leg has one small spine below. The first leg is longer than the second by the tarsus, metatarsus and half the tibia. The pedicle is not visible from above. At the end of the tarsus of the palpus are two small spines.

The cephalothorax and the front part of the abdomen are covered with light yellowish hairs. A wide, glistening, dark band crosses the abdomen, its front edge being a little in front of the middle, and behind this hairs of a lighter yellow than those in front extend to the spinnerets. All the legs are yellow. The falces are slightly rugose and have iridescent coppery reflections.

Two males, from Sarawak.

The sternum of this species is not so pointed as is usual in *Myrmarachne.*

Myrmarachne borneensis sp. nov.

♂. Length 8.5 mm., not including falces. Falx 2 mm. Legs 1432, first longer than second by tibia, metatarsus and tarsus.

The integument is black, and in our specimen the only hairs remaining are some white ones which thinly cover the anterior sides of the cephalothorax and the clypeus. The horizontal falces are flattened above and rugose, narrowest at the proximal end, with a spine above at the inner distal end. The inferior margin has numerous small teeth, and the superior margin several larger ones. The first legs have the coxa and tarsus light-colored, the trochanter medium brown, and the other joints dark brown. The second legs are light excepting the dark coxæ and dark streaks on the other joints. The third have the coxa, trochanter and femur dark and are otherwise light-colored, and the fourth have the coxa, trochanter and tarsus light and the other joints dark. There are no lateral spines. The first leg has eight pairs of long spines under the tibia and two pairs under the metatarsus. The second tibia has three pairs and one unpaired spine on the anterior border at the distal end. Those on the posterior border are much longer and stouter than those on the anterior. The metatarsus of the second leg has two pairs of long spines.

The palpus has, on the outer upper corner of the tibia, a pointed apophysis, and below this, on the side of the same joint, some very stout hairs, which are nearly thick enough to be called spines. The tibia and patella are nearly equal in length and taken together do not equal the tarsus, which has a coiled tube.

One male, from Sarawak.

Linus crassipalpis sp. nov.

♂. Length 5 mm. Legs 4123, all the tibiæ fringed below.

The cephalothorax is short and very high, and is steeply inclined in both directions from the dorsal eyes, the posterior slope being convex. The sides are not far from parallel, there being a slight widening behind the dorsal eyes. The quadrangle of the eyes occupies about one-half of the cephalothorax and is plainly wider in front than behind. The front row is plainly curved downward, the eyes being close together. The middle ones are large and bulging, and are twice the size of the lateral. The second row is nearer the third than the first, with the eyes rather large. The third row is about as wide as the cephalothorax at that place. The labium is plainly wider than long.

Our specimen is rubbed. The cephalothorax has white hairs in a wide band on each side, and in a central band on the thoracic part. On each side of this band, on the cephalic plate, and surrounding all the eyes, are yellow hairs. The abdomen shows no distinct pattern, but has white hairs in front, yellow farther back, and dark-brown at the end. The clypeus is half as wide as the front middle eyes and is covered with short yellowish hairs. The falces are vertical, short and weak. They are dark in color with short yellowish hairs. The palpus is reddish with thick yellow hairs. The tarsus is much enlarged. The legs are long and dark-colored, except the metatarsi and tarsi, which are pale. They are nearly equal in thickness, and have black fringes on the tibiæ. These fringes are easily rubbed off in handling.

This species might be *L. subvexus* except for the curve of the first row of eyes. Thorell emphatically states that in his species this row is not curved downward, but is straight.

One male from Sarawak.

Cyrba armillata sp. nov.

This species has red hairs around the eyes, projecting reddish falces and pale palpi.

♀. Length 4.8 mm. Legs 3124, first pair a little the stoutest.

The cephalothorax is high and slopes in both directions from the dorsal eyes, the thoracic part falling more steeply after the first third. The sides are widest at the dorsal eyes, being nearly parallel in front but contracted behind. The cephalic part is as long as the thoracic. The front eyes are large, the lateral more than half the middle, and close together, the row being curved downward. The second row is about halfway between the others, and the third is but little narrower than the cephalothorax. The sternum is truncated in front. The anterior coxæ are separated by the width of the labium, which is a little longer than wide. The falces project and are rather stout and long, with six teeth on the lower margin and two on the upper. The first and second legs, besides lateral spines, have 3–3 under the tibia and 2–2 under the metatarsus.

Our specimen is imperfect. The cephalothorax is reddish-brown, darker on the sides than above. The eye-region is bordered by rufous and white hairs which surround all the eyes, extending between those of the third row. Back of this, on the upper slope of the thorax, is a thick patch of yellowish-white hairs. The cephalic plate and the lower sides are rubbed bare. The clypeus is narrow, edged with white hairs. The falces are reddish. The abdomen has a dark central band extending from the front end to the middle, where it meets the first of two curved transverse dark bands which cross the dorsum, one at this point and one farther back. The intervening spaces seem to have been covered with white hairs. The palpi are pale and the legs pale barred with reddish-brown, the first pair being the darkest and a little the stoutest, with the tibia but little longer than the metatarsus.

A single female.

FISSIDENTATI.

Canama rutila sp. nov.

♀. Length 7.5 mm. Legs $3\overline{41}2$, not hairy, first and second pairs scarcely stouter than the others.

The cephalothorax is high and falls steeply in both directions from the dorsal eyes, the thoracic slope being slightly rounded in front and more abrupt than the cephalic. It is widest in the cephalic part, the thoracic narrowing from the dorsal eyes to the end. The sides are nearly vertical. The quadrangle of the eyes is one-third wider than long, is wider behind than in front, and occupies nearly half of the cephalothorax. The front eyes are somewhat separated and form a straight row, the lateral being more than half as large as the middle. The second row is halfway between the others, the eyes being separated from those of the third row by a depression. The dorsal eyes are on the edge of the cephalothorax. The falces are stout and vertical, the upper margin bearing two teeth and the lower a bifid ridge, the two points being equally long. The sternum is oval, slightly truncated. The front coxæ are separated by fully the width of the labium, which is a little longer than wide. The spines of the anterior legs are 3–3 on the tibia and 2–2 on the metatarsus, besides laterals. The posterior legs have many strong spines, with two circles on the metatarsus of the third and three on the metatarsus of the fourth.

The general color is light, but the eyes are on black spots. The body has a covering of white hairs, streaked and banded with red hairs. The falces and clypeus are yellow. The palpi are long and pale with some black and white hairs on the tarsus. The legs are light-colored with black spines. They have some short red hairs on the patellæ and some black hairs on the metatarsi and tarsi. The under parts are pale, the maxillæ and labium being tipped with black hairs.

One female, from Sarawak.

Microhasarius animosus sp. nov.

♂. Length 4.2 mm. Legs 1342, first pair slightly enlarged and fringed.

♀. Length 5 mm. Legs $\overline{13}42$, first and second pairs a little the stoutest.

We put this species into *Microhasarius* although it does not entirely agree with *M. pauperculus* E. S., the only other representative of the genus.

The cephalothorax is higher and shorter in the male than in the female. The cephalic part is inclined, and the thoracic drops steeply from the dorsal eyes to the posterior border. The sides are slightly wider behind than in front. The front eyes are close together, this row being slightly curved in the male and straight in the female, with the lateral more than half as large as the middle eyes. The second row is halfway between the others, and the third row is a little narrower than the cephalothorax. The quadrangle is a little wider in front than behind. The falces are vertical, with two teeth on the upper, and a compound bifid tooth on the lower margin. The sternum is cordate, nearly as wide as long, and widely truncated in front. The front coxæ are separated by more than the width of the labium, which is wider than long. In the male there is a short, stiff fringe of dark hairs under the femur and tibia of the first leg. The first and second legs have three pairs of spines under the tibiæ, besides laterals, and two pairs of very long spines under the metatarsi, with no laterals. The metatarsi of the third and fourth pairs have each two circles.

In the male, the ground color of the cephalothorax is reddish-brown. Our example is somewhat rubbed, but there seems to have been a covering of bright red hairs. A transverse snow-white band crosses the cephalic part just in front of the dorsal eyes, and far back on each side of the thoracic part is a large oval spot of pale golden hairs, ringed with black. Under alcohol, the abdomen is pale, mottled with dark streaks, but when dry it shows pale golden hairs covering the front end, with a black band low down on the anterior border, a middle region with some bright red hairs, which, perhaps, completely covered it in a fresh state, and a somewhat triangular golden region behind, outlined in black. The first leg has the patella brown and the tarsus pale, but is otherwise dark. There is a black fringe under the femur and a slighter one under the tibia. The other legs are pale with dark rings. The palpus is pale except the tarsus, which is brown, and has long white hairs on the femur.

The female is much like the male, although the abdomen seems to have been covered with a mixture of red and white hairs. The legs are brown with pale tarsi, the first having a slight fringe under the tibia. The palpus is all brown, the tarsus having some dark hairs and one long spine on the outside, behind the middle.

One male and two females, from Sarawak.

Mantius difficilis sp. nov.

♀. Length 5.5 mm. Legs $\overline{34}12$, scarcely differing in thickness. The cephalothorax is moderately high and is very slightly inclined in both directions from the dorsal eyes, the thoracic part falling more steeply in the second half. The sides are parallel and nearly vertical in front, but grow narrow from the dorsal eyes backward. The quadrangle of the eyes is wider behind than in front, is nearly twice as wide as long, and occupies two-fifths of the cephalothorax. The front eyes are all separated and form a row which is curved downward, the middle being less than twice as large as the lateral. The second row is about halfway between the others, and the third row is as wide as the cephalothorax. The falces are not quite vertical. They are weak and rather long, with two teeth on the upper, and a bidentate ridge on the lower margin. The sternum is oval, not truncated. The coxæ are separated by less than the width of the labium which is longer than wide. The spines of the anterior legs are 3–3 on the tibia and 2–2, very long, on the metatarsus, besides laterals. The patellæ are all spined on both sides. The posterior legs have numerous small spines and three circles on the metatarsi. The spinnerets are not visible from above, being short, with their insertion on the under surface.

Our example is rubbed nearly bare. The eyes are on black spots. The cephalic part shows a few white hairs on a dark background. The thoracic part is brown, and seems to have had wide white bands on the sides. The abdomen is of a dull gray color with a few white hairs. The legs and falces are pale yellowish-brown.

One female.

Mantius armipotens sp. nov.

♂. Length 6.5 mm. to 10 mm. Legs 1342, first stoutest and fringed.

The cephalothorax is high, with the cephalic part very slightly inclined and the thoracic falling steeply in a rounded slope. It is nearly vertical and parallel in front, but grows narrower toward the end of the thoracic part. The eyes are on tubercles with depressions between. The quadrangle is a little wider behind than in front, is one-third wider than long and occupies nearly half of the cephalothorax. The front eyes are large and sub-touching and form a row which is curved downward. The middle are less than twice as large as the lateral. The second row is halfway between the others. The third row is as wide as the cephalothorax. The falces are stout, vertical, and convex in front. The upper margin has two teeth, one larger than the other, and the ridge on the lower margin is bidentate. The sternum is oval, very slightly truncated. The front coxæ are separated by the width of the labium which is longer than wide. The tibia and metatarsus of the first leg are fringed. With the exception of the tarsi, all the joints of all the legs are spined. In the first and second the tibiæ have 3-3 and the metatarsi 2-2 besides laterals. In the third and fourth the metatarsi have two circles.

The cephalothorax is of a dark reddish-brown color, while the abdomen is much lighter and yellowish. The cephalic part is covered with golden hairs, the color deepening to red around the eyes. The sides have wide white bands which pass around the lower thoracic part. The abdomen, judging from the marks that are left on our specimens, is covered to the ends of the spinnerets with a mixture of white and reddish-golden hairs, and has two impressed white dots. The falces are dark brown with some long white hairs. The clypeus is very low. The palpus is reddish-brown with two longitudinal white lines running as far as the tarsus. The first leg is brown, the patella being light-colored, while the tibia and metatarsus are darkened and have a heavy, stiff, black fringe. There are some short red and white hairs on the upper surface, and the under side of the femur has a dark streak. The other legs are light brown. The mouth parts are dark brown tipped with white. The sternum is yellow with a few white hairs, while the coxæ are much darker and are marked by a sooty black streak which extends, in some cases, on to the trochanters and femora.

Three males, from Sarawak.

Maileus gen. nov.

The cephalothorax slants steeply in both directions from the dorsal eyes, the thoracic part falling still more abruptly after the first half. It rounds out widely at the posterior part, the sides being vertical and parallel in front. The quadrangle occupies two-fifths of the cephalothorax, is a little wider in front than behind, and is nearly one-fourth wider than long.

The front eyes are close together in a straight row, the lateral being more than half as large as the middle. These eyes bulge out on the sides so that the first row is wider than the cephalothorax at that place. The second row is halfway between the others, and the third is as wide as the cephalothorax.

There are neither tubercles nor depressions. The falces project forward, but are not horizontal. They are rather short, and are convex above, with small fangs. There are two teeth on the upper and one bifid tooth on the lower margin. The sternum is nearly as wide as long, cordate, and widely truncated in front. The front coxæ are separated by fully the width of the labium, which is about as wide as long.

In *fuscus,* the type species, of which we have only the female, the relative length of the legs is 4312. The first and second legs have three pairs of spines under the tibia and two under the metatarsus, besides lateral spines. The third and fourth legs have many strong spines, there being two circles on the metatarsus of the third and three on the metatarsus of the fourth.

The width of the sternum and labium brings this genus close to *Microhasarius* E. S., but it differs in the spinal armature and in the shape of the cephalothorax.

Maileus fuscus sp. nov.

♀. Length 5.5 mm. Legs 4312, first pair a little the stoutest.

The ground color of the cephalothorax is dark on the sides and brown in the middle. The sides are covered with yellowish-red hairs and have a white line around the lower margin. A central longitudinal white band extends from the middle of the cephalic to the middle of the thoracic part. Around the eyes the hairs are bright red. The clypeus is low with a few white hairs. The abdomen has a central longitudinal scalloped white band, in the middle of which is a dark line, ending, behind, in two chevrons. The upper sides are mottled brown, and the lower sides are white, spotted with brown and black. The palpi are pale, and the legs pale with dark rings. The falces are yellowish.

One female, from Sarawak.

Ptocasius gratiosus sp. nov.

♂. Length 8.2 mm. Legs $\overline{13}42$, first and second pairs stoutest.

The cephalothorax is high with a very rounded upper surface, inclined in both directions from the dorsal eyes. The sides form a gently curved line from front to back, and are scarcely wider below than above, excepting at the dorsal eyes, where they are widely swollen. The quadrangle of the eyes is a little wider behind than in front, is one-third wider than long, and occupies nearly half of the cephalothorax. The front eyes are close together in a straight row, the middle nearly twice as large as the lateral. The eyes of the second row are a little nearer the first than the third row, and are separated from the latter by deep depressions. The dorsal eyes are placed on tubercles, and form a row nearly as wide as the cephalothorax. The falces are heavy, with short, strong fangs. They are not quite vertical, being visible from above. The upper margin has two teeth, and the lower a ridge which is unequally bifid. The sternum is oval and truncated. The front coxæ are separated by the width of the labium, which is a little longer than wide. The spines of the anterior legs are 3–3 on the tibia and 2–2 on the metatarsus, besides laterals. The posterior legs have many strong spines, the metatarsus of the third having two circles and that of the fourth three circles.

This is a dark species, and our example is rubbed nearly bare. The cephalic plate is dark-colored and glistening, the thoracic part is brown, and there seem to have been wide white bands on the sides. The abdomen, which is rather slender and tapering, shows alternate transverse bands of lighter and darker brown which seem to have been covered with white and yellow hairs. The first and second legs are dark, with femora and tibiæ almost black, polished, and slightly iridescent. The posterior legs are brown with the femora darkened. The palpi, which are very slender at their insertion, are brown with some white hairs on the tarsus. The falces are dark and iridescent, with bluish reflections, and have some short white hairs scattered over the front faces.

We have one male, from Singapore, in the Workman collection.

Rooseveltia gen. nov.

The cephalothorax is high, very long and wedge-shaped, the cephalic part being narrow and not inclined while the thoracic widens out and falls in a gradual slope. The quadrangle of the eyes is a little wider behind than in front, is one-fourth wider than long and occupies two-fifths of the cephalothorax. There are no tubercles nor depressions. The front eyes are slightly separated and form a curved row, the middle being nearly twice as large as the lateral. The second row is half-way between the others, and the third is nearly as wide as the cephalothorax. The falces project but are not horizontal. The upper margin is rounded out so as slightly to overhang the lower, and has one short, round tooth and a second very tiny one between this and the fang. The ridge on the lower margin is not bifid, having only a point at one corner. The sternum is oval, truncated in front. The first coxæ are separated by the width of the labium, which is longer than wide. The first and second legs have three pairs of spines under the tibia and two pairs under the metatarsus but lack lateral spines, while the posterior legs have three circles on the metatarsi. In *R. mutilla,* the type species, the relative length of the legs is 4132, the fourth pair being much the longest. The metatarsi are much longer than the tarsi, especially in the third and fourth pairs.

This genus seems to belong near *Hasarius.*

Rooseveltia mutilla sp. nov.

♀. Length 10 mm. Legs 4132, femur of the first thickened, otherwise slender.

This species looks like some hymenopterous insect and is said by Mr. Shelford to mimic a *Mutilla.*

Our example is somewhat damaged. The ground color of the cephalothorax is dark, the upper surface being covered with yellowish-red hairs which run down to form bands on the sides and thoracic part. The clypeus is edged with white and has a coppery red spot under each of the middle eyes. The abdomen is marked by transverse bands of black and yellow, the yellow parts seeming to have been covered by red hairs. The palpi are covered with beautiful white scales which have iridescent pink reflections, and have, under the tarsus, a bunch of dark hairs. The falces are dark and iridescent, the upper surface being covered with short black bristles. The legs are dark and are marked with double longitudinal lines of white scales, most distinct on the femora of the third and fourth pairs. On the first and second legs these lines widen toward the end and cover the tarsi.

One female, from Kuching.

Goajara gen. nov.

The cephalothorax is rather high and very wide,—much wider than the quadrangle of the eyes. The sides are nowhere parallel, their widest point being in the middle of the thoracic part. The cephalic part is slightly convex, but not inclined, and the upper surface of the thoracic is nearly on a level with it for two-thirds of its length, there being a very gradual fall from the dorsal eyes. The quadrangle is a little wider in front than behind, is one-fourth wider than long, and occupies less than two-fifths of the cephalothorax. The front middle eyes are subtouching and are twice as large as the laterals, which are well separated from them. The four form a straight row The second row is a little nearer the first than the third, and the third is much narrower than the cephalothorax. The falces project and are stout and convex. The upper margin bears two teeth, one much larger than the other, and the lower has a truncated ridge, without any teeth, like that of the falx of *Euryattus Bleekeri* Dol. The sternum is rounded, nearly as wide as long, truncated in front and having a blunt point behind. The coxæ are separated by the width of the labium, which is plainly longer than wide. The maxillæ are narrow at the base and very wide at the extremity. The first leg has the patella and tibia long and stout, and the metatarsus long and slender. The tibia has three very small spines on the posterior margin, and four stout ones on the anterior. The metatarsus has a small spine near the base, on the posterior border, and a very tiny one near the distal end. The tibia of the second has three on the anterior and two on the posterior margin, and the metatarsus has two pairs, without laterals. The posterior legs have a few weak spines.

This genus is much like *Thianitara* E. S., one of the group of Unidentati, in the spinal armature. It seems to be most nearly related to *Servaea.*

Goajara crassipes sp. nov.

♂. Length 8.2 mm. Legs 1$\overline{34}$2, first pair darkest and stoutest, without long hairs but with heavy spines on the tibia.

Under alcohol the general color is reddish-brown. The cephalothorax has a central longitudinal white band from front to back, and wide white bands on the sides, while the slender, tapering abdomen has, on each side of the middle, white bands running from base to apex and approaching each other behind. Outside of these are two bands somewhat darker than the brown in the middle of the dorsum, and still lower down the sides are covered with white hairs. When dry, the spaces between the white bands on the cephalothorax show red hairs which grow thick around the eyes. The white bands on the sides, which are marked, just above the margin, by a jet black line, pass forward as far as the outer edges of the front middle eyes, and there end abruptly, leaving the wide clypeus bare. This appearance is, perhaps, due to the rubbing of the hairs in our specimen. In the abdomen the middle brown region seems to have been covered with yellow hairs. The first leg is deep reddish-brown, the metatarsus and tarsus being a little lighter-colored than the other joints. The femur has black streaks in front and behind, and seems to have been covered with short white hairs. On the front face of the metatarsus, near the base, is a round black spot. The other legs are light brown, all the tarsi being short. The palpus is pale yellow excepting the tarsus, which is brown. The falces are red-brown. The brown venter is marked by four lines of white spots, like chains of beads. The sternum, coxæ and maxillæ are light yellow, but the labium is brown.

One male, from Sarawak.

Vailima gen. nov.

The cephalothorax rises to a ridge at the dorsal eyes, the cephalic part being strongly inclined, and the thoracic falling abruptly. In the cephalic part the sides are almost vertical, rounding out a little beyond the eyes of the second row, but the third row is wider than the cephalothorax, projecting beyond it, as the sides slope inward. The thoracic part is narrower than the cephalic. The quadrangle of the eyes occupies more than half of the cephalothorax, is nearly twice as wide behind as it is long, and is wider behind than in front. The front eyes are moderately large, in a row that is curved downward, all separated, the middle nearly twice as large as the lateral. The second row is a very little nearer the first than the third. The dorsal eyes are on tubercles. The sternum is very narrow and is three times as long as wide. The front coxæ are separated by less than the width of the labium, which is a little longer than wide. The falces are rather short and are moderately stout. They have a compound tooth on the lower, and two teeth on the upper margin.

In the type species, *V. masinei,* the first and second legs have, besides lateral spines, three pairs under the tibia and two pairs under the metatarsus. The posterior legs have many strong spines.

This genus belongs to the Harmochireæ, and resembles *Harmochirus,* which, however, has the front row of eyes curved upward, the quadrangle only one-fifth wider than long, and much enlarged first legs. It is also near *Simaethula,* but differs in having the lip but little longer than wide, the maxillæ normal, and the posterior legs strongly spined.

Vailima masinei sp. nov.

♂. Length 5.5 mm. Legs 1342, first and second pairs a little the stoutest.

The cephalothorax is dark reddish-brown, with the cephalic plate lighter than the rest. The lower margin is black, and above this is a wide bright band of snow-white hairs, around the sides and back and across the clypeus. Higher up is a band of red hairs which borders the cephalic plate, surrounds all the eyes, and forms a crescent just behind the dorsal eyes. The few hairs that are left on the cephalic plate, in our specimen, are white. The falces are reddish-brown with long white hairs. The palpus is pale except the tarsus, which is tinged with red. The abdomen is broken and rubbed. There is a tuft of white hairs in front, and it seems to have been white in the middle and at the end, with yellowish sides. The first and second legs are reddish-brown with black hairs on the femur and tibia and white hairs on the patella. The first has a very light short fringe of black hairs under the patella, tibia and metatarsus. The other legs are lighter-colored and have a band of black and a band of white hairs on the femur.

A single male.

UNIDENTATI.

Afiola gen. nov.

This genus is near *Pseudamycus*, but the slope in both directions from the dorsal eyes is not so steep as in that genus. The cephalothorax is wider behind than in front and a little wider below than above. The quadrangle of the eyes is one-fourth wider than long, occupies a little less than one-half of the cephalothorax, and is slightly wider behind than in front. The first row is straight, the lateral being separated from the middle eyes and two-thirds as large. The second row is halfway between the others. The dorsal eyes are large, and are placed on tubercles, so that a depression separates them from the eyes of the second row. The third row is a little narrower than the cephalothorax. The front coxæ ar separated by only the width of the labium, which is a little longer than wide. The maxillæ have a sharp point at the outer side. The sternum is rather narrow and is truncated in front. The falces are vertical, wide and short, with one stout tooth on the lower margin, and two, close together, on the upper. The tarsus of the palpus is about as long as the patella and tibia together. The first and second legs have the tibiæ armed with 3-3 spines and laterals, and the metatarsi with 2–2 and laterals. The third and fourth legs have many long spines.

The type of this genus is *A. benjarei.*

Pseudamycus has no lateral spines on the metatarsi, has the quadrangle of the eyes wider in front, and the lateral eyes of the first row less than two-thirds as large as the middle eyes.

Afiola benjarei sp. nov.

This is a large spider with a dark cephalothorax. The first leg is deep reddish-brown with a black fringe under the patella, tibia and metatarsus.

♂. Length 9 mm. Legs 1324, first pair much stouter than the others.

The cephalothorax is dark reddish-brown. There is a wide central snow-white band from the first row of eyes to the posterior end, and on each side of this are bands of red hairs. The sides, in our specimen, are rubbed, but seem to have had bands of red and white hairs. The hairs under the eyes of the first row are white. The falces are dark red with short white hairs on the front faces. The palpi are reddish with black and white hairs. The abdomen, under alcohol, is light yellow with a thin growth of black hairs over it. When dry it seems to have had a band of white hairs down the middle, with red hairs on each side and white hairs lower down. The venter is light-colored, with two longitudinal rows of yellow spots. The legs are tinged with red, the tarsi being lighter than the other joints, and the third and fourth pairs paler than the first and second. The front face of the femur of the first is smooth and black. From below, all the coxæ, trochanters and femora are lighter-colored than the other joints, and the coxæ and trochanters of the first and second, and the femora of the four pairs (especially of the second and third), have dark, longitudinal bands on the anterior and posterior borders. From above, these longitudinal streaks are visible on the second, third and fourth pairs. The first leg, and the second, in a much slighter degree, have black fringes under the patella, tibia and metatarsus. The tarsus of the first is pale, except a reddish spot at the end.

This species is distinguished from *Palpelius arboreus,* which it resembles, by having the metatarsus of the first leg dark, with a black fringe throughout its length. In *arboreus* this joint is pale, and has no fringe.

One male.

Bathippus Shelfordii sp. nov.

This is a slender, long-legged species, with a metallic band on the abdomen. The first leg has a ridge of hairs above the femur, and a fringe below the patella.

♂. Length 8 mm. Legs $31\overline{42}$, the third longer than the second and fourth by the tarsus and metatarsus. The metatarsus of the third is very long.

The cephalothorax is high, the cephalic part being nearly level, while the thoracic falls in a rounded slope from the third row of eyes. The sides are widely rounded out in the thoracic part. The quadrangle of the eyes occupies one-half of the cephalothorax, is less than one-fifth wider than long, and is wider in front than behind. The first row is curved up, the eyes being large and subtouching, the lateral further back than the middle and more than half as large. The second row is halfway between the others. The dorsal eyes are on black tubercles and form a row narrower than the cephalothorax. The clypeus is only a line. The falces are long, oblique and divergent, the fang being nearly as long as the falx. There is a short apophysis near the distal end and a small tooth at the proximal end above. The lower side has one tooth near the distal end. The sternum is oval and wide with a projection behind, and is slightly truncated in front. The front coxæ are widely separated. The labium is but little longer than wide, and is only one-third as long as the maxillæ. The patella of the first leg is as wide as long and is rounded above. The third leg is enlarged at the junction of the tibia and metatarsus.

The first leg, besides lateral spines, has 4-4 under the tibia and 3–3 under the metatarsus; the second, besides laterals, has 3–3 under the tibia and 2–2 under the metatarsus.

Our specimen is rubbed. The cephalothorax is reddish-brown with a wide pale streak, probably once covered with white hairs, over the middle of the thoracic part, and small black tubercles in the eye-region. There are patches of white hairs under the eyes on the sides as well as under the lateral eyes on the face, and a few white hairs appear on the middle of the cephalic part and over the first row of eyes. The abdomen had, evidently, a brilliant metallic band down the middle and seems to have been white on the sides. The falces are reddish-brown with darkened edges. The legs are reddish-brown with the proximal part of the femoral joints pale. The first and second have also a pale region at the proximal end of the tibia. The femur in the first has a ridge of black hairs above, which extends, though diminished in length, over the patella. The patella, in both first and second legs, is enlarged and flattened, with the front face slightly metallic, and a tuft of long black hairs below. The palpus is long, and has the tibia longer than the tarsus, with a straight apophysis at the distal end. It is pale except the tarsus, which is tinged with red. The venter is dark. The coxæ and sternum are pale, and the long maxillæ are brown with a fringe of black hairs on their inner edges.

This species is most easily distinguished from *B. manicatus* E. S. by the apophyses on the falces.

One male.

Bathippus sedatus sp. nov.

The male is dark, the legs brightly tinged with red, the front face of the femur of the first black. The female has two dark streaks on the thorax.

Length, ♂ 6.3 mm., ♀ 6.7 mm. Legs, ♂ $31\overline{24}$, first and third nearly equal; third longer than fourth by nearly the tarsus and metatarsus; ♀ 3142.

The shape of the cephalothorax is like that of *B. Shelfordii*. The quadrangle of the eyes occupies more than half of the cephalothorax, is one-fifth wider than long, and is very slightly wider in front than behind. The front eyes are large and form a plainly curved row. They are close together in the male, separated in the female. The middle are less than twice as large as the lateral. The second row is halfway between the others. The third row is narrower than the cephalothorax. The clypeus is narrow. The male falces are long, horizontal and divergent, with long, curved fangs. On the upper side is a long, pointed apophysis at the proximal end, and a short, stout one at the distal end. The under side has a small tooth near the middle and a very long, wide, blunt ridge, much longer than it is high, at the distal end. In the female the falces are vertical, with one conical tooth in the middle of the lower margin, and two, nearer the base, on the upper side. The sternum is slightly truncated in front. The coxæ of the first pair are widely separated. The labium is wider than long and is one-third as long as the maxillæ.

The spines are very long. Both first and second legs, besides laterals, have 3-3 under the tibia and 2-2 under the metatarsus.

There is a slight enlargement in the third leg, at the junction of the tibia and metatarsus, but the patella of the first, unlike that of *B. Shelfordii,* is normal.

B. manicatus E. S. from Borneo has one conical tooth at the base of the upper margin of the falx, while the lower side has one at the distal end, and also a long, pointed apophysis about three times its own width from the insertion of the fang. The third leg has the junction of the tibia and metatarsus enlarged, and the patella of the first is plainly longer than wide. The first and second legs, besides lateral spines, have 3-3 under the tibia and 2-2 under the metatarsus.

Our specimens are rubbed. The male has the cephalothorax reddish-yellow with a wide white band over the middle of the thorax and a large white spot over the first row of eyes. The eyes of the second and third rows are on black tubercles. The hairs around the eyes are red. The sides are bare. The abdomen is brightly iridescent on the back and is marked on the sides by transverse bands of black and yellow, the yellow bands being formed by hairs. The falces are red, deepening to black at the edges. The palpi are white with reddish tarsi. The first leg has the femur and patella almost entirely black, the other joints being dark except a clear red region at the proximal end of the tibia. The other legs are red, excepting a pale region at the proximal end of the femora and a black band on the front face of the femur of the second. The mouth parts are dark brown, and the maxillæ have black hairs along the inner edges.

In the female the cephalothorax is reddish-yellow with small black tubercles at the sides of the eye-region and two dark bands extending from the dorsal eyes to the posterior margin. Low down on each side, on the thoracic part, are two dark points, extending a little way up from the margin. These points, and the dark bands on the upper thoracic part, were probably covered with black hairs. The hairs around the border of the cephalic plate are bright red, but the sides of the cephalic part are rubbed bare. The lower half of the ring around the front eyes is white, while the upper part is red. The abdomen has a bright iridescent band down the middle. The sides seem to have been covered with alternate transverse bands of black and yellow hairs. The spinnerets are black. The legs are yellow, slightly tinged with red. The palpus is pale with some thick, light brown hairs on the tarsus.

One male and one female, from Mt. Pennissata.

Bathippus serenus sp. nov.

This is a yellow species with four pairs of black spots on the abdomen.

♀. Length 6.7 mm. Legs 3142, nearly equal in stoutness.

The cephalothorax and eyes are like those of *B. Shelfordii*. The clypeus is one-third as wide as the middle eyes of the first row. The falces project a little and are long and very stout. The sternum is broadly truncated in front and has a narrow projection behind. The front coxæ are widely separated. The labium is broader than long. The spines are long and slender, the first and second legs having, besides lateral spines, 3-3 under the tibia and 2-2 under the metatarsus.

The cephalothorax is yellow with black tubercles at the sides of the eye-region. The hairs on the cephalic plate and around the eyes of the second and third rows are yellow with an intermingling of red, and those around the front eyes and on the clypeus are white. The abdomen is light yellow with an iridescent band down the middle, on the edges of which, in front, are dark streaks, and, further back, four pairs of black spots. The sides are covered with glistening yellow hairs, with a little red near the dark spots. The spinnerets are jet black. The clypeus, falces, palpi and legs are yellow, the legs tinged with red. The mouth parts are yellow, the maxillæ with black hairs on the inner edges.

One female.

Eugasmia olivacea sp. nov.

This is a dark olive-green species, beautifully marked with white, and having bushy white hairs on the falces.

♂. Length 5 mm. Legs 1342, first pair much the longest.

The cephalothorax is rather long and moderately high, convex above, inclined forward from the second row of eyes and falling very slightly behind the dorsal eyes through two-thirds of the thoracic part, after which the descent is steep. It is widest in the middle, rounding gently in front and behind. The quadrangle of the eyes is a little wider in front than behind, occupies one-half of the cephalothorax and is one-fourth wider than long. The front eyes form a very slightly curved row, the lateral being half as large as the middle and a little separated from them. The second row is nearer the first than the third, and the third is narrower than the cephalothorax. There are no tubercles nor depressions. The sternum is rounded, truncated in front, and is nearly as wide as long. The coxæ are separated by the width of the labium, which is longer than wide. The falces are stout and projecting, with long white hairs. The lower margin has one stout tooth, the upper two, one larger than the other. The spinal armature is 3-3, with laterals, for the tibiæ and 2-2, with laterals, for the metatarsi of the first and second legs. The third and fourth legs have many strong spines. There is a very slight fringe of light hairs on the femoral joints, most pronounced on those of the first pair.

The cephalothorax and abdomen have a covering of olive-green hairs marked with a pattern in brilliant white. On the lower sides of the cephalothorax are white bands which do not meet behind, but which end in oblique bars projecting upward. The space between the eyes of the second and third row is occupied by a white band which passes outward and backward around the dorsal eyes, narrowing as it goes. Another short white band begins a little within the end of this one, and extends a short distance backward on the thoracic slope. Between and a little back of the eyes of the third row is a central white spot. The front faces of the falces are thickly covered with long, bushy, projecting white hairs, and there are shorter white hairs on the clypeus. The green abdomen has a black band low down on the front end, and back of this a wide, brilliant white band extending on the sides to the middle. Back of this, on the sides, are oblique white bars. On the front part of the dorsum are two abbreviated longitudinal white bands, and back of the middle is a transverse white band, broken in the middle. Around the posterior end is a white ring. The legs are dark with conspicuous oblique white bands. The palpus is dark brown with black hairs.

Eugasmia coronata E. S. (*Ergane coronata* E. S. and *Plexippus sannio* V. Hass.) has a prominent shoulder on the falx which distinguishes it from other species. *E. sannio* Th. (*Plexippus sannio* Th. and *Hasarius sannio* Th.), *Eugasmia* (*Eris*) *barbata* Karsch. and *E. olivacea* resemble each other, but differ in their palpi and to some extent in their marking, *sannio* and *olivacea* having on each side of the cephalothorax two white bands, the lower ones occupying one-third of the height, the upper ones narrower, not meeting behind, while in *barbata* the bands are of nearly equal width, the upper ones meeting. *Barbata* is also distinct by the shape of the fang, which is widened, with a shoulder on the outer side at the proximal end.

Of *olivacea* we have a single male, from Sarawak.

Erasinus gracilis sp. nov.

In this species the cephalothorax is dark with white marks, the abdomen pale brown, and the legs light yellowish.

♂. Length 5.5 mm. Legs 3214, about equal in thickness.

The cephalic part is high and convex, not inclined. The thoracic falls steeply from the dorsal eyes. The sides are nearly vertical in front but widen a little in the thoracic part. The quadrangle of the eyes occupies more than half the cephalothorax, is only one-fifth wider than long and is plainly wider in front than behind. The first row is straight, with the lateral scarcely half as large as the middle eyes, and a little separated from them. The second row is halfway between the others, with a depression on the sides, behind. The third row is about as wide as the cephalothorax. The sternum is long, oval, truncated in front. The first coxæ are separated by fully the width of the lip, which is wider than long. The falces are directed obliquely forward. The upper margin has two teeth, the larger one being near the insertion of the fang. In the first and second legs the spines are 3-3 on the tibia and 2-2 on the metatarsus, both joints having laterals. The metatarsus of the third has two circles and that of the fourth three circles. The tarsus of the palpus is elongated, exceeding the patella and tibia together, and has a long, black, whiplike apophysis which passes under the tibial apophysis. The bulb is cone-shaped with its base at the cup of the tarsus.

The cephalothorax is darker than the abdomen. There is not much left on our single specimen, but the cephalic part and the entire abdomen seem to have been covered with golden iridescent scales. There is a white band on each side in front, a white spot between the dorsal eyes, and a wide, somewhat crescent-shaped white band halfway down the thoracic slope. The falces are reddish-brown, and the legs pale yellow, lighter than the palpus.

One male, from Sarawak.

Hyllus nebulosus sp. nov.

♀. Length 11 mm. Legs $\overline{34}12$, nearly equal in thickness.

The quadrangle of the eyes is equally wide in front and behind, is one-third wider than long, and occupies two-fifths of the cephalothorax. The first row is bent slightly downward, the middle being twice as large as the lateral eyes which are a little separated from them. The second row is in front of the middle, and the third is a very little narrower than the cephalothorax. The sternum is oval, not truncated. The front coxæ are separated by about the width of the labium, which is longer than wide. The falces are long, strong and vertical.

The tibial spines on the first and second legs are 3-3 with small laterals, the metatarsal 2-2 without laterals, and there are small patellary spines. The third and fourth legs have numerous spines, those on the patellæ being larger than in the first and second.

The general color effect is brown. The whole cephalothorax is covered with mixed red and yellow hairs, which produce a mottled appearance. There are indistinct yellowish bands on the middle of the thorax, and around and below the eyes. The clypeus has long white hairs, and there are yellowish hairs on the falces. The abdomens of our specimens are rubbed. The dorsum seems to have been covered with brown hairs, and has a central longitudinal angular band, whitish, edged behind with black. On the sides are three or four indistinct whitish spots, faintly outlined in black.

The femoral joints of the first and second legs are yellow excepting a dark ring at the distal end, while those of the third and fourth have dark rings at both ends and are yellow in the middle. The other parts of the legs are light and dark brown, with many short yellowish hairs. The palpus is light brown with black and white hairs.

Two females, from Bidi.

Hyllus pulcherrimus sp. nov.

In this species the first legs are iridescent blue with white scales. The male has the abdomen metallic green, while in the female it is marked with red, green, black and white.

Length, ♂ 11 mm., ♀ 14.5 mm. Legs, ♂ 1432, first pair very much longer than the others, through the elongation of the femur, tibia and metatarsus; ♀ 14$\overline{32}$.

In all of our specimens the cephalothorax is rubbed. The eye-region is iridescent blue. The sides have wide white bands, not meeting behind, narrowing in front, and stopping in a line with the second row of eyes. One specimen has a central white band on the thoracic part and some white hairs on the eye-region. Another has some green scales near the dorsal eyes. In the male the abdomen is brilliant metallic green, with some whitish bands low on the sides. The legs are iridescent blue with patches of white scales, those on the upper surface arranged in a slender longitudinal line. The joints of the first are much elongated, and the tarsus is as stout as the metatarsus. There is a black and white fringe which begins with some thin hairs under the patella, grows heavier under the tibia, is thickest and longest under the metatarsus, and which extends, though much diminished, to the end of the tarsus. The palpi are bronze-colored, with longitudinal lines of white scales. The falces are stout, vertical and parallel. They are iridescent, with white hairs. In the female the abdomen has an elaborate pattern. Around the front end and passing on to the sides is a white band. Parallel with this, but higher up on each side, is a short white band edged with velvety black, which ends in a rounded knob, and further back, in a line with this, are two white spots. Just back of the white basal band is a curved band of glistening green scales which runs backward and ends in a point on each side, and down the middle of the back is a band of the same green scales which is edged with white bands or spots. The spaces around these markings are filled in with rich dark red hairs. The legs are like those of the male, excepting that the first pair is not elongated. The first and second pairs have a circle of white hairs at the proximal end of the tarsus. The palpus has on each joint a patch of brilliant orange-red hairs. The falces are reddish-brown with white hairs.

H. giganteus, H. pterygodes and *H. naerii* all have the falces projecting and divergent in the males. *H. lacertosus* C. K. has them vertical.

Margaromma spatiosa sp. nov.

♂. Length 5.5 mm. Legs $12\overline{43}$, first and second stoutest.

The cephalothorax is moderately high and is nearly flat above, from the first row of eyes through half of the thoracic part, and there falls steeply. The sides are parallel from the middle of the cephalic to the middle of the thoracic part, narrowing in front and behind. They widen out below. The quadrangle of the eyes occupies about half of the cephalothorax, is one-fifth wider than long, and is about equally wide in front and behind. The front eyes are moderately large, near together, and form a slightly curved row, the middle being less than twice as large as the lateral. The second row is a little nearer the first than the third, and the third row is plainly narrower than the cephalothorax. The sternum is oval and truncated in front. The coxæ are separated by the width of the labium, which is about as wide as long. The falces are strong and projecting, the upper margin having two small rounded teeth close together while the lower margin is unarmed. On the first leg the spines are 3–3, with laterals, on the tibia, 2–2, without laterals, on the metatarsus. The second leg has three uniserial spines and laterals on the tibia and 2–2 with small laterals on the metatarsus. The metatarsal spines on the first pair are exceedingly long, reaching almost the end of the tarsus. In all the legs the tibiæ and patellæ differ but little in length.

Our specimen is badly rubbed. It is a stout spider, with the cephalothorax larger and darker-colored than the abdomen. The eye-region is black with red hairs around the eyes. The anterior thoracic part has the integument reddish. There are white bands around the sides and behind, and under the lateral eyes are white hairs growing with their tips toward the middle of the clypeus. The abdomen is of a medium brown color, much lighter than the cephalothorax, and shows a few white and red hairs. The falces are iridescent green and very rugose. The legs and palpi are light brown, the legs having the femoral joints darkened. The first leg is darker than the others, which show alternate light and dark bands. They all have a good many long and short white hairs.

While this species does not entirely agree with Simon's description of the genus *Margaromma,* it closely resembles Keyserling's type, *M. funesta.* We have one male, from Sarawak.

Orsima formica sp. nov.

♂. Length 6.5 mm. Legs 1432. ♀. Length 7 mm. Legs 4132, femur of the first slightly thickened in both sexes.

The cephalothorax is rather high, with the cephalic plate nearly level. The thoracic part falls steeply in the female, but in the male rounds off in a longer, more gradual slope. It is a little wider in the thoracic than in the cephalic part and is slightly narrower above than below. The quadrangle of the eyes occupies nearly half of the cephalothorax, is one-third wider than long, and is a little wider behind than in front. The front eyes are close together in a straight row, the middle being twice as large as the lateral. The second row is halfway between the others. The dorsal eyes stand out prominently and form a row about as wide as the cephalothorax. The sternum is rounded behind, truncated in front. The first coxæ are separated by the width of the labium, which is a little longer than wide. The clypeus is narrow. The falces are vertical and rather long. The lower margin has one tooth, and the upper two, one large and one small. The legs are slender. The first and second, besides lateral spines, have 3–3 under the tibia and 2–2 under the metatarsus. The spines on the posterior legs are very weak. In the male the abdomen is strongly constricted behind the middle and is wider behind this point than in front of it. The spinnerets are long.

The coloring is very brilliant. In the male there is a wide bright band of iridescent green extending from the front eyes to the posterior margin and occupying the entire upper surface. The sides of the thoracic part are black, but those of the cephalic are covered with iridescent pinkish scales, which extend across the clypeus. All around the lower margin of the cephalothorax is a narrow band of silvery white. The abdomen has a covering of silvery iridescent scales, with two transverse bands of deep coppery red, one in front of and one behind the constriction. From the front one, two curved bands of the same red color extend forward, partly enclosing a circular spot of the iridescent scales. The sternum and venter are also covered with iridescence. The falces are light yellowish. The palpi are dark, covered with shining scales, as is also the femur of the first leg. The tibia and metatarsus of the fourth are black in the middle with pale extremities. Otherwise the legs are pale yellow with black streaks in front and behind.

The coloring of the female is similar, excepting that a transverse band of white iridescent scales, coming up from below, crosses the abdomen behind the middle, taking the place of the constriction in the male. The femur of the first leg is not darkened, the palpi, as well as the legs, being pale yellow with black streaks in front and behind.

Three males from Kuching and one female from Sarawak.

Mr. Shelford says that this species mimics an ant. Its form is certainly ant-like, although its coloring is gorgeous and striking. Although it has but two, instead of three, pairs of metatarsal spines, it agrees very well with Simon's description of the genus *Orsima* which heretofore has had but one representative, *O. constricta* from Congo.

Pseudamycus E. S.

The cephalothorax is high and slopes rather steeply in both directions from the dorsal eyes. The sides are sometimes nearly vertical and parallel, sometimes widened out below and behind. The quadrangle of the eyes occupies half or nearly half of the cephalothorax, is one-third wider than long in front and is plainly wider in front than behind. The front eyes are all large, the middle being twice or nearly twice as large as the lateral. They form a straight row. The eyes of the second row vary in position. The dorsal eyes are large and are placed on tubercles. They form a row which is nearly as wide as the cephalothorax at that place. The sternum is oval, truncated in front. The coxæ of the first pair of legs are separated by more than the width of the labium, which is longer than wide. The falces are nearly vertical and about as wide as the first row of eyes. The spines are long and strong, the first and second legs having three pairs besides lateral spines under the tibia and two pairs under the metatarsus. The posterior legs have many spines.

The type species, *P. albomaculatus* Van Hassett, has the relative length of the legs in the male 1324, the first being much the longest.

Pseudamycus sylvestris sp. nov.

♀. Length 10 mm. Legs 3412, fourth pair not so stout as the others.

The thorax falls steeply from the high cephalic plate, the sides being almost vertical and parallel. The sternum is rather narrow for *Pseudamycus*. The first row of eyes is bent down. The falx has one tooth on the lower and one on the upper margin. On the first and second legs the tibia has, besides lateral spines, 3–3, while the metatarsus has 2–2 without laterals. On the third and fourth legs the spines are numerous and strong.

Our specimens are badly rubbed. The cephalothorax is yellow. The eyes are placed on large black tubercles and have yellowish-white hairs around them. On the clypeus are long white hairs. The integument of the abdomen is pale with a pattern formed of dark streaks. On the pale parts are some white hairs. The falces are smooth, of a reddish color with white hairs. The legs are pale, tinged with red, the tibia of the first being darkened at the distal end.

We have one female.

Pseudamycus amabilis sp. nov.

This is a large and distinctly marked female. The legs are yellow, the cephalothorax reddish-yellow with red and yellow hairs on the eye-region. The abdomen has a wide light band down the middle. The anterior sides have dark streaks on a light ground, and the posterior sides are dark brown, each marked with a conspicuous white or yellow band.

♀. Length 9 mm. Legs 3124, first and second pairs a little the stoutest.

The cephalothorax slopes rather steeply in both directions from the dorsal eyes and is wider in the thoracic than in the cephalic part. The lateral eyes of the first row are more than half as large as the middle eyes and are a little separated from them. The eyes of the second row are about halfway between the lateral and the dorsal eyes and are separated from the latter by a deep depression. The falx has one tooth on the lower margin and opposite to this, on the upper margin, two teeth, close together.

The spines are long. The tibiæ of the first and second legs have 3–3 with laterals, and the metatarsi have 2–2 without laterals. On the third and fourth legs they are numerous and strong.

In our specimens the sides of the cephalothorax are rubbed bare, but all the eyes are surrounded by yellow hairs, which also grow thickly on the cephalic square. A band of bright red hairs runs along the side of the cephalic plate from the lateral to the dorsal eye, and there is a red patch behind the dorsal eye. The hairs on the clypeus are white. The falces are reddish, the palpi pale and the legs yellow. The abdomen has a band of yellow hairs down the middle which has a brown streak in the middle, in front. The anterior sides are marked with lines of yellow and brown hairs. The posterior sides are covered with dark brown hairs marked with a pair of white or bright yellow bands, and, further back, a pair of yellow bars. The venter is light-colored, with a large dark patch in the middle, upon which are two longitudinal lines of white spots.

We have four females from Sarawak.

Palpelius arboreus sp. nov.

This is a medium-sized dark species with a black fringe under the patella and tibia of the first leg.

♂. Length 6.8 mm. Legs 1342, first and second a little the stoutest.

The sides of the cephalothorax are nearly parallel, the widest point being just behind the dorsal eyes from which the thoracic part falls steeply. The front eyes form a straight row, the lateral being more than half as large as the middle eyes, and separated from them. The second row is nearer the third than the first. The third row is scarcely narrower than the cephalothorax.

The tibia of the palpus is about as long as the tarsus. The falx has one tooth on the lower margin. The upper margin has two, one longer than the other, not quite opposite the one below. The spines are long, the first and second legs having 3-3 under the tibia and 2-2 under the metatarsus, besides lateral spines on both joints. The third and fourth legs have strong and numerous spines, there being a circle of five on each metatarsus.

Our specimens are somewhat rubbed. The cephalothorax is dark, the cephalic plate being black, with patches of red hairs along the sides, white hairs on the middle, and rings of red hairs around the front eyes. There is a tuft of long white hairs on the middle of the clypeus. The abdomen, which, under alcohol, is pale with brown chevrons, when dry shows a covering of yellow hairs and a good many dark brown streaks which form indistinct transverse bands. Low down on each side, at the posterior end, is a large spot of red hairs. The falces are dark red. The palpus is reddish with a pale spot at the end of the tarsus. The legs are light brown and have the patella and tibia, in the first and second pairs, darkened and bearing a fringe of black hairs below. We have two males.

Palpelius albofasciatus sp. nov.

A medium-sized species with a conspicuous transverse white band, edged with black, on the abdomen.

♀. Length 7 mm. Legs 3412, first and second thickened.

The cephalothorax is large and high and convex. The cephalic part slopes a little forward; the thoracic rounds off gradually in the first third and then drops steeply. The sides are nearly parallel through the middle part, widening somewhat behind the dorsal eyes, and are a little wider below than above. The quadrangle of the eyes is one-fourth wider than long, is equally wide in front and behind and occupies nearly half of the cephalothorax. The front eyes are subtouching and form a row that is plainly curved down. The middle are fully twice as large as the lateral. The second row is a little nearer the first than the third, and the third is slightly narrower than the cephalothorax. Between the eyes of the second and third rows is a distinct groove. The falces are vertical and rather stout, with one tooth on the upper and one on the lower margin. The sternum is rather pointed behind, wider and rounded in front. The abdomen is narrower than the cephalothorax and is pointed behind. The first and second legs are without lateral spines, the tibia having 3–3 below, and the metatarsus 2–2. There are numerous spines on the third and fourth, the metatarsus of the third having two, and that of the fourth three circles.

The cephalothorax is red-brown, with the eyes on black tubercles. Judging from our specimen, the eyes are surrounded with red hairs. White hairs grow over the cephalic sides and upward in an oblique bar between the eyes of the second and third rows. There are long white hairs on the clypeus and on the brown falces. The front end of the abdomen is covered with white hairs. Behind the middle there is a wide transverse white band deeply edged with black, and back of this are alternate black and white chevrons. The legs are barred with brown and black, the first and second pairs being the darkest. The black parts seem to have borne black, and the brown parts white hairs. The palpi are barred with lighter and darker brown.

One female, from Sarawak.

39—S. & A.

Palpelius nemoralis sp. nov.

This is a large species with the first and second legs stoutest, bearing fringes.

♂. Length 10 mm. Legs 1324.

The cephalothorax is highest at the dorsal eyes. The cephalic part is strongly inclined, and the thoracic falls steeply. The sides are sometimes nearly parallel, sometimes rounded, but always a little widest in the thoracic part. The quadrangle of the eyes occupies about one-half of the cephalothorax, is one-third or one-fourth wider than long, and is equally wide in front and behind. The front eyes are large and are close together, forming a row that is a little curved downward. The middle are less than twice as large as the lateral. The second row is about halfway between the others. The third row is narrower than the cephalothorax, the eyes being on large black tubercles. The sternum is oval and rather narrow, and is truncated in front. The front coxæ are separated by the width of the labium, which is but little longer than wide. The falces are long, stout and projecting, and have one tooth on the lower margin, and two, one larger than the other, on the upper margin. The first and second legs have, besides lateral spines, 3–3 under the tibia and 2–2 under the metatarsus. The third and fourth legs have numerous spines. The tarsus of the palpus is about as long as the tibia and patella together.

The cephalothorax is dark brown with a white line around the margin, and bright yellow hairs on the sides. The hairs around the eyes are bright red. Our specimens are rubbed and have no hairs left on the cephalic plate. Those on the dark red clypeus and falces are white. The abdomen has a thin covering of bright yellow hairs on a dark brown ground. On each side, at the posterior end, is a spot of red hairs. The legs are dark reddish-brown with pale tarsi. The first leg, which is darker than the others, has a thick black fringe under the patella, tibia and tarsus, which is repeated, in a less degree, on the second leg. The palpus is pale excepting the tarsus, which is red.

We have a light and a dark variety of this species.

Pancorius fasciatus sp. nov.

♂. Length 8.5 mm. Legs $13\overline{42}$, first a little the stoutest.

The cephalothorax is high and convex, rounding up from the first to the third row of eyes, and then down, in an equal degree, through two-thirds of the thoracic part, when the descent becomes steeper. The sides are widely rounded, as in males of *Thyene,* the widest point being behind the dorsal eyes. The cephalothorax is plainly narrower above than below. The quadrangle of the eyes occupies less than two-fifths of the cephalothorax, is one-fourth wider than long, and is slightly wider in front than behind. The front eyes are large and close together, the middle being nearly twice as large as the lateral. This row is curved upward. The cephalothorax is depressed behind the eyes of the second row, which is halfway between the others. The third row is plainly narrower than the cephalothorax, the eyes being elevated. The sternum is rounded, not much longer than wide, and truncated in front. The coxæ of the first legs are separated by more than the width of the labium, which is longer than wide. The maxillæ have long apophyses at the outer corners. The falces are vertical and very wide, with long, strong fangs. They have one tooth on the upper and one on the lower margin. The armature of the first and second legs is 3–3 on the tibia and 2–2 on the metatarsus, with stout, large lateral spines on both joints, those on the metatarsus being so low down as almost to form a third inferior pair.

The specimen which we have shows a black iridescent cephalic plate, and a thoracic part of reddish-brown. Yellowish-white hairs form a band down the middle of the thoracic part, and a few hairs of the same color are left around the eyes. Long white hairs border the edge of the clypeus and are scattered over the falces. The sides of the abdomen are dark and seem to have been covered with deep yellow hairs. Down the middle is a wide band of pale yellow hairs, which is somewhat arrow-shaped in front, and is outlined on the sides with black. The legs are reddish-brown, the tarsi lighter in color than the other joints, covered with short white hairs and having a thin uneven fringe of brown hairs on the tibia of the first.

One male.

The spine on the falx distinguishes the males of *protervus, curtus, dentichelis* and *borneensis* from *fasciatus.*

Pancorius animosus sp. nov.

This species has the cephalic plate red with a white central band.

♀. Length 8.5 mm. Legs $3\overline{41}2$, first and second pairs a little the stoutest.

The cephalothorax is rather high with the cephalic part plainly inclined forward. The thoracic part has a horse-shoe shaped part which falls a little from the dorsal eyes, and beyond this the descent is steeper. The sides are parallel and nearly vertical, widening very slightly below the eyes and then curving inward, so that the lower margin of the cephalic and of the anterior thoracic part is not visible from above. The quadrangle of the eyes occupies two-fifths of the cephalothorax, is one-fourth wider than long and is very slightly wider in front than behind. The front eyes are rather large, close together, in a row that is bent downward, the middle being less than twice as large as the lateral. The eyes of the second row are a little nearer the lateral than the dorsal eyes and are placed behind large black tubercles which rise between them and the lateral eyes. The third row is nearly as wide as the cephalothorax. The sternum is longer than wide and is truncated in front. The front coxæ are separated by the width of the labium, which is a very little longer than wide. The falces are vertical and stout with a single tooth on the lower margin, and two opposite, one larger than the other, on the upper margin.

In the first and second legs the tibiæ have 3–3 spines, and the metatarsi 2-2. Lateral spines are found on the tibiæ but are lacking on the metatarsi.

Our specimen is damaged. The cephalothorax is reddish-brown with a black band around the lower margin and black tubercles on the eye-region. The cephalic plate is covered with red hairs except for a central white band. Between the eyes of the second and third rows are patches of white hairs, and lower down on the sides are wide white bands which meet behind. The hairs around the eyes of the first row are red, excepting at the inner edges of the middle eyes, where they are white. The clypeus is narrow and has long white hairs at the edge. The face has lines of red and white hairs under the lateral eyes. The falces are reddish with white hairs. The abdomen is badly damaged, but shows a dark band around the front end with a white band above it, and some white hairs behind. The legs are banded with dark and light brown, the femur and tibia being darker than the other joints, especially in the first and second legs. They have a good many white hairs. The palpi are brown with black and white hairs.

A single female.

Telamonia resplendens sp. nov.

♀. Length 4.5 mm. Legs 4312, first pair stoutest.

The cephalothorax is high, with the cephalic part level and the thoracic falling steeply from the dorsal eyes. The sides are vertical in front, but widen out a little below in the thoracic part. The quadrangle of the eyes occupies more than half of the cephalothorax. The front eyes are close together in a straight row, the middle being twice as large as the lateral. The second row is a little in front of the middle. The third is as wide as the cephalothorax, with the eyes projecting. The clypeus is two-thirds as wide as the middle eyes. The falx has a single tooth on the lower margin. The lateral and inferior spines on the first and second legs are all long. The tibia of the first has four pairs, and the metatarsus three pairs; the tibia of the second three pairs, and the metatarsus two pairs.

The cephalothorax is covered with very brilliant dark blue scales. There are wide white bands low down on the sides of the thoracic part, and some white hairs over the eyes and on the clypeus. The abdomen is light brown with two dark streaks on the dorsum and a dark curved band on each side, and between these bands are bright iridescent scales. The palpus has bright scales on the tibia, and the femoral joints of all the legs are more or less iridescent. The color of the legs is light brown, the first having a dark streak down each side.

One female.

Telamonia cristata sp. nov.

A handsome species with wide white bands and a central white spot on the thorax, and a transverse white band between two black bands on the abdomen. Over the middle eyes of the first row are tufts of black hairs.

♂. Length 5.9 mm. Legs $1\overline{43}2$, first pair stoutest, darkest and much the longest.

The cephalothorax and eyes are like those of *T. annulipes*, excepting that the front row is more plainly curved, with the lateral a little separated from the middle eyes. The sternum is truncated in front.

Our specimen is rubbed but still shows handsome markings. The cephalothorax is dark-colored, with black tubercles in the eye-region. The cephalic plate is covered with bluish iridescent scales, but in the middle, over the first row of eyes, is a large spot of white iridescent scales; on each side of this, projecting obliquely over the middle eyes, is a tuft of black hairs, which shows conspicuously from in front. The white iridescent scales appear also in patches between the eyes of the second and third rows, in a central spot on the thorax, and in wide bands which begin under the dorsal eyes and meet behind. Above these bands is a wide black band and below them is the black margin. The front, sides and face are dark, with a line of white hairs on the edge of the clypeus, which is one-half as wide as the middle eyes. The abdomen has a covering of golden yellow hairs with a darkened region in front. Across the middle is a transverse band of white iridescent scales bordered in front and behind by a black band. At the posterior end are three black spots, one in the middle and one on each side. In front of the side spots are patches of the white scales. The palpi are white, covered with white iridescent scales, excepting the tarsi, which are dark with dark hairs. The legs are brown, with light-colored metatarsi and tarsi, and a pale region at the proximal end of the femur in the third and fourth. They are almost entirely covered with white iridescent scales. The femur and patella of the first leg are somewhat thickened. The falces are dark brown, making a contrast with the white palpi. They are vertical, and in the first half they are parallel, but in the second they diverge widely. The fang is long. There is one tooth on the lower margin, and one on the upper.

We have one male from Manila, which is described here because of its resemblance to *T. annulipes.*

Telamonia annulipes sp. nov.

A beautiful yellow species marked with spots of iridescent white outlined in black.

♂. Length 6.5 mm. Legs $\overline{14}32$, first pair plainly stoutest.

The cephalic part is nearly level. The thoracic falls in a long, rounded slope from the third row of eyes. The sides widen out in the thoracic part. The quadrangle of the eyes occupies less than one-half of the cephalothorax, is about one-fifth wider than long, and is a little wider in front than behind. The front eyes are near together and moderately large, and form a slightly curved row. The middle are less than twice as large as the lateral. The second row is halfway between the others. The third row is not as wide as the cephalothorax. The sternum is wide in front and narrow behind, not truncated. The front coxæ are separated by the width of the labium, which is much longer than wide. The falces are broad, flattened and nearly vertical, with a long, pointed tooth below. The upper margin has several very fine teeth.

The spines of the first legs are 3–3 under the tibiæ and 2–2 under the metatarsi, besides lateral spines on both joints. The proximal pair on the metatarsus of the first is very stout.

The cephalothorax is yellowish-brown with darker eye-region and black tubercles for the eyes. The cephalic plate has a covering of blue iridescent scales. There are white iridescent scales in a patch above the first row of eyes, behind the dorsal eyes, and in a wide band on the sides and back of the thoracic part. Above and below this white band are black bands. In our specimen the sides of the cephalic part are rubbed bare, the white band beginning abruptly at the dorsal eyes. There is a line of white hairs at the edge of the clypeus which is one-third as wide as the middle eyes. The abdomen has a covering of silky golden hairs. At the front end is a large patch of iridescent white scales with a dark band in front of it and two black spots behind. Two transverse bands of these white scales cross the dorsum further back, one in the middle, which is edged behind by two black crescents, and one at the posterior end, which is broken, just in front of the spinnerets, by a large, round black spot. The falces are brown. The palpus is white with white hairs, except the tarsus, which is dark with black hairs. The legs have alternate rings of dark hairs and white iridescent scales. The first leg has the femur and patella dark, the tibia and metatarsus white with dark rings at the end, and the tarsus white.

We have one male.

Taivala gen. nov.

The widest point of the cephalothorax is at the dorsal eyes, the sides in front being slightly rounded while behind they contract sharply. The highest point is also at the dorsal eyes, the slope in both directions being rather steep, that behind becoming more abrupt after the first third. The quadrangle of the eyes occupies half of the cephalothorax, is one-fourth wider than long, and is slightly wider behind than in front. The anterior eyes are large, the middle close together, the lateral slightly separated from them and about half as large. This row is slightly curved downward. The second row is halfway between the others, and the third is nearly as wide as the cephalothorax. The sternum is narrow and is truncated. The front coxæ are separated by less than the width of the labium, which is plainly longer than wide. The falces bulge out in front. There is a single tooth on the lower margin, while the upper has two teeth, near together.

In the female of the type species, *T. invisitata*, the relative length of the legs is $\overline{34}\overline{12}$. The first and second legs have, besides lateral spines, three pairs under the tibia and two pairs under the metatarsus, and the third and fourth legs have many spines.

Taivala is most like *Pseudamycus* and *Afiola,* but is distinguished from these genera by having the quadrangle of the eyes wider behind than in front and by the shape of the cephalothorax.

Taivala invisitata sp. nov.

The cephalothorax is dark reddish-brown, with light yellow hairs on the sides and thorax and reddish-yellow hairs on the eye-region. A narrow band of yellowish-white hairs begins between the eyes of the second and third rows, curves outward around the dorsal eye and runs back on the thorax to meet the one on the opposite side, and directly behind the dorsal eye, in the darker region thus enclosed, is a white dot. From the meeting point of the two bands, a streak of the same color passes forward, in the middle line, as far as the dorsal eyes, and in some specimens there is a suggestion that this bifurcates and joins the one between the eyes of the second and third rows, forming a circle around the dorsal eye. On the side, below the band, at the end of the cephalic part, are two short, oblique, whitish rays. It may be that perfect specimens would show a still more elaborate pattern. There are white hairs on the clypeus and on the front faces of the dark red falces. The palpi are light-colored with a dark spot at the beginning of each joint, this giving a barred appearance. The legs are light brown with darker bars, which are more distinct in some specimens than in others. The ground color of the abdomen is made up of streaks of red and black. A white band crosses in front and passes on to the sides, where it is more or less broken, ending in a pure white spot. Down the middle is a broken white band consisting of two somewhat triangular white figures and, behind these, two transverse white bands.

Several females. Sarawak.

Taupoa gen. nov.

The cephalothorax is high and slopes steeply in both directions from the dorsal eyes. In front it is no wider than the first row of eyes, but at the second row it begins to widen. The widest point is behind the dorsal eyes. The quadrangle of the eyes occupies more than half of the cephalothorax, is wider than long by only the width of the lateral eyes, and is a little wider in front than behind. The front eyes are large and all close together in a slightly curved row. The lateral are more than half as large as the middle eyes, and are placed much further back. The lateral and dorsal eyes are on tubercles. The eyes of the second row are very small and are about halfway between the others. The third row is scarcely narrower than the cephalothorax at that place. The sternum is wide and very much rounded. The front coxæ are separated by plainly more than the width of the labium, which is a little longer than wide. The falces are small and vertical with a conical tooth on the lower margin and two teeth, near together, one larger than the other, on the superior margin. The type species has the relative length of the legs 3214, the third pair plainly longest. The first and second legs have, besides lateral spines, three pairs under the tibia and two under the metatarsus. One of the posterior lateral spines on the tibia in both first and second legs is so low down as to be nearly in a line with the inferior spines. The posterior pairs have many strong spines. Although this genus belongs to the Unidentati, in appearance it approaches *Lyssomanes.*

Taupoa mira sp. nov.

This is a delicate, light-colored species of medium size, the abdomen being brilliantly iridescent.

♀. Length 7 mm. Legs 3214, first, second and fourth pairs nearly equal, first and second a little the stoutest.

Our specimens are rubbed. The cephalothorax is yellow with the eyes on black tubercles. The sides are bare, but the eye-square seems to have been covered with bright red hairs.

The hairs around the eyes are snow-white with an intermingling of bright red. The clypeus is wide and retreating, with white hairs. The abdomen is covered with silky golden hairs and brilliantly iridescent white hairs, the pattern, unfortunately, being indistinct. There seems to have been a wide white band down the middle, and two transverse white bands. The anterior sides are golden. On each side, between the transverse white bands, is a dark bar covered with golden hairs, and at the posterior end, on each side, is an abbreviated dark band running longitudinally, also covered with golden hairs. The spinnerets are dark-colored. The under surface is light with a dark streak down the middle of the venter. The falces are small and yellow, the palpi white, the legs yellow.

Two females.

Viciria concolor sp. nov.

This male, under alcohol, is of a general light brown color, the legs being tinged with red. There are no marked contrasts excepting the black eye-tubercles. The first and second legs are fringed.

♂. Length 10 mm. Legs 1324, long, nearly equal in thickness. The front eyes form a straight row, the middle being fully twice as large as the lateral, which are a little separated from them. The small eyes are placed on the same tubercle with the laterals, and are nearer to them than to the dorsals. The third row is plainly narrower than the cephalothorax. The clypeus is one-third as wide as the large middle eyes. The falces project and are rather long and stout, with one tooth on the lower, and two on the upper margin, the one nearer the fang being the larger. The tarsus of the palpus has a spine which is directed toward the tibial apophysis. The spinal armature of the first and second legs is 3–3, with laterals, on the tibia, and 2-2, with laterals, on the metatarsus. The posterior legs have numerous spines.

Our single specimen is rubbed nearly bare. The cephalothorax is of a pale yellowish-brown color, the eyes placed on black tubercles and having left around them some white and red hairs. The clypeus is bare. The abdomen seems to have been covered with silvery-white and golden scales, but no pattern is distinguishable. The legs are reddish-brown, the first pair darkest, with a short dark fringe under the patella and double brown fringes on the tibia and metatarsus. That on the tibia is short above, and at the proximal end below, increasing in length to the extremity. The metatarsus has the proximal end bare. The upper fringe is short, and the lower one increases in length from the middle of the joint to the extremity. These fringes are repeated on the second leg. The falces are yellowish. The palpus has the femur and patella pale, and the other joints reddish.

One male, from Sarawak.

V. petulans, which resembles this species in size and in the fringing of the legs, lacks the tarsal spine on the palpus and has, under alcohol, a dark band between two white bands on the abdomen. *Arrogans* has the first metatarsus white, not fringed. *Miranda* has no fringe on the second leg. *Paludosa* is marked with black and white.

Viciria arrogans sp. nov.

The female is yellow, the male brown, both with the cephalic square white bordered with red, and a white herring-bone stripe edged with red on the abdomen. The male has the tibia of the first leg dark and heavily fringed above and below, while the metatarsus is all white, without dark hairs.

Length, ♂ 9 mm., ♀ 9.5 mm. Legs, ♂ $\overline{31}\overline{42}$, ♀ $\overline{34}\overline{12}$, first and second pairs stoutest.

The first row of eyes is a little bent downward, the middle ones being not quite twice as large as the laterals, which are separated from them. The second row is nearer the first than the third, and the third row is plainly narrower than the cephalothorax at that place. The clypeus is narrow in the male and wide in the female. The falx, in both sexes, has one tooth on the lower, and two, close together, on the upper margin. The spinal armature is rather peculiar, the tibia of the first leg having 3–3 and laterals, the tibia of the second 2–3 and laterals, while the metatarsus in both first and second has 2-2 without laterals. The third and fourth legs have many strong spines.

In the palpus of the male the tarsus is about as long as the tibia and patella together. The tarsal spine found in *miranda, concolor* and *paludosa* is lacking in *arrogans.*

In the male, the cephalothorax has a black edge, above which is a band which shades from brown up to red. Above this, the sides and thoracic part are yellow, covered with white hairs. The cephalic square is covered with white or light yellow hairs, and is bordered by a red band which includes all the eyes. The red color runs back over the middle of the thoracic part separating the two white bands. The clypeus is covered with long white hairs. The abdomen is dark brown on the sides, and has, on the dorsum, a white or light yellow herring-bone stripe edged with bright red. The amount of color in the legs varies. Usually the first and second legs have the femur, patella and tibia red or reddish-brown, with red and black hairs. The tibia of the first, and, in a less degree, that of the second, have thick fringes of black hairs above and below. The metatarsus and tarsus are pure white. The third and fourth legs are much lighter, and have the metatarsus much longer than the tarsus. In the third the femur and patella are from light to dark brown, the tibia has the proximal half light and the distal half darker, while the metatarsus and tarsus are light. The fourth leg is light with a longitudinal black band on the posterior side of the femur. The palpi are red or reddish with red and black hairs. The falces, which project, are dark reddish-brown. The under surface is very striking. The venter and sternum are dark; the mouth-parts are light or dark brown; and the coxæ are white with inky-black bands along their front faces. In one specimen these bands, on the third and fourth legs, are on the under surface.

In the female, the body, legs and palpi are light yellow with a scattering of long white hairs. The cephalic plate is covered with white hairs and is bordered by a band of bright red hairs which includes the eyes. The clypeus has a narrow snow-white band across the upper part, while below it is yellow and bare, of a deeper color than the light yellow falces. The yellow abdomen has a longitudinal band of bright red on the dorsum, upon which is a herring-bone stripe of pure white hairs. The under surface is yellow, the cephalothorax lighter than the abdomen.

Viciria miranda sp. nov.

The legs are long and slender. The tibia and metatarsus of the first are dark-colored and fringed. The palpus has the tarsus about as long as the femur, and nearly twice as long as the tibia and patella together.

♂. Length 7.5 mm. Legs 3124, long, first and second pairs a little the stoutest.

The face is rather broad, the front eyes being close together in a straight row, the middle fully twice as large as the lateral. The second row is nearer the first than the third, and the third is narrower than the cephalothorax. The clypeus is one-third as wide as the middle eyes. The falx has one tooth on the lower margin and two, close together, one larger than the other, on the upper. The spines are long, the first and second legs having 3–3 under the tibia and 2–2 under the metatarsus, besides laterals. On the third and fourth legs they are numerous.

Like *V. paludosa,* this species has a tarsal spine on the palpus which nearly touches the tibial apophysis.

Our single specimen is badly rubbed and the abdomen is damaged. The cephalothorax is reddish-yellow with light yellow hairs around the side eyes and red hairs above the front row. The clypeus and falces are dark. The abdomen is pale yellow. The legs are rather light-colored, the first and second darkest. The first, second and third have a black band on the front face of the femur, which is especially wide on the second. The tarsus is white in the first pair, brownish in the others. There is a fringe of black hairs on the distal half of the tibia of the first leg, and through nearly the whole length of the metatarsus. That on the metatarsus is double, although the upper part is not so extended as the lower, which is lacking only at the proximal end. There is no fringe on the second leg. The palpus is very long and slender. The tarsus is reddish, the other joints pale with a black streak below.

Viciria lucida sp. nov.

A pale female, with the metatarsus in the third and fourth legs only a little longer than the tarsus. The cephalothorax is yellow with the eyes on black spots, while the abdomen is light-colored, with two slender, longitudinal dark bands converging at the spinnerets.

♀. Length 8.5 mm. Legs 3412, not differing much in thickness.

The front eyes are scarcely separated from each other and form a straight row, the middle being twice as large as the lateral. The second row is nearer the first than the third, and the third is very little narrower than the cephalothorax at that place. The falx has one tooth on the lower, and two, close together, on the upper margin. In the first and second legs the tibia has, besides lateral spines, 3–3, below, and the metatarsus has 2–2 without laterals.

Our specimens are both rubbed, so that a complete color description is impossible. The yellow cephalothorax seems to have had the cephalic plate covered with light yellow hairs. The eyes are on black spots, and touches of bright red appear in front of the dorsal eyes. The clypeus is two-thirds as wide as the middle eyes and has upon it some white hairs. The abdomen seems to have been covered with white hairs, and has two dark longitudinal bands, or lines, converging toward the spinnerets. The falces, palpi and legs are yellow. The under surface is yellow, with from one to three dark longitudinal bands on the venter, and a black bar on each side just in front of the spinnerets.

This species is much like *V. moesta,* being most easily distinguished by the shorter metatarsus of the third and fourth legs. It has no dark spot on the cephalic plate, the cephalothorax is narrower at the third row of eyes, and the venter has dark bands.

Viciria paludosa sp. nov.

A small, slender male, marked with black and white bands on the cephalothorax. The first leg is not fringed. The palpus is short, the tarsus being about equal to the patella and tibia and nearly as wide as long.

♂. Length 7.5 mm. Legs $\overline{34}12$, not very long, nearly equal in thickness.

The face is narrow. The front eyes are close together in a straight row, the middle being fully twice as large as the lateral. The second row is nearer the first than the third. The third is plainly narrower than the cephalothorax at that place. The clypeus is one-third as wide as the middle eyes. The falx has one tooth on the lower and one on the upper margin. The spines are long, the tibia having 3–3 and the metatarsus 2–2 in both first and second legs, besides lateral spines.

The palpus, like that of *V. miranda,* has a tarsal spine above the apex of the apophysis on the tibia.

Our single specimen is somewhat rubbed. The cephalothorax has a white longitudinal band on the cephalic plate, the region on each side being bare. A broad black band extends entirely around the lower sides and back, and above this is a broad white band. On the thorax, just behind the dorsal eyes, is another black band. There are long white hairs on the clypeus. The falces are reddish-brown. The abdomen has snow-white hairs in front, and a white herring-bone stripe down the middle with a dark band on each side. The venter is brown with two white spots in front, a dark streak down the middle, and white spots on the sides. The legs are light, the first and second pairs tinged with red. The femoral joints are banded longitudinally in front and behind with black. There are no fringes. The palpus is reddish.

Viciria petulans sp. nov.

The cephalothorax has the sides and cephalic plate covered with white hairs, the latter being bordered with red. The abdomen has a brown band, darkest at the edges. The tibia of the first leg is lightly fringed, and the metatarsus, which is white at the proximal end, is dark at the distal end, with black hairs.

♂. Length 9-11 mm. Legs $\overline{31}42$, first and second pairs a little the stoutest.

The front eyes are close together in a straight row, the middle being twice as large as the lateral. The second row is nearer the first than the third. The third is plainly narrower than the cephalothorax. The clypeus is narrow. The falx has one tooth on the lower, and two, close together, one larger than the other, on the upper margin. The spines are long, the first and second legs having, besides laterals, 3-3 under the tibiæ and 2–2 under the metatarsi.

The palpus has the tarsus about as long as the femur and about twice as long as the patella and tibia together. The femur has three stout hairs. There is no tarsal spine.

Under alcohol the cephalothorax appears pale with a dark line on the margin, and with black spots around the eyes and in the middle of the cephalic plate. When dry, the cephalic part is seen to be covered with white hairs, bordered by a band of red hairs. The rings around the front eyes are red above and white below, and the hairs on the clypeus are long and white. Just under the lateral eyes the hairs are white, and below these there is a patch of red hairs. There are wide white bands around the sides of the cephalothorax, separated behind by a black band which passes upward from the margin of the posterior thoracic part. Under alcohol the abdomen is white with a brown band, darkened at the edges, down the middle. When dry the sides are seen to be covered with white hairs. The central band is also covered with white hairs except at the edges, where there are lines of black hairs. The falces are usually dark reddish-brown with a pale region near the insertion, but are sometimes all yellow. The palpus is pale, excepting the tarsus, which is dark reddish-brown. The first and second legs are darker than the third and fourth, being tinged with reddish-brown. They have light double fringes of black hairs on the tibia, and more distinct black fringes, also double, at the darkened end of the metatarsus, the proximal end of the metatarsus and the tarsus being white. In the third and fourth legs the metatarsus is much longer than the tarsus. The venter is dark. The sternum is sometimes all pale, but is usually pale in the posterior third and inky-black in front. Looked at from below, the coxæ, trochanters and femora are pale, with an iridescent black streak along the front side. From above, a similar black streak is visible along the back sides of the same joints.

The males of *V. petulans* and *V. arrogans* may be distinguished by the metatarsi of the first legs, which in the former species are darkened and fringed at the distal end, while in *arrogans* they are pure white. In *petulans,* the femur, patella and tibia of the palpus are pale, while in *arrogans* these joints are reddish-brown.

Viciria moesta sp. nov.

A white female, with the metatarsus in the third and fourth legs nearly twice as long as the tarsus. The cephalothorax is very pale yellow, with the eyes on black spots and a dark spot in the middle of the cephalic square, while the abdomen is white, with two slender, longitudinal reddish bands converging toward the spinnerets.

♀. Length 9 mm. Legs $\overline{4}\overline{3}\overline{12}$, first and second a little the stoutest.

The front row is straight, with the middle eyes slightly separated from each other and more widely from the laterals, which are about half as large. The second row is nearer the first than the third, and the third is plainly narrower than the cephalothorax at that place. The falx has one tooth on the lower margin and two, near together, on the upper.

In the first and second legs, the tibiæ have 3-3 spines with laterals, and the metatarsi 2–2 without laterals. The third and fourth legs have many spines.

In our specimens the sides of the cephalothorax are rubbed bare. The color is very pale, with dark red or black spots around the eyes and in the middle of the cephalic plate, which is covered with white hairs. There are long white hairs on the clypeus, which is two-thirds as wide as the middle eyes of the first row. The abdomen is white, covered with snow-white hairs, and has two slender lines of red or brown, separated in front but united at the spinnerets. The falces are yellow with some short white hairs. The palpi and legs are white with white hairs and black spines. The venter is white with a transverse black bar in front of the spinnerets.

This species is most easily distinguished from *V. lucida* by the greater length of the metatarsus in the third and fourth legs. It differs also in the dark spot on the cephalic plate, the greater width of the cephalothorax at the third row of eyes, and the white venter.

AN INVESTIGATION INTO THE BREAKING OF WATCH MAINSPRINGS IN GREATER NUMBERS IN THE WARM MONTHS OF THE YEAR THAN IN THE COLD MONTHS.

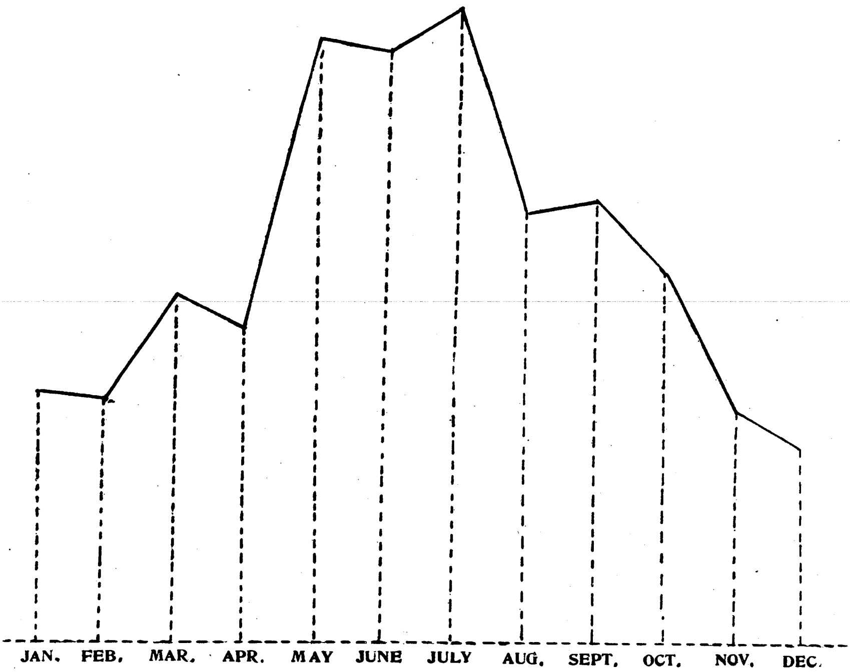
RICHARD G. NORTON.

(With Plate XXXV).

In looking over my watch-repairing record, I find that for a period of ten years, from January 1, 1880, to January 1, 1890, nearly twice as many mainsprings were broken during the months of April, May, June, July, August and September as were broken during the months of January, February, March, October, November and December. For another period of ten years, from June 10, 1893, to June 10, 1903, the record shows a total of 693 springs broken, of which 449 broke during the warm months of April, May, June, July, August and September, and 244 broke during the cold months.

It is supposed by many persons that mainsprings break in greater numbers during electrical storms than at other times; but I have good reason to think that electricity has little or no influence in the matter, since clock springs would be expected to break from the same cause. There are as many clock springs in use as watch springs, and probably more, and I am sure that during my practice of repairing watches and clocks not more than a dozen clock springs have broken to one hundred watch springs. In fact, there have been periods of a year during which I have not had occasion to replace a broken clock spring.

It is a well-known fact that platers of watch cases remove the steel springs from the cases before placing the cases in potas-



Curve showing relative numbers of watch mainsprings broken during the various months of the year.

The numbers for each month, based upon records covering the decade from June 10, 1893, to June 10, 1903, are as follows:

January, 37.	July, 94.
February, 36.	August, 65.
March, 51.	September, 67.
April, 46.	October, 55.
May, 89.	November, 35.
June, 88.	December, 30.

sium cyanide solution; otherwise the springs would break as soon as they were used, if they did not do so while still in the solution.

Some twenty years ago I had two clock movements, each of which had two springs. The springs were under stress and had been for several weeks. I dipped the movements, with the springs wound up, into a weak solution of potassium cyanide for a few minutes; upon removing them from the solution, one spring broke while in my hand, another in a few minutes, the third within fifteen minutes, and the fourth the next day. The springs were of good quality, polished and blued. The bluing was not effaced.

We know that leather and hoofs of animals, as also prussiate of potassium, bound around iron which is then subjected to a given heat and while hot plunged into water, will case-harden the iron and convert its surface into a kind of steel. We also know that upon filing the surface of a block of tool steel and then rubbing the surface with the hand, the surface becomes hardened so that upon filing the steel again the file does not "bite" readily.

The facts above mentioned incline me to think that during excessively warm and sultry weather there emanate from the human body certain substances which have an effect upon the already hardened steel similar to that cited above—possibly some subtle emanation not yet discovered—and of a kind that is less active in the cold months.

Assuming this cause to be eliminated, the springs, in the nature of things, would break, but not in greater number in any one month than in another.

The two decades mentioned would seem to be a fairly good basis upon to reason.

The diagram accompanying this paper shows the number of springs broken during each month for the ten years from June 10, 1893, to June 10, 1903.

WISCONSIN'S QUARTZITE IMPLEMENTS.

CHARLES E. BROWN.

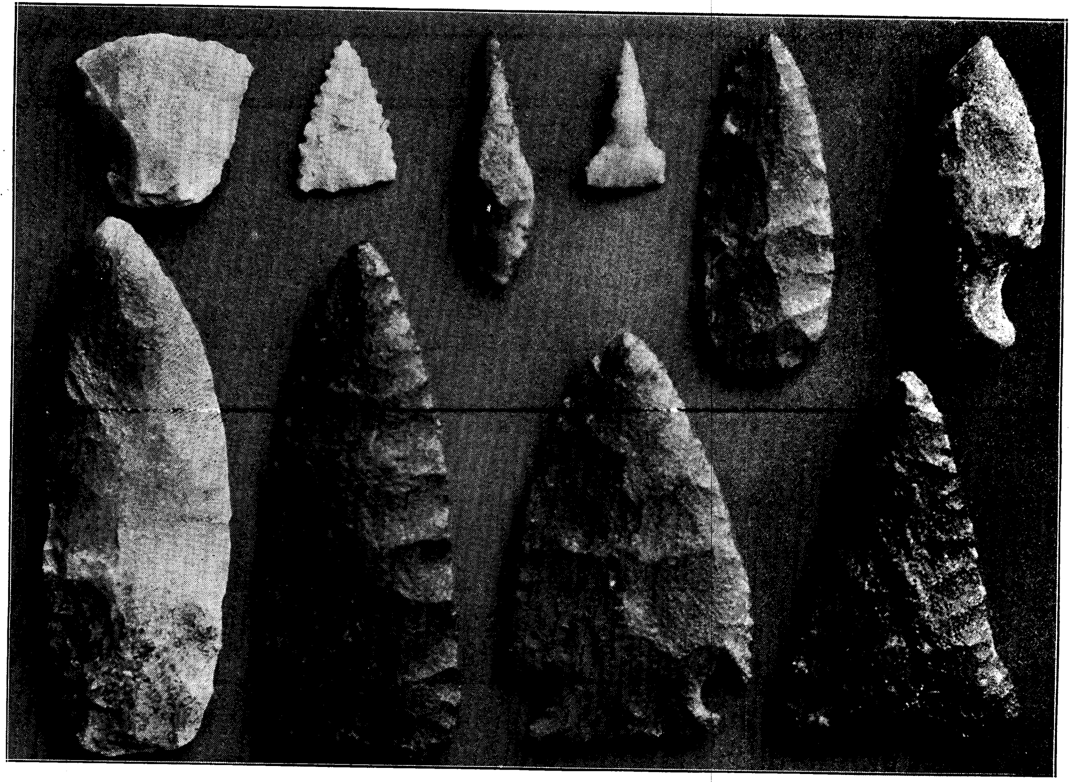
(With Plates XXXVI and XXXVII).

Not the least interesting of Wisconsin's prehistoric implements are her quartzites, and it is therefore strange that in her archaeological literature they should have been so utterly neglected. It is because the author believes them worthy of greater attention on the part of local students that this modest contribution is offered.

On the subject of Wisconsin's rich store of native copper implements and ornaments, their authorship, manufacture and functions, volumes of matter good, bad and indifferent have been written, and largely, perhaps, in consequence of the great interest in these, the study of other classes of aboriginal artifacts, none the less interesting and worthy of investigation, and some of them peculiar to this region, has been retarded.

This, however, is not altogether unfortunate, since it leaves to the student of the present day, when careful and painstaking research conducted according to enlightened and scientific methods is becoming the rule, an opportunity to solve, unhampered by previously constructed and illy substantiated theories, the problems of their origin, purpose, workmanship and distribution.

Wisconsin's quartzite implements are certainly worthy of attention. Examples are to be seen today in every one of several hundred local, public and private cabinets. The F. M. Benedict, H. P. Hamilton, the Logan museum, and others of the larger Wisconsin collections, are already rich in specimens of this material, the Benedict and Logan museum collections



perhaps particularly so. The late F. S. Perkins of Burlington is known to have taken a great interest in them and to have possessed in the several collections assembled during his lifetime many fine examples.

The great beauty of many of these aboriginal artifacts must be seen to be appreciated. No description or ordinary illustration can convey an adequate conception of the beauty of the material or of the artistic excellence of the workmanship of many of them. What agate and obsidian implements are to the West, our quartzites are to Wisconsin. We have thus perhaps but little reason to covet the idols of our neighbors. The range of color is broad, from white to dark bluish gray, from light through various shades of brown to a rich orange, and from pinkish to a bright carmine. Those of a light brownish color, the "maple sugar" color of some collectors, are perhaps the most common and widely distributed. A small number are of chocolate brown, brick red, dark purplish or intermediate shades of color. Not infrequently one implement exhibits several shades of color in the shape of bands or clouds.

Like other stone implements, they present all grades of workmanship and finish. Some, perhaps the majority, are of ordinary workmanship, while others are finely or exquisitely chipped, and occasionally are found specimens whose surfaces have been smoothed and the traces of the ancient flint chipper's art thus wholly or partly obliterated.

THE IMPLEMENTS.

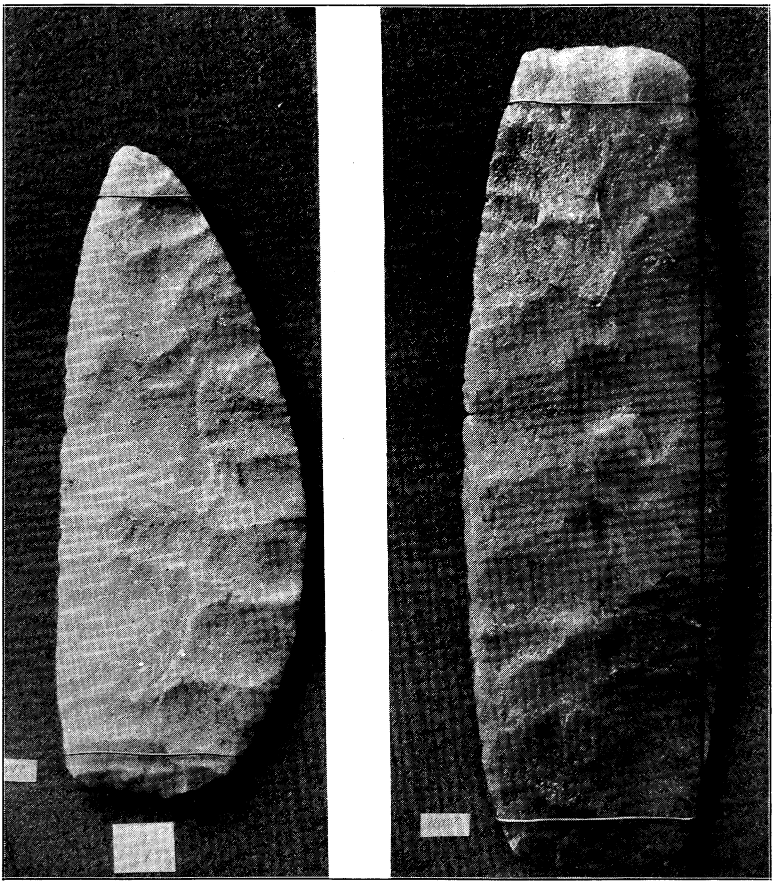
Among the very large number of specimens examined by the author in various Wisconsin collections, arrow and spear points and knives far outnumber all other classes of quartzite implements. The number of quartzite drills and scrapers which have come to his notice is comparatively small. Among the arrow and spear points, the variety of form appears to be almost, if not quite, as great as among the flint implements, not a few of even the more graceful types being successfully imitated in this refractory material. Several of the forms referred to below are figured in Plate XXXVI.

A considerable number of small triangular points have in the past been collected from an aboriginal village site located near the outlet of Wind lake, in Racine county. Some of these, in the writer's possession, are delicate marvels of aboriginal workmanship, and do not exceed half an inch in size. Among them are a few of pentagonal shape. All are of a light brownish quartzite. Others have come from various sites in the Fox river valley, the Wisconsin valley and the Lake Michigan shore region. From certain sites on the shores of Lakes Buffalo and Winneconne, hundreds have been collected. Small triangular points with serrated edges are apparently of rare occurrence.

Triangular points of larger sizes are also found. A few of these have indented bases. A series of five of these of a dark grayish color, possibly of the Portland quartzite, were found by the writer accompanying a burial on the extensive Two Rivers sites. One of the largest of these triangular points, in the Benedict cabinet at Waupaca, of the same material as the foregoing, measures 7½ inches in length and 3½ inches across the indented base. In the Vogel collection at Milwaukee are several fine, large-sized triangular points.

The stemmed forms of arrow and spear points are the most numerous. Many of these are rudely, some very well made. A small number have the shoulder produced to form a barb. Some fine examples of the stemmed forms in variously colored material are in the Logan museum at Beloit, in the Benedict collection, and in the H. R. Denison collection at Milwaukee. A particularly large point from Keyesville, Richland county, in the possession of Rev. J. G. Laurer, measures nearly 7½ inches in length and over 2½ inches across the extreme width of its broad blade. Specimens with beveled edges are of very uncommon occurrence.

The stemless or leaf-shaped forms are likewise quite numerous. The precise function of many of these is not always readily ascertained. Many, of crude workmanship, are evidently simply blank forms awaiting conversion into serviceable implements. Quite a number are doubtless knives, and some may have served as projectile points. They range in size from 1¼ inches to over 6 inches. One beautiful ex-



ample in the Schuette cabinet at Manitowoc, found in that city, is pointed at the extremities, 8⅛ inches in length and 2¾ inches in breadth at its middle.

Long, slender blades with straight or rounded, or more rarely indented, bases, occur in various Wisconsin cabinets. Some of these are remarkable examples of the aboriginal stone-worker's art. One of these, in the Laurer collection, is 8⅛ inches in length and less than ½ inch in width at its middle. It comes from Monroe county. An example from Waupaca, in the Benedict collection, is 8½ inches in length.

What is perhaps the finest quartzite ceremonial as yet obtained in Wisconsin (Plate XXXVII, Fig. 2) is in the Elkey collection in the Logan museum at Beloit. Both extremities of this piece are nearly square, the sides curving gradually to meet them. It is 8⅛ inches in length, less than 2 inches in width at the squared ends, and 3 inches in width at the middle. It is finely chipped, semi-transparent at the edges, and of a grayish color, clouded at one extremity with orange. It comes from Dykesville, Kewaunee county.

A specimen from Brookfield, Waukesha county, of opaque, grayish-white quartzite, formerly in the W. H. Ellsworth collection, was diamond-shaped in outline. It measured 6½ inches in length and 1¾ inches in width at the middle. A knife of whitish quartzite (Plate XXXVII, Fig. 1), 7⅛ inches in length, comes from Clifton, Monroe county. One edge of this specimen is nearly straight, the other broadly curved. It measures nearly 3 inches across its middle. Specimens similar in outline have been obtained from other localities. Rarely there is seen, among the smaller of these stemless quartzites, a style of point from either side of the surface of which, from the base upward, a long narrow flake has been struck, presumably to allow of the better attachment of a wooden shaft or haft.

From the banks of the Wisconsin river near Richland City was obtained a large semi-circular knife or scraper. This implement measures nearly 4½ inches across its straight edge.

Quartzite discs are of infrequent occurrence in collections. One of these, of ochre-colored quartzite, measuring nearly five inches in diameter, comes from Waupaca county. A smaller disc of a grayish color is in the Logan museum. The locality is Whitestown, Vernon county.

Several quartzite celts or hatchets, from Cedarburg and Boltonville, are in the Ellsworth collection, now in Beloit college. Their surfaces are roughly chipped. The largest measures about 4½ inches in length. The existence of several quartzite hammers or club-heads has been reported, but none of these have been examined by the writer.

Discoidals or "tchunkee" stones of this material are occasionally obtained from local village sites. These are very symmetrical in form and smoothly polished. A fine specimen in the Benedict collection, of a light brownish color, measures 3½ inches across its face and one inch in thickness. The depressions on either face are of a nearly uniform depth of ¼ inch and extend to within about ¼ inch of the circumference, leaving a narrow rim. A somewhat smaller specimen of the same type, from the township of Moundville in Columbia county, is in the Logan museum. In the S. D. Mitchell collection at Green Lake is another fine example. Excelling all of these in point of excellence of workmanship, is a discoidal now deposited in Milwaukee-Downer college by the Wisconsin Archaeological Society. This specimen is probably the one described and figured in Lapham's "Antiquities of Wisconsin" (Fig. 58), although the illustration given of it there is poor. It measures about 3¼ inches across the face of the disc and 1½ inches in thickness. The cups are conical and connected at their apices, thus giving a perforation through the center. This is the only quartzite discoidal known to the author, which possesses this feature. It was found at Milwaukee. The material is of a light brownish color.

THE MATERIAL.

The following brief notes as to the nacure and occurrence of quartzite in Wisconsin, condensed by the author, are extracted from the report of Dr. E. R. Buckley, formerly assistant geologist of the state, in "The Building and Ornamental Stones of Wisconsin" (Bull. Wis. Survey, No. 4).

"Originally it was a sandstone, formed through aqueous deposition, which later became cemented through metamorphic agencies. It is composed essentially of quartz (grains), and the cementing material is silica. Iron oxide is often present, imparting to the rock a red or brown color. Frequently other very subordinate constituents are associated with the quartz. The color varies through white, gray, red, blue or brown. Quartzite is one of the hardest and most durable, and an exceedingly refractory stone, and is worked only with the greatest difficulty.

"Quartzite is quite widely distributed, in isolated areas, throughout that portion of the state largely underlain by sedimentary rocks. It is all of pre-Cambrian age, and thought to be mainly Upper Huronian, although in some instances there is no reliable information on this point. Numerous outcrops of quartzite occur in Sauk county, some thirteen distinct areas having been mapped. Together they constitute what are known as the Baraboo bluffs. Extensive outcrops are found in Barron county, near Rice Lake, in Jefferson county, near Waterloo, and in Dodge county, near Portland.

"Other large mounds of quartzite occur in Juneau county, near Necedah, and in the central portion of Chippewa county, T. 32, R. 7 W. Besides the above mentioned areas, quartzite outcrops in many places in the great northern crystalline area, but the outlines of these areas have not yet been determined."

In a recent letter, Dr. Buckley has very kindly furnished the following additional information:

"The quartzite in the Baraboo bluffs varies in color, but is chiefly of a pinkish or reddish tint. That at Rice Lake is frequently almost white, although this is also mainly stained with iron oxide. That at Waterloo and Portland is slightly colored, although the tinting is much lighter than at Baraboo. The Necedah quartzite is also tinted. Most of the quartzite near Wausau and Mosinee is either white or transparent and glassy. Some of this, however, is also tinted a light reddish or pinkish color.

"In the western and southwestern parts of the state—at Arcadia, for example—there are layers of quartzite in the Potsdam sandstone which have a "maple sugar" color and appearance. I have found arrowheads in these parts of the state which resemble the quartzite referred to, and I have been led to believe that these were the sources of much of the material from which they were made."

T. C. Chamberlin mentions that many boulders of bluish-gray flinty quartzite found in the eastern sections of the township of Deerfield, Dane county, have evidently come from mounds of Archaean quartzite that rise through the St. Peters sandstone in Portland township, in Dodge county. Some of the Mosinee hills quartzite he reports as stained with yellow, translucent in thin pieces and very brittle (Geology of Wisconsin, vol. 2.)

REMARKS.

Associated with other aboriginal workshop refuse, on many as yet uninvestigated Wisconsin village and camp sites, chips, flakes and blanks of quartzite are to be found. At various places along the shores of Lake Buffalo, in Marquette county, such evidences and quartzite implements are reported to have been formerly quite abundant. Of the latter, one Montello collector is known to have possessed hundreds of examples.

Publius V. Lawson of Menasha, the well known student of archaeology, in a recent letter says:—"I have found chips of quartzite and cores or stock blocks from which implements had been or might have been made. Quartzite implements are found on the shore of Lake Winnebago at Brighton Beach, at Little Lake Butte des Morts at Winneconne, and in the township of Poygan, in Winnebago county. I have triangular points from Aztalan, the shell heaps of Little Butte des Morts, and from Bear lake, in Waupaca county."

An attempt is now being made by Wisconsin students to locate, in the Baraboo ranges and elsewhere, the quarry sites from which the raw material was obtained by the aborigines, and where it was probably "roughed out" into forms convenient for transportation to the village and workshop sites. When this is accomplished, a more complete study will be possible of the methods of manufacture and of the distribution of these implements within the bounds of the state.

Quartzite implements are widely distributed throughout Wisconsin, and while it is probable that the greater frequency of their occurrence in certain localities than in others is due to the absence of other suitable and more easily worked materials, it is probably equally true that the aboriginal inhabitants of other parts of the state appreciated the durability and beauty of quartzite, and that trades were conducted and extended journeys made for the purpose of securing it.

To what extent Wisconsin quartzites, either as blank forms or as finished implements, may have reached surrounding states in the course of aboriginal trade, we do not know. With the great supply at hand it would appear to have been unnecessary for our aborigines to import any of this material from Ohio or elsewhere.

THE GROWTH AND ORGANIZATION OF THE STARCH GRAIN.

R. H. DENNISTON.

(With Plates XXXVIII—XL.)

INTRODUCTION.

Perhaps no subject was more studied by the earlier investigators of the plant cell than the starch grains and the plastids with which they are associated, and some of the first data which were established as to the organization of the cell were worked out in this connection. In more recent years the nucleus and its functions have claimed an excessive share of the attention of cytologists, and the recent summaries of our knowledge of starch and plastids show little advance beyond the discoveries of Schimper and Schmitz. Visible stages in the process of starch formation are still unknown, with the exception of one or two discoveries to be mentioned later.

The main steps by which our present views of starch and plastids were developed may be briefly summarized as follows: Our real knowledge of starch formation and the function of the chlorophyl bodies dates from the work of Sachs in 1862 (31, p. 365). In this paper Sachs advanced the doctrine that the starch in the chlorophyl grains is the first visible product of assimilation, a doctrine which has stood to the present time for the chromatophore without pyrenoids. This is the current statement of the textbooks. Timberlake, however (39, p. 624), has found that in *Hydrodictyon* the starch grains are formed from segments of the pyrenoids, so that in this case the starch is not the first visible product of assimilation.

Various theories were held by the earlier writers as to the nature and manner of origin of the chloroplasts or chlorophyl-bearing bodies of the cell. Mulder believed that they form from starch grains. Von Mohl thought that they have their origin in the cytoplasm. Schimper (34, p. 6) first developed the conception that the chloroplasts are permanent cell organs and arise only by the division of pre-existing similar bodies. He studied especially *Hyacinthus, Daphne* and *Torenia,* three plants widely separated systematically, and found chromatophores in the embryo-sac and egg cell of each. He also found chromatophores in the egg cells of the moss *Atrichum* and of the liverwort *Anthoceros.* On these observations he bases his doctrine that the chloroplasts are permanent cell organs and never arise *de novo* from the cytoplasm. Schimper also developed the doctrine that chlorophyl bodies, leucoplasts and chromoplasts are all homologous structures and proposed the term "plastid" to include them all (34, p. 30). He also believed that the leucoplasts and chloroplasts are capable of further metamorphoses into other sorts of plastids, but that the chromoplasts are fixed, as a rule, although he claims to have found the red and yellow chromoplasts in the carrot becoming green on exposure to light.

Schmitz (37) described the presence of chloroplasts in both the egg cells and spores of the Algae and agrees with Schimper that they are permanent cell structures for these plants. Von Mohl, in 1837, discovered that the chlorophyl grains can be separated into two substances, a green material soluble in alcohol and ether, and a colorless proteid which determines the form of the grain. Sprengel and Meyen believed the chlorophyl grains to be little vesicles. Nägeli was a supporter of the latter theory and thought that he could distinguish in the chloroplast a whitish membrane with green contents.

In more recent times the vesicular theory has had but few supporters, and Von Mohl's theory as elaborated by Sachs is the one generally accepted. According to this latter view, the chlorophyl grain is composed of a ground mass of colloidal consistency which in its chemical composition is probably a proteid. In this the green substance is imbedded.

Pringsheim concluded that the proteid of the chlorophyl grain consists of a spongy reticulum, which he called the "stroma." This stroma is saturated with a green solution consisting of an oil, in which the cholorophyl is dissolved. Pringsheim's results have been supported by those of Schmitz and Meyer, who were of the opinion that the stroma consists, not of a homogeneous plasmatic body, but of a porous, spongy mass. Meyer has also found dark-colored grains imbedded in the stroma, which he calls "grana." Schimper concluded that the chloroplasts consist of a colorless stroma containing numerous vacuoles filled with the green chlorophyl in solution.

Nägeli, in 1846 (23, p. 143), was the first to observe the leucoplasts. He described them as vesicles filled with starch. Schimper, in 1880 (35, p. 881), described the leucoplasts as specialized colorless organs of the cytoplasm which he called "starch formers." In a later paper he gave them the name "leucoplasts." According to Schimper, the earliest mention of chromoplasts is by Unger in 1846. Von Mohl (20, p. 361), in 1851, mentions the yellow crescent-shaped color bodies found in the yellow leaves of *Strelitzia*. Schimper (34, p. 2), in 1885, found evidence that they are homologous with the chloroplasts and may arise from the same rudiments in the egg.

The leucoplast has been termed by many physiologists a cell organ. We also consider a plant cell from one of the higher plants as a unit of structure of an organ of the plant. The higher plants are made up of tissues and organs, and from this standpoint the cell is the unit which cannot be sub-divided into units comparable to cells. But the cell is also an organism, and we may properly speak of those parts of the cell which have a permanent existence and perform a special function as cell organs. These are not homologous, however, with the organs of the higher plants, nor is the organization of the cell directly comparable to that of a plant part. From this standpoint we may call plastids and vacuoles cell organs. Verworn (41, p. 58) has proposed to call them "organoids," but there seems to be slight justification for calling them *organ-like* bodies when they belong to a morphologically different class.

The plastid, in the formation of the starch grain, shows several points of resemblance to the plasma membrane in the formation of the cell wall. Both are plastic proteid bodies from which carbohydrates are formed. The carbohydrates in each case show a similar stratified structure, the starch grains being formed of laminae which are laid down upon the surface of the grain much as the cellulose layers are deposited in forming the cell wall. There is, however, probably no great significance to be attached to this similarity.

THE STRUCTURE OF THE STARCH GRAIN AS INDICATED BY ITS STAINING REACTIONS.

Fritzsche (11, p. 129), in 1834, in the case of the potato starch grain, first noted the presence of concentric layers which completely surround what he called a spherical space. This space is usually located at one end of the grain. He believed the appearance of light and dark layers is caused by the varying water content, and that the density of layers deposited by day is different from that deposited by night. The outside layer is of special density according to Fritzsche, due to its becoming infiltrated with a large amount of proteid substance.

Von Mohl (21, p. 45) believed as did Fritzsche, that starch grains consist of superimposed layers of varying density, but composed of the same substance. He found no cavity in the center in fresh grains, but noted that one is developed on drying. Nägeli (24, p. 18) also thought that the layers of the starch grain are due to differences in density as a result of varying water content. He believed that the layers are closed vesicles, and that they form, not one outside the other, but one inside the other.

Schimper (36, p. 192) believed that the young starch grains are composed of a homogeneous dense substance. The grains increase in size, and a weakly refractive region develops in the middle. This is the hilum. The formation of the hilum causes a reduction in the strain on the surrounding starch, with the result that a loose layer forms between two denser ones.

Strasburger (38, p. 147) considered the weakly refracting layers as limiting lines or adhesion surfaces between lamellar complexes. Meyer (18, p. 107), holding that the grains are composed of crystalline units, explained the light and dark layers by the assumption that where there are many and large pore canals between the trichites the layers are loose, and that where the trichites are more closely packed the layers are dense. He observed also that, when grains are dried at 20°C over sulphuric acid in a vacuum, scarcely a trace of lamination remains.

Salter (32, p. 6) found that the starch grains show alternate light and dark blue layers with Flemming's triple stain. He concluded, since the aniline dyes are so easily removed from the stained starch grains, that staining is merely a process of imbibition of the coloring matter between the particles of starch substance. The layers taking the dark violet stain he supposes to be loose and watery, the less refractive layers of the unstained grain.

Meyer (18, p. 149) stained with methyl violet and then applied a very dilute solution of calcium nitrate, with the result that a large part of the stain was precipitated as a granular mass in what he holds to be the loose layers. Neither Meyer nor Salter furnished satisfactory evidence as to whether it is the dark or light layers of the unstained grain which take the deepest color in staining.

Fischer (7, p. 81) carried these precipitation experiments somewhat further by using picric acid as a precipitant instead of calcium nitrate. He allowed a drop of the dilute aqueous stain to dry on the section, then added a few drops of picric acid solution and washed with water. He found that the following stains were not at all taken up by the grain: nigrosin, Hessian purple, diamond red, carmin, anilin blue, cyanin and Congo red. The following gave a uniform coloration of the starch substance: acid fuchsin, corallin, eosin, crocein, tropaeolin, Martin's yellow and haematoxylin. The following gave fine-grained precipitates in the watery zones: fushsin, safranin, methyl blue, methylen blue, indigo carmin, indulin, methyl violet and gentian violet; the latter in the form of large crystalline grains. Radial crystal needles were formed by Bismarck brown, chrysodin, malachite green, brilliant green and thionin. Fischer says that it was plainly to be seen that the precipitates were not in the denser substance of the grain, but in the watery zones. The periphery always remains unaffected.

This peripheral layer of the starch grain has already been described in a preliminary paper (5), and is discussed further below; its staining capacity, form and constancy seem to indicate that it is different in composition from the layers inside.

The following experiment gives strong evidence that the violet stain passes through the orange layer readily but is not absorbed by it. In microtome sections, as already described, the staining of a large eccentric *Canna* grain may be watched under the microscope by allowing a solution of gentian violet to run under the cover. The layers inside this peripheral layer begin to absorb the stain at once, but the outer layer is not at all affected. The violet stain passes through the outer layer without being fixed. Of the layers inside, some are stained a deep violet, others take up only a small amount of stain and appear pale violet in color. This phenomenon is quite inconsistent with the view held by Salter that the outer layer is merely denser starch.

Rarely, in large *Canna* starch grains, we find the peripheral orange-stained layer followed toward the inside by a narrow dark violet layer, broadest at the posterior end (see Pl. XXXIX, Fig. 36). Next toward the inside of the grain there is a layer which is stained in some cases orange and in others pale violet. This layer is fairly broad and is continuous around the hilum. The remaining layers of the grain, with the exception of those immediately surrounding the hilum, are incomplete.

Oftentimes in the same material, a dark crescent-shaped line appears in the middle of a broad orange peripheral layer and at the posterior end of the grain (see Fig. 38). The orange material between this line and the inner violet layers usually shows a faint violet color though still predominantly orange. This appears to be the beginning of a violet layer, since, in a somewhat later stage, the whole of the region between the dark violet line and the violet starch layer takes the violet stain and becomes the outermost violet layer of the grain. The dark violet line in but few instances was seen to pass around the hilum, but as the sides of the grain are approached the line becomes narrower and finally disappears. As has been pointed out, the peripheral layer stained by orange is transformed in the growth of the grain into violet-staining layers. This may be due to a condensation of the carbohydrate material, brought about by the abstraction of water, or to a more deeply seated chemical change. It is possible that this orange-staining substance is already carbohydrate material, which has been brought inside the leucoplast and which is then transformed by the addition of water into starch and gains the capacity to fix the violet stain. This would seem to be a more natural assumption than that starch can show such a variable reaction to the same stains, as assumed by Salter.

In the development of the cell plate in root tips, the equatorial zone was found by Timberlake (40, p. 97) to become filled with a substance that stains strongly with the orange of the triple stain. This substance appears to be entirely homogeneous and with ruthenium red or iron haematoxylin appears colorless while the cell wall is stained. Timberlake says: "The similarity of this substance to that of the cell wall, together with its presence in the region of the spindle in which the cell wall appears later, I have taken to signify the presence of a carbohydrate substance destined for the formation of the new cell wall."

In the germinating seeds of *Coix lacryma,* the walls of the endosperm cells disappear after the young plant has attained some size, and are apparently used to nourish the growing plant. These walls, while in process of solution, take the orange stain when the triple stain is used.

Preparations which I have studied show that the cellulin bodies in the cells of *Saprolegnia,* which are carbohydrate in nature, take a bright orange when stained by the triple stain. Noll (27) has shown that these bodies in the Siphoneae are used to plug up holes in the walls of living cells, caused by wounds.

Thus, in a number of cases, we have a transition substance either in the formation or solution of carbohydrates, which shows a strong affinity for the orange stain. In the case of the starch grain and in the cell wall this substance appears to be a stage in the formation of still more complex compounds.

We find the very young starch grains either staining entirely orange or showing a large proportion of orange. We find an outer layer of orange material in the older grains, and by following the course of development of the starch grain, we are led to believe that the orange-staining substance in young and old grains is identical.

Newcombe (26, p. 49) has shown that the enzyme which dissolves starch in a number of plants is likewise able to dissolve cell membranes. As mentioned above, the cell walls of the endosperm of a germinating seed of *Coix lacryma* take a bright orange while in process of solution, probably by an enzyme action. In these cells the starch grains are also much corroded and show orange-stained borders of the corrosive channels.

It is quite possible that the substance first formed from starch by the action of diastase is the same that is present in the orange layer in the formation of the grain. The evidence certainly favors the view that the orange layer is a viscid mother substance, similar to that assumed by Mikosch, which becomes more and more concentrated by additions from without, until layers of starch form in its interior which first become visible in the dark blue line above referred to.

In the young grains, starch is deposited equally all round, but soon the grain shows an eccentric growth, the mother substance being formed more abundantly at one end. The plastid, however, continues its function of transferring carbohydrate material to the mother substance inside, which is too viscid to allow the additions from the thicker part to diffuse readily to the mother substance at the opposite end of the grain, under the thinner part of the plastid. In this manner, the mother substance under the thicker part of the plastid soon becomes saturated, and it is on this side that the thick portions of the starch layers are deposited. This assumption is in harmony with the fact that, when the eccentric layers begin to form, they are simply thinner on the anterior end, then they become incomplete, and finally are laid down on the posterior end only.

The question as to the existence of a specially defined outer layer of the starch grain was early raised and has been discussed by various authors. Fritzsche (11, p. 138), in 1834, was one of the first to point out that the peripheral part of certain varieties of starch grains shows a somewhat different reaction to stains than the central portions, and supposed it to be due to the presence of certain foreign matters in this layer which render it more resistant.

Nägeli (24, p. 186), in a paper published in 1847, held that the outer part of the starch grain is composed of cellulose. This, however, was soon disproved. Crüger (4, p. 41), in 1854, described a layer between the protoplasm and the starch grain which "does not stain with iodine, nor does it stain brown as readily as the surrounding protoplasm." As he makes no mention of the plastid in other connections, it is possible that this is what he saw, and his figures bear out this view.

In 1885, Mikosch suggested the existence of an intermediate region between the grain and the plastid, which is filled with the so-called "mother substance" for the grain. Mikosch's conception agrees well with what I have described below as the specially differentiated peripheral layer. Meyer (18, p. 149) denies the existence of such a mother substance and says that normal starch grains do not possess a specially differentiated outer layer, but that he found such a layer in a few cases in starch from a potato.

Such a layer is described by Salter (32, p. 40), who believes that it is composed of starch but that it is denser than the remainder of the grain. This density is due, according to Salter, to the fact that the loose layers become much thinner at the periphery of the grain, hence the peripheral portion of the grain is made up chiefly of the dense layers which join and run around the hilum in large eccentric grains such as those of *Canna* and potato. Salter's drawings in a number of cases show this peripheral portion of the grain stained bright orange, but he does not attribute this to a difference in composition between this and the inner blue-stained portion.

I have found a peripheral layer present in some cases and not in others, and have further undertaken to determine the conditions under which it occurs, as discussed below. The method of proving, by the use of Flemming's triple stain, that a differentiated peripheral layer is present in certain grains and perhaps at certain stages in the development of all starch grains, has been described in detail, but without figures, in a previous paper (5).

The method is in brief as follows: A series of slides was prepared by exposing for different lengths of time to the various stains. In every case, the slides were exposed to the safranin for five minutes; after washing in water, six slides were exposed to gentian violet for five minutes each, then treated with orange for the following different lengths of time: one minute, five minutes, ten minutes, twenty minutes, sixty minutes and three hours. It was found that with the exposure to orange for one minute, the peripheral layer is stained a pale violet. The inner layers are stained a dark violet. With the exposure to orange for five minutes, a peripheral orange layer is plainly differentiated, extending entirely around the violet portion of the grain. This orange-staining peripheral layer appears in all the other preparations in this series. Where the exposure to the orange is for sixty or one hundred minutes, the layers inside still show a pale violet color. Where the exposure to orange is for three hours, the grain becomes orange in color, except for a few layers midway between the hilum and the posterior end of the grain which remain violet.

It is seen from this series of slides that when once the grain is stained violet, a long exposure to orange is necessary to remove the violet from any of the grain but the layer in question, while but a few minutes suffice to remove all traces of violet from this layer and to replace it by orange. This seems to indicate that differences either of a chemical or physical nature exist between the body of the starch grain and the outer layer.

I have studied most fully by this method the large eccentric grains of *Canna* and of potato, which show the orange layer most sharply if the starch from rhizomes of growing plants of *Canna* or from ordinary fairly grown potatoes is studied. In the *Canna* grains, the orange zone extends around the inner violet-stained layers as a complete layer, usually fairly uniform in thickness (Pl. XXXIX, Fig. 37), or sometimes somewhat broader at the posterior end of the grain (Pl. XXXVIII, Fig. 1). Sections cut from any given portion of the rhizome of *Canna* usually contain starch grains which show a certain uniformity in staining and differ slightly from those in other regions, but in most cases a peripheral orange layer is present on a large proportion of the grains, whether the sections are taken from regions nearer to or more remote from the growing point.

A rhizome of *Canna* which had lain dormant through the winter, but from which a strong shoot was growing at the time the preparation was made, showed, almost invariably, starch grains with orange-staining peripheral layers. The outer starch layers of these grains showed slight corrosion, and no doubt these grains were being used for the development of the shoot.

The small grains, which show their laminae distinctly, show this peripheral layer with great uniformity. In certain preparations, the large grains do not show an orange layer, while the smaller grains in the same preparation show the layer distinctly.

In other material it was impossible to demonstrate a differentiated peripheral layer, either on the large or small grains, and it seems fair to assume that these have been in a growing condition.

The starch grains in the stem of *Pellionia Daveauana* are large and of the eccentric type. In the outer part of the cortex, the grains are not so large and are enclosed in relatively large chloroplasts (Pl. XXXVIII, Figs. 17-20). The grains nearer the center of the stem are large, and the chloroplasts are extended as thin membranes somewhat thicker at the posterior side of the grain. When treated with the triple stain, a peripheral orange-stained layer is clearly differentiated. The layers of starch in the body of the grain are violet in color and fairly uniform in shade.

In the parenchyma cells of the fleshy rootstocks of *Dieffenbachia seguina,* large starch grains are present. They are elongated in form, with the hilum close to one end. In many of these grains, the effect of a change in position of the plastid is shown. In these grains the laminae are in two series which are often at nearly right angles to each other (Fig. 32). When stained with the triple stain, an orange layer is differentiated at the periphery and the interior layers are stained violet.

The starch grains in the parenchyma of the false bulb of *Phajus grandiflorus* are large, and the hilum is situated near one end, often in a small projecting tip. The leucoplast in these grains is often distended by a linear crystal of calcium oxalate. A peripheral orange layer is differentiated by the triple stain.

The starch grains of wheat, barley and rye are lenticular in form with a central hilum. Both in material which has been fixed and in fresh material, an orange-staining peripheral layer may be demonstrated by the use of the triple stain.

The starch grains from *Zea mays* are polygonal or rounded in form, with a distinct central hilum and concentric layers. The leucoplast is demonstrated with difficulty, but an orange-staining peripheral layer is present on many of the grains.

In the endosperm of the seeds of *Coix lacryma jobi,* the starch grains have a polygonal form. The hilum is central, and the grains with but few exceptions show a broad orange-staining peripheral layer. In the germinating seeds of this plant, the cellulose cell walls are stained orange with the triple stain. It is probable that the cellulose of the cell wall is modified in some way to make it available for the use of the growing plant in germination. A similar orange-staining substance is produced in the formation of the cell walls, as shown by Timberlake.

Of seven different commercial starches prepared as chemically pure starch by Eli Lilly & Co., two showed the peripheral layer in nearly all the grains; these were potato and tapioca starch. In wheat, bean, corn and oat starches, peripheral layers were found in a few grains. The pea starch showed no differentially stained peripheral layer in any case. It is quite possible in the case of these chemically pure starches that the method of preparation might remove in some cases any peripheral transition layer.

A short treatment with iodine in aqueous solution, in the case of *Canna* starch, leaves the peripheral layer perfectly white, while the inner parts of the grain stain blue. If the iodine acts for some time, the peripheral layer gradually acquires a blue color. With iron haematoxylin, in starch grains of *Canna*, potato and wheat, this layer does not stain, while the rest of the grain is colored in each case. With Correns' silver nitrate precipitation method, these starches show no precipitate in this peripheral region. These differences in staining qualities certainly show that either chemical or physical differences exist between the body of the starch grain and this outer layer, and as this layer is present especially in young grains and in grains in the process of solution, it may be properly called a transition layer.

If the exact conditions and stage of growth from which the starch was taken could be ascertained in every case, the explanation of the presence or absence of a transition layer might be at once apparent. If the orange-staining peripheral layer is a transition substance, then we should expect to find it on starch grains from parts of plants which are not fully developed or where storage of starch is going on, such as growing tubers and rhizomes and unripe seeds and fruits, and an examination of the facts leads us to believe that such is the case. As noted above, in the rhizome of *Canna* the starch grains were probably still in an actively growing condition. The *Canna* rhizome was from a growing plant, and the starch grains were probably still immature.

The potato was one taken from the bin, and the condition of the plant at the time the tuber was gathered is, of course, unknown; but of a number of potatoes which were apparently mature, none were found in which the starch grains did not show the peripheral layer in the majority of cases. It may be that in such watery tubers the peripheral layer never passes into typical starch.

In the cases of *Phajus*, *Dieffenbachia* and *Pellionia*, the plants from which the starch preparations were made were actively growing. In the commercial starches, the method of cleaning and preparing will certainly have much to do with the presence or absence of any peripheral portion of the grain, as well as the relative maturity of the parts of the plant from which the starch was taken.

In the case of pea starch, no peripheral layer could be demonstrated, and it is possible that the starch matures more rapidly in this plant than in the others studied. Bean starch showed but few grains with an outer differentiated layer. These were grains of small size and probably immature.

In preparations of *Canna* which show the starch grains to be partially dissolved by natural corrosion by diastase, an orange layer appears quite constantly at the periphery of the portion of the grain remaining. The width of this orange layer is usually quite uniform although but a fragment of the laminated grain may remain inside. The structure and appearance of these corroded grains will be more fully discussed below. The fact that we have orange-staining layers in grains in process of solution as well as in grains in process of formation throws further light on the nature of this material as a transition substance.

The appearance of the so-called strata or concentric layers of the starch grain as seen when mounted in water has been variously characterized by different authors. Strasburger describes the layers as appearing to contain varying amounts of water, and as separated by dark limiting lines. Meyer discusses the varying appearances obtained by focusing through the grain with low and high magnifications, but gets no new data as to the composition of the layers. Salter uses the terms "dense" and "lax" to describe the layers of the starch grain.

I have naturally found the median optical section of the grain the most favorable for study, and my descriptions are based on the appearance of the strata as so seen. In this case they are of course approximately at right angles to the plane of the slide and appear sharply defined.

The starch grains in the rhizome of *Canna* have been found to be specially favorable for comparative studies of the unstained and the stained grains. The attempt has been successfully made to identify a layer or series of layers in an unstained grain and then in the same grain to determine successively the effect of different stains on these same layers. The material was fixed in Flemming's weaker solution and imbedded in paraffin. Microtome sections 10 μ in thickness were used. The sections were fixed to the slide and the paraffin removed by xylol, the xylol removed by absolute alcohol, and the sections were then mounted and examined in water.

I selected a large grain from a slide prepared in this manner. At the posterior end of the grain there appeared two broad, highly refractive layers (Pl. XL, Fig. 42 A, *a* and *b*). These are broadest in the middle line of the grain and thin out gradually to the sides. Between these layers there is a layer (*1*) which has the appearance of being an open water space It is thickest at the median line and tapers gradually to the sides. Toward the hilum from *b* there is a dark, slightly refractive layer separated from *b* by a dark line. This layer appears to be divided, the inner portion being paler in color. The remaining layers of the grain appear but faintly, with the exception of those immediately surrounding the hilum, which are fairly distinct. The appearance of this grain as just described is that seen in median optical section. If the focus is raised or lowered we may get the appearance of light layers where there were dark layers and vice versa. This is due of course to the curvature of the layers, a change in focus bringing into view the next inner or outer layer which may be different in refractive index.

The grain above described, mounted in water, is magnified 980 diameters and drawn by the aid of a camera lucida. If now the grain is kept under observation and a dilute aqueous solution of iodine drawn under the cover by placing drops of the solution at one side and filter paper at the other, the grain will slowly take on the characteristic blue color. In a short time the whole grain is colored uniformly a deep, dark blue, but it is noticed that certain layers take the blue color more readily than others. The outer part of the refractive layer *a* is the first to show the iodine reaction, and in this it is followed by the inner part of the same layer. These two parts of the layer *a* thus become clearly differentiated, and the inner part (a'', Fig. 42 B) takes the darker stain.

Layer *b* takes on the blue color but slowly and remains for some time the lightest layer in the grain. It shows a marked contrast to the two darker layers a'' and *c*. Layer *c* stains readily and in a short time becomes the most deeply stained layer in the grain.

Although layers *a* and *b* are the first to show the effect of iodine, it appears to enter gradually around the peripheral portion of the grain until the whole grain is colored a dark blue. As a result of treating with iodine, the open region *1* disappears and between a'' and *b* a dark line appears. There is also a dark line between *b* and *c*.

If we now wash out the iodine by drawing alcohol under the cover glass, we shall get the following results: When the washing out is partially complete, it is seen to have been removed first of all at the periphery of the grain. The grain is kept constantly under observation, a drop of 95 per cent alcohol being placed at one edge of the cover and drawn through by a piece of filter paper at the opposite side. The layer *a* of the unstained grain is now seen still more clearly to be composed of two layers, the outer one becomes colorless and the inner one a medium blue. The crack-like region *1*, which appeared as a dark line in the grain stained with iodine, still appears as a dark line. This region is probably filled with an aqueous solution in the unstained grain, and closes up when iodine is applied.

Layer *b* of the unstained grain, which colored but slightly in iodine, shows two regions when alcohol is applied, an outer pale blue region and an inner darker region. The dark line *2* which is present at the inner border of *b* in water and in iodine, does not change in appearance with the alcohol.

Layer *c*, which takes a dark blue color in iodine, becomes pale blue when alcohol is used. The washing out of the iodine by alcohol causes a slight shrinkage in the grain, most noticeable at the hilum. If now this same grain is kept under observation and stained by gentian violet followed by orange G, some further interesting data are obtained. Here again the stains are applied at one edge of the cover and drawn through by means of filter paper. The gentian violet is allowed to remain five minutes; it is then washed out by water, and orange G is applied and allowed to remain three minutes. This is washed out by absolute alcohol, and the preparation is cleared by clove oil. During the time of this process there is no change in the position of the grain, and a third drawing was made of the same portion of the grain showing the appearance of the strata when stained by the gentian violet and orange. (Fig. 42 C). Around the entire periphery of the grain there appears an orange layer (*a*). This corresponds approximately with the pale blue layer *a′* of the grain stained with iodine. The next layer *a″* is pale blue and corresponds with *a″*. Following this layer there is a thin pale blue layer. This is layer *1* of the grain treated with iodine. The pale blue layer *b* of the grain stained with iodine is split up into two layers, *b′*, a dark blue layer, and *b″*, paler in color, in the grain stained with gentian violet.

The dark line *2* appears as a narrow, very pale blue layer. The dark blue layer *c* appears in the same position as the dark blue layer *c* of the grain stained with iodine.

The results of this staining experiment are summarized in the following table:

Starch grain represented in Plate XL, Figure 42.

A (In water.)	*B* (In iodine solution.)	*C* (In gentian violet and orange G.)
a—refractive layer	*a'*—light blue *a''*—dark blue	*a'*—orange *a''*—light blue
1—crevice	*1*—dark line	*1*—narrow blue layer
b—refractive layer	*b*—pale blue layer	*b'*—dark blue layer *b''*—light blue layer
2—dark line	*2*—dark line	*2*—narrow light blue layer
c—dark, slightly refractive layer	*c*—dark blue layer	*c*—dark blue layer

We find thus that layers which appear single when mounted in water may be really double or perhaps even made up of a number of layers. The differentiation of the parts in such a case is not sufficient to enable one to make them optically distinguishable as individual layers when the grain is mounted in water. That, none the less, considerable difference exists between these parts is shown when the grain is stained.

The regions of the dark lines *1* and *2*, marking the surfaces of *a, b* and *c,* swell somewhat in the treatment with gentian violet and orange and stain a pale blue color. It is probable that these are thin spaces filled with watery solutions which are relatively slightly refractive.

When gentian violet and orange are used after iodine, the spaces apparently open slightly and seem to contain some starch which is stained a pale blue. It is further noteworthy that although the layer *c* is not so refractive as *b* in water, it stains fully as darkly as the darker portion of *b*. The view is thus on the whole confirmed that the cause of the difference in appearance of the layers in grains mounted in water is due to their difference in density which in turn results from differences in composition, the layers which contain the largest proportion of starch and the smallest proportion of water being the more highly refractive.

A second grain (Fig. 43) from the same *Canna* material was treated in the same manner as the grain just described. Drawings were made of identical portions of the outer layers of the grain as they appear with the different reagents: Fig. 43 *A* shows the grain mounted in water; *B* shows the grain treated with iodine, the drawing having been made before the grain was completely darkened by the reagent; *C* shows the iodine partly washed out by the alcohol; *D* shows the layers stained by gentian violet and orange. The following table explains the appearance of the layers when treated with the different reagents:

Starch grain represented in Plate XL, Figure 43.

A (in water.)	*B* (in iodine.)	*C* (in alcohol.)	*D* (in gentian violet and orange G.)
a—Highly refractive region.	*a'*—Layer which has not so fully taken on the nature of starch, hence is faintly blue in color. *a''* —A blue starch layer.	This layer is now pale blue in color, the color becoming lighter from inside toward periphery. There is no sharp line separating two parts.	The layer *a'* is of different composit'n and takes orange; *a''* is starch and takes gentian violet like rest of grain.
1—A dark line, probably a crack filled with watery colloidal mass.	This layer is broader and paler in color.	In alcohol this layer is still broader.	This layer is about the same width as in alcohol. It stains pale blue.
b—Highly refractive layer.	Contracted slightly and stains blue.	Contracted a little more and blue partly removed.	Characteristic blue stain with gentian violet.
2—A dark line similar to *1*.	*c* and layers anterior to *c* have contracted, leaving space at *2*.	Contraction goes on with consequent broadening of *2*.	Stains pale blue, contains relatively small amount of starch.
c—Slightly refract'e layer.	In iodine this layer stains uniformly with those next to it on inside. It is pale blue in color.	The iodine is easily removed, leaving layer pale blue in color.	This layer stains less deeply than *a* or *b*.

In this grain there is an outer refractive region which has the appearance of a single layer when the grain is mounted in water. This outer region is similar to the region *a* in the grain represented in Figure 42. In both grains it consists of two layers which are differentiated by iodine or by gentian violet and orange. When iodine is washed out of this region, it is removed from *a'* first and then gradually from the outer part of *a''*, so that the sharp line separating the two layers disappears.

The dark line *1* which separates *a''* from *b* becomes broader in iodine, and is no longer dark, but swells somewhat and stains a pale blue. It becomes broader by the contraction of the layers *a'* and *b* and stains less deeply, probably because it contains less starch than these layers. This layer stains less intensely with gentian violet than *a''* and *b*, which bears out the assumption that it contains less starch.

Layer *b* shows the same reactions to stains as *a''*. The dark line *2* shows the same characteristics as *1*. It does not appear as a dark line except in water, and in its place there appears a layer which is pale blue in iodine and in gentian violet and which probably contains very little starch material. This layer appears to swell when iodine or alcohol is applied, due no doubt to the contraction of adjacent layers.

Layer *c* is less refractive in water than either *a* or *b* and probably contains less starch material. In iodine and also in gentian violet it contracts considerably and takes a pale color with both these reagents.

From the study of grains such as the above it is plain that the ordinary conception, that the visible elements of the grain consist of denser layers of starch alternating with more watery layers, must be extended to include the appearance of sharp lines marking the boundaries of the highly refractive layers and also spaces which are practically open crevices between the layers and which may become wider or narrower with the contraction or expansion of the denser layers or of the entire grain.

The grain of Figure 42 shows the existence of crevices most clearly. Such a crevice appears conspicuously between *a* and *b* when the grain is mounted in water. It closes up and appears as a dark line when the grain is mounted in iodine solution, and as a narrow light blue layer in gentian violet. Similar crevices exist at *2* in the same grain and at *1* and *2* in the grain of Figure 43, although the latter are narrower. Such crevices are most sharply distinguished from the starch layers by the readiness with which they change their width on the application of reagents to the grain. Their width is apparently entirely determined by the swelling power of the adjacent layers, and it is to be noted that the inner layers of the grain appear to be less dense than the posterior layers; they contract noticeably when alcohol or iodine is applied.

The refractive layers also vary in thickness and density. The thicker layers do not all color with the same intensity with iodine or with gentian violet. It is also clear that those layers which take the deepest color are in general the densest layers.

They are highly refractive in water, and the stains are removed from them with greater difficulty than from the layers which are not so dense.

ANALYSIS OF STRUCTURE BY CORROSION AND SOLUTION.

Blocks of starch-bearing tissues were taken from a rhizome of *Canna* in a region which had recently produced a vigorous shoot. The material was fixed, imbedded and sectioned in the ordinary way and Flemming's triple stain was used.

Many of the large eccentric grains were found still enclosed by plastids and invariably showed corrosion. Where the plastid is thickest the corrosion of the grain appears the greatest in extent, and frequently the broader posterior end of the grain beneath the thicker part of the plastid is reduced to a mere point (Fig. 39). Occasionally grains appear in which solution has taken place at both ends more strongly than in the middle. In such cases a spindle-shaped grain results. Frequently the anterior end is reduced to a point and takes the orange stain (Fig. 30).

In these large eccentric grains from *Canna*, the corrosion in the plastid seems to be upon the surface of the grain only, and all the layers of the grain which reach the surface seem to suffer from the action of the diastase in nearly the same degree. A slight difference in the rapidity of solution in certain layers is noticed, however, in some preparations. The pale violet layers are acted upon with the greatest rapidity. The ends of the dark violet layers project farther on the corroded margin than do the ends of the light layers (Fig. 39).

The appearance of these corrosion channels in the wheat starch is similar to that of the figures which Goldschmidt has described as forming in $CaCO_3$ spheres when treated with HCl, as will be noted further below.

Starch grains artificially corroded by solutions of diastase are more favorable material for making observations on the behavior of the different layers of grain. If slides with sections of starch-bearing tissues are placed in a tube of diastase solution, to which a few drops of chloroform are added to prevent bacterial growths, the corrosion usually takes place in two or three days if the temperature is kept at about 40°C. The principal difficulty in the use of this method lies in the loss of sections in the diastase, but usually a sufficient number remain to give a few corrosion figures.

The large eccentric grains of *Canna* (Pl. XXXVIII, Fig. 28), treated in this manner for two days, show a strongly marked peripheral orange layer except for one or two small areas, usually on the posterior end. The conspicuous outer dense layers have been dissolved in a number of spots, but remain fairly intact. Considerable substance has been removed from the interior of the grain, and parts remaining in the interior of the grain quite generally take the orange stain (Figs. 26, 27). In some cases, the inner portions of the *Canna* grain have been completely dissolved and there remains only a shell made up of parts of the outer violet layers (Fig. 29).

The highly refractive layers in the unstained grain contain, as we have seen, a relatively small amount of water, and these are the layers which would naturally be expected to be most resistant to the action of diastase. We have found that in some cases the refractive layers of the unstained grain are not homogeneous but consist of a number of layers. Some of these component layers take a deeper and some a paler color. Evidence of the same condition is found in corroded grains, and in every case the parts which are stained most deeply with gentian violet are least acted upon by the diastase.

In oval starch grains from germinating wheat and barley which are enclosed by the plastid and which show the effect of diastase action, the corrosion does not take place evenly around the periphery, but peculiar pits and canals are formed beginning at the periphery and extending irregularly into the center of the grain.

In the later stages of corrosion there seems to be a tendency on the part of the corrosion channels to follow concentric lines in the interior of the grain. An effort was made to learn which layers were most attacked but without success. The interior of the grain takes an almost uniform stain after diastase action has gone on for some time. In the earlier stages of diastase action, however, in certain wheat grains in which the corrosion channels have penetrated but a few layers, there appear irregularities along the walls of the channels; but no good evidence could be secured as to whether the light or the dark layers were more susceptible to diastase action.

A noticeable fact in connection with these corroded grains is that the portions of the layers bordering directly on the corrosion channels show a margin of orange-stained material which blends gradually into the violet of the unaffected portions.

Krabbe's observations led him to believe that the substance of the starch grain is removed, molecule by molecule, and that there is no general penetration of the grain. He used iodine as a stain, and found that the parts of the grain remaining showed no difference in staining properties from the intact grain. His results, when compared with the conditions observed in Figure 28, show how little reliance can be placed on observations of corroded grains in water, even when stained with iodine.

Flemming's triple stain shows the borders of the corrosion channels plainly differentiated in corroded *Canna* grains; the material bordering the canal takes the orange stain. Iodine is not a good differential stain, and does not show slight differences either in the composition or the structure of the starch grains. Whether or not there is a penetration of diastase in all cases beneath the surface of the corrosion canals, there is plainly, in the case of *Canna* starch, a transition layer in all surfaces which are being corroded. The presence of orange-stained material over the entire corrosion surfaces of the grains suggests very strongly that a substance is found at the time of solution of the grain similar to that present on the surface of grains which are being formed.

The experiment was tried of crushing large *Canna* grains which had previously been stained by the triple stain. The crushing was effected by pressing on the cover of a freshly made slide with an eraser before the balsam had hardened. A number of deep radial cracks running from the surface inward are formed in this way. This fact probably has no significance in determining the finer structure of the starch grain, as substances which we know are not formed of radially placed elements show radial cracks when crushed in this way.

The experiment was next tried of crushing the unstained grains and then staining with gentian violet and orange; it was found that much of the inner portion of the grain takes the orange stain, only a few layers at the outside taking the violet.

The natural inference drawn from the result of the above experiments is that the orange does not stain the inner parts of the intact starch grain because it does not reach them, but on the other hand it must not be supposed that the orange layer at the outside of the grain is simply the effect of the washing in of the orange. On some of the crushed grains which stain orange in the interior there is a peripheral orange layer, and on others there is not. It is to be remembered, also, that the width of the orange layer does not vary proportionally to the length of time through which the orange is allowed to act on the grain. If the grain is stained for five minutes each in violet and orange, the orange peripheral layer is differentiated when present, and there is no essential change in appearance though the time of the exposure to orange be doubled.

The appearance of the orange-staining material in the interior of the grain seems to indicate that this portion of the grain is also somewhat different in composition from the peripheral violet layers, and it is quite probable that we have in the interior of mature starch grains a change taking place which results at the same time in a loss of laminated structure. The exact nature of this change is difficult to determine experimentally, but it may well be a change from a less to a more soluble condition; if we can accept Meyer's conclusion that the starch grain is made up of amylose and amylodextrine, it is possible that this portion of the grain contains a larger proportion of the more soluble amylodextrine. Fischer (10) has found that this portion of the grain is in a semi-fluid condition in grains soaked in water.

In a preparation made from a grain of wheat which has begun to germinate, the starch grains are more or less corroded. Often the starch grains will be corroded in such a way that they will appear as if cut off on one or more edges (Figs. 40, 41), and on these corroded surfaces there appears an orange-staining area in which no lamination whatever is present, comparable in this respect to the orange-stained central portion of the mature *Canna* grains already mentioned. Where the outer starch layers are still intact, no additional orange-staining substance appears. This appears to be a further bit of evidence that the inner portion of mature starch grains has undergone some change.

SWELLING AND SOLUTION.

If starch grains are treated with various reagents, they swell and give some very curious and interesting figures. It is a question whether the swelling caused by such reagents as potassium hydroxide, acetic acid, chromic acid, chloral hydrate or hot water is due to imbibition of the reagent between the particles of starch substance or to molecular changes in the particles themselves.

Potato starch grains treated with chromic acid (15%) show at first a slight enlargement of the hilum crack; then the formation of fine radiating cracks, arranged like the barbs of a feather, beginning at the hilum and extending to near the posterior end of the grain. Frequently this area of radiating lines runs part way toward the opposite end of the grain from the hilum and then divides, forming a V-shaped figure. This area spreads and draws toward the margin, and an opening is formed in the central part of the grain. Further, the grain continually increases in size till the outer layers are ruptured. This usually takes place at a point near the hilum. The whole interior of the grain is dissolved out, and the layers at the posterior end and extending part way down the sides are all that remain. The limits of these layers show very sharply, and in some of them fine radial lines appear.

If a potato starch grain is treated with potassium hydroxide (10%), a crack forms, beginning at the hilum and extending toward the posterior end of the grain (Pl. XL, Figs 44-50). Narrow radiating cracks gradually extend from the central crack toward the periphery. The hilum crack enlarges, and at the same time the layers at the anterior end of the grain begin to push out.

When once this swelling of the anterior part of the grain commences, it proceeds rapidly (Fig. 45). The crack at the hilum continues to enlarge, forming a large cavity in this portion of the grain (Figs. 46, 47). The size of the anterior part of the grain soon considerably exceeds that of the posterior part. When the anterior part of the grain has swollen considerably, a peculiar invagination takes place beginning at the outside at a point near the hilum (Figs 48–50). This infolding appears to relieve the tension caused by the formation of a large internal cavity. The posterior portion of the grain is the last to swell, and if the grain is stained by the triple stain this unswollen portion takes a faint violet color and the swollen portion an orange color. Undoubtedly this swelling of the grains is caused by the absorption of water in the layers. The parts immediately surrounding the hilum take up the water most readily and are the first to swell. The outer layers of the grain are thinnest at the anterior end of the grain, and it is at this end that the stretching is greatest. The crack which begins at the hilum extends through the central part of the grain toward the posterior end and evidently follows the direction of the most readily absorptive material. The layers at the posterior end of the grain are less easily penetrable by the water and maintain their form for a longer time than the inner portions.

Krabbe is of the opinion that the streaming motions which take place when a crystal of alum is brought into contact with a solvent also play an important part in the solution of starch grains by diastase.

More recently, Goldschmidt (12, p. 656) obtained corrosion figures on spheres of calcium carbonate subjected to the action of strong acids, which in their earliest stages show a strong resemblance to those formed in the wheat starch grain as the result of diastase action. The figures which appear in the calcite crystals take the form at first of hemispherical hollows; these Goldschmidt attempts to explain by the supposition of the presence of molecular streams directed toward the crystal in a line perpendicular to its surface and of returning streams which pass in the opposite direction carrying portions of the crystal in solution.

It seems quite possible to explain the small hemispherical depressions which appear in the early stages of solution by diastase in the same way, as the result of molecular streams between the solid and the solvent. But it is only the figures formed at the beginning of the corrosion of the starch grain that may thus be accounted for. The later stages in corrosion, in which the canals penetrate more deeply into the grain, and which in some cases follow concentric lines, are explained by the fact that certain layers in the interior of the grain are more readily acted upon than others by the diastase solution, and in this way the solution follows the easily soluble layer as the path of least resistance. In the wheat starch grain, it could not be determined which layers of the unstained grain, the highly refractive or the slightly refractive, form the solution paths, as the diastase causes the grain to take a fairly homogeneous stain.

THE DEVELOPMENT OF THE STARCH GRAIN.

Regarding the development of the starch grain, three general views have been held. The first, that the outside of the starch grain is the part first formed, later growth taking place toward the center, was proposed by Munter (22, p. 194) in 1845. He treated the starch grains from the rhizome of *Gloriosa superba* L. with sulphuric acid, and because water appears to be drawn out from the central layers and a large crack is formed in the hilum region, he concluded that the central layers are softer and more watery, and therefore younger, than the outer layers. A similar conclusion was reached by Walpers in 1851 (45, p. 905), in his studies on arrow-root starch. Hartig, in 1855 (14, p. 905), examined the starch of *Canna* and potato and came to a somewhat similar conclusion, that the growth is from the outside toward the center. Nägeli (24), in 1858, proposed the theory of growth by intussusception for all organic structures including the starch grain. This meant to him that all growth takes place in the interior of the grain, and that it proceeds from the surface inward.

The third view, which is universally accepted at the present day, is that the starch grain grows by the addition of concentric layers. Fritzsche (11), in 1834, noted that the outer layers were more resistant to acids and alkalies than the inner and did not consider that the last layers formed need necessarily be less resistant. Cruger (4), in 1854, made the highly interesting suggestion that a layer of substance between the grain and the plastid is a starch-forming substance. This view is strikingly in harmony with the facts brought out on material carefully fixed and stained by modern cytological methods as described in this paper.

The question of the permanence of the plastid about the entire grain is closely associated with that of its method of growth. Schimper (35, 36), in 1880 and 1881, studied the starch in the cortical parenchyma of the stem of *Philodendron grandifolium* and the medullary parenchyma of *Peperomia stenocarpa* and concludes that these grains are invariably found at first enclosed entirely by plastids; but the material of the plastids is soon broken through and the starch grains project freely into the protoplasm. This conclusion of Schimper's is probably incorrect and due to the fact that on large starch grains the plastid becomes so thin on the anterior portion of the grain as to be visible only with difficulty. In a later paper, Schimper finds that when starch formation is most active the plastid may disappear to an almost invisible remnant and may again regain its former size when starch formation ceases, but he did not change his views as to the ability of the starch grain to project freely into the surrounding protoplasm.

He states that in the large eccentric grains of *Dieffenbachia* the growing end is the one upon which the plastid is fastened, and that when a portion of the starch grain projects freely into the cytoplasm and comes in contact with a second plastid an addition of layers may be made at that point also. In this way he accounts for the peculiar branched grains found so commonly in this plant. It seems quite probable that the regions in which the plastid is thicker are all parts of one plastid and not separate plastids, as Schimper supposed.

The fact that after a starch grain is partially dissolved in the plastid, leaving an irregular and corroded outline, new layers are added filling up the depressions in the corroded surface, is offered as further evidence by Schimper (36, p. 187) in favor of the theory of external growth. It was found that in the development of the storage starch grains of *Dolichos lablab,* periods of solution were followed by periods of growth of the grain in the plastid. After a period of solution, the outline of the remnant of the starch grain is very irregular, but the new layers added fill up the depressions and form regular layers around the corroded fragment.

Salter describes in considerable detail the development of a potato starch grain. There first appears, when the grain is stained with the triple stain, a rounded white body in the center of the plastid. In this body there soon appears a dark violet dot at the center. A narrow pale violet zone is next seen surrounding the center point. This zone darkens in color at the margin and becomes the first lax lamina, eccentricity being already indicated by the fact that it makes its appearance first on the side turned toward the thicker part of the leucoplast. The second lamina appears in the same manner as did the first, the peripheral portion remaining colorless.

I have examined starch grains from a potato for the stages in growth and find that while the first appearance, that is of the colorless body in the plastid, is as Salter describes, there appears to be no eccentricity of the grain shown when the first violet layer forms, and indeed several violet layers usually form before there is any tendency toward eccentricity (Pl. XXXVIII, Fig. 14). Later in the development, the plastid collects more at one side of the grain and eccentric layers are formed.

In suitable *Canna* material stained by the triple stain of Flemming, we find the different stages in the development of a starch grain very clearly shown (Figs. 2-5). Certain of these show no signs of lamination, others no larger in size show one or two pale violet circles but no broad violet layers (Fig. 3).

Still other grains show a pale violet region at the center (Fig. 9). Slightly larger grains show a central dark violet region, surrounded by a pale violet layer, and this in turn by an orange-stained peripheral layer (Fig. 5). The early violet layers appear to be made up of starch substance distinct from the orange-staining material of which the young grain is composed. As the grain enlarges, more violet layers form and the orange peripheral layer retains a fairly uniform thickness around the grain (Figs. 10-12, 34).

Frequently young grains of *Canna* appear which are stained entirely orange with the exception of one or two minute dots (Fig. 16). These dots are no doubt the beginnings of regions which will later take the violet stain. A grain in a neighboring cell (Fig. 15) is enclosed by a plastid. The grain is stained orange, but with a small violet-stained region at the center which is evidently made up of two parts, each with its own hilum.

A small grain which has an eccentric position in the leucoplast, but which has not as yet any eccentric layers, is often present (Fig. 13). A concentric grain of *Canna* often shows a thin leucoplast, a broad orange layer and a pale violet central region (Fig. 14).

In many large grains the leucoplast can be traced entirely around the periphery (Fig. 33); in others (Fig 31) but a remnant of it remains.

Certain grains show the effects of solution in the plastid and subsequent growth, with a shifting of the plastid (Fig. 32). The layers in the corroded portion show the effect of corrosion most strongly at the posterior end of that portion of the grain. With a period of renewed growth, the plastid shifts its position and the new layers are put down at an angle of about 45° to the old. Probably the plastid remains as a membrane around the grain, but the layers appear to be deposited only where the plastid is thickest.

In the concentric starch grains found in the seed of *Coix lachryma,* the small grains stain completely orange and show the plastid as a layer of uniform width at the periphery;

slightly larger grains show the central portion of the grain stained violet and the peripheral portion orange.

In the chloroplasts in the central portion of the leaf of *Pellionia daveauana,* several assimilation starch grains are found if the leaf is examined at the close of a bright day (Figs. 21, 22, 24). They vary in number from one to four in a plastid, and quite commonly the plastid is stretched to a thin membrane at certain points. In form, the grains are round, oval or lens-shaped. These grains show no lamination whatever, but a faint crack is present in the middle of the grain. Chloroplasts from leaves of the same plant, if examined the following morning, show that in many cases the starch grains have been entirely removed (Fig. 25); in other cases, slender remnants of the starch grains remain. These remnants show the effects of solution equally on all parts of the surface (Fig. 23).

In all the above cases the grain begins as a more or less strongly orange-stained body, which may well represent a mass of the same transition substance which is found as a peripheral layer in the later stages of growth.

CONCLUSIONS.

A specially differentiated orange-staining layer is present on the periphery of the starch grains from the following plant parts: rhizomes of *Canna* and *Dieffenbachia*, stem of *Pellionia,* tuber of potato, false bulb of *Phajus*, kernels of wheat, barley, rye and corn, and seeds of *Coix*.

In all these cases it is probable that the grains were either growing or being dissolved away at the time the preparations were made. A notable case described above was that of the starch from a rhizome of *Canna,* which had lain dormant through the winter, but from which a vigorous shoot was growing at the time the material was fixed. This starch showed an orange-staining peripheral layer on nearly every grain. In this case, the outer layers of the starch grain were slightly corroded, and the starch was evidently being used for the development of the shoot. Starch from the rhizomes of mature

Canna plants show the peripheral layer equally well, and at this time the grains were probably in a growing condition.

As noted, starch grains from the rhizomes of *Dieffenbachia* and the false bulbs of *Phajus,* which show the peripheral layer, were from plants which were presumably actively storing starch.

The germinating grains of wheat, barley, rye and corn and the seeds of *Coix* show starch grains which have the orange-stained layer at the periphery, and this is clearly a corrosion layer. Thus we find this layer present both in starch grains which are growing and in those which are being used up, and the evidence is strong that it is a transition substance laid down as a continuous layer between the plastid and the starch strata.

In the case of all the above starches, the orange-stained zone is not due simply to the washing in of the orange stain; this is the only region stained by the ordinary exposures to orange, and a much longer exposure does not stain the layers of starch adjacent to this peripheral layer. Further evidence that there is a differentiated peripheral layer is obtained by the careful use of the ordinary iodine staining, using a dilute solution of iodine in water. A peripheral layer remains unstained while the inner layers are colored violet.

The facts show clearly enough that there is a transition layer present between the plastid and the starch grain, and that this layer differs characteristically in its staining reactions from the starch of the inner layers. I am of the opinion also that this difference in staining reaction is evidence that the peripheral layer is chemically different from the layers beneath.

I have, in a preliminary paper (5), advanced the hypothesis that this peripheral layer is a viscid mother substance which becomes more and more concentrated by additions from without until layers of starch are laid down on its inner surface. Where the plastid surrounds the starch grain as a layer uniform in thickness, we may suppose that the material in the peripheral layer is of the same density at every point, this density increasing by the addition of fresh material till a layer of starch of uniform thickness is crystallized; if, on the other hand, the plastid is thicker on one part of the grain, more material will be added to the peripheral layer at that part, and if we consider the mother substance of this layer to be too viscid to allow the added material to spread readily to the opposite end of the grain, the thicker parts of the layer will be deposited at the part of the grain where the plastid is thickest. All available evidence seems to favor this hypothesis as an explanation of the peripheral layer and the method of growth of the grain.

Although in many cases it is impossible to discover the plastid on the starch grain in thin sections, it is probable that it remains on the grain through the stages of growth and solution. It is exceedingly thin and oftentimes is removed in the preparation of the slide.

Salter claims to have found plastids on all the grains of *Pellionia*, but on the material from the potato he was unable to find the plastid in every case.

By a careful series of observations on the same grain treated successively with different reagents, I have convinced myself that in addition to more or less dense layers of starch, there are sharp lines, as shown in Figure 43, *1* and *2*, which mark the boundaries of highly refractive layers, and also spaces or open water-filled crevices which widen or become more narrow with the swelling and contraction of the adjacent dense layers.

The layers which take the deepest color with gentian violet and iodine are in general the densest layers. They are highly refractive when mounted in water, and stains are removed from them with difficulty. In the case of precipitates formed in the grain, of course the conditions are just the opposite of those in ordinary staining, and, as described above, there is no question that the zones of granules, formed by precipitating methyl violet with calcium nitrate or with picric acid, lie in the more open watery strata and in the crevices between the denser strata of the grain.

Meyer holds that the loose and not the dense layers take the deepest stains, and this view has since been accepted by Salter. It seems to me natural that the parts of the grain which contain the most solid starch substance would be the ones which are most deeply colored, and the evidence from Figures 42 and 43 is very convincing that this is the case. This is also evidence that the stains are not simply held mechanically between the particles of starch but that they enter into combination with the latter.

In old grains of *Canna* it is often impossible to differentiate layers at the organic center of the grain, the material in this region often appearing as a homogeneous mass. If such grains be crushed so that radial cracks extend through the dense peripheral layers, and if these crushed grains are then stained with gentian violet and orange, it will be found that the entire interior mass of the grain which does not show stratification is also bright orange in color. The staining confirms the observation that the central region of old grains may have been altered characteristically in its nature. In corroded grains, this central portion is often stained orange after the peripheral layers have been penetrated by corrosion channels; or, where corrosion has continued, the central mass may be entirely removed before the peripheral layers show much alteration.

As noted above, if a potato starch grain is treated with a 10 per cent potassium hydroxide solution, the region surrounding the hilum becomes granular in appearance and is the first portion of the grain to swell. The outer starch layers are the last to be affected, showing that they are, no doubt, the most resistant layers of the grain.

From these facts, it seems probable that the central portion of old starch grains has been so modified that it is different in composition from the more peripheral layers. It may be a transition substance similar to that produced by the action of diastase in corroding the grains, as noted further below. Fischer finds that the material from this region can be squeezed out as a fluid mass from grains mounted in water.

As just noted, it was found that where large eccentric grains such as those of the *Canna* or the potato are subjected to the action of diastase, channels are formed passing through the outer dense layers more or less distinctly, but when the interior of the grain is reached the corrosion is more general, with the result that the interior is dissolved out.

Diastase acts somewhat differently in the grains of wheat and barley; in these grains, channels are often formed running from the periphery to the center. These channels later spread along certain of the concentric layers, probably the less dense, although this could not be definitely determined.

Salter, on the other hand, is of the opinion that, because young starch grains are stained with difficulty by the ordinary stains and take up the orange of the triple stain, they are dense and homogeneous starch masses. For the same reasons, he is of the opinion that the peripheral layer of older starch grains is the densest layer in the grains. His reasons do not appear to be well founded. The orange stain combines readily with the material formed in the corrosion of the starch grain and also, as found by Timberlake, with the substance formed in the manufacture of the cell plate. These are transition substances, and it is but natural to suppose that the orange-staining peripheral layer of the starch grain is a third transition substance. There is small doubt that this layer differs in chemical composition from the violet starch layers, and all the evidence seems to indicate that it is not a dense layer, but rather a loose layer of transitory nature.

BIBLIOGRAPHY.

A fairly complete bibliography up to 1895 is given by Meyer (18).

1. BUETSCHLI, O.: Über den feineren Bau der Stärkekörner. *Verh. Natur.-hist. Med. Verein Heidelberg, N. F.,* v.

2. ——Über die Herstellung künstlicher Stärkekörner oder von Sphaerokrystallen der Stärke. *Verh. Natur.-hist. Med. Verein Heidelberg,* v.—1897.

3. ——: Untersuchungen über Amylose und Amyloseartige Körper. *Verh. Natur.-hist. Med. Verein Heidelberg,* vii.

4. CRUGER: Westindische Fragmente, III. *Bot. Zeit.*—1854.

5. DENNISTON, R. H.: The structure of the starch grain. *Trans. Wis. Acad. Sci., Arts and Letters,* xiv.—1904.

6. EWART: Assimilatory inhibition. *Journ. Linn. Soc.,* xxxi.—1895.

7. FISCHER, H.: Über Inulin, nebst Bemerkungen über den Bau der geschichteten Stärkekörner. *Cohn's Beitr. zur Biol. der Pflanzen,* viii.—1902.

8. ——: Über Stärke und Inulin. *Beih. zum. Bot. Centralbl.,* xii.—1902.

9. ——: Microphotogramme von Inulinsphaeriten and Stärkekörner. *Ber. Deutsch. Bot. Ges.,* xxi.—1903.

10. ——: Über Stärkekörner und ihr Verhalten gegen Farbstoffe. *Beih. zum. Bot. Centralbl.,* xviii.—1905.

11. FRITZSCHE: Über das Amylum. *Ann. Physik und Chemie.*—1834.

12. GOLDSCHMIDT, V.: Zur Mechanik des Lösungsprocess. *Zeitschr. f. Krystallographie und Mineralogie,* xxxviii.—1904.

13. GRUESS: Über das Eindringen von Substanzen besonders Diastase in Stärkekörner. *Jahrb. f. wiss. Bot.*—1895.

14. HARTIG, T.: Über den Bau des Stärkemehls. *Bot. Zeit.*—1855.

15. KRAEMER, H.: On the continuity of protoplasm. *Proc. Amer. Phil. Soc.,* xli.—1902.

16. Kraemer, H.: The structure of the starch grain. *Bot. Gaz.*—1902.
17. ——: Further observations on the structure of the starch grain. *Bot. Gaz.*—1905.
18. Meyer: Untersuchungen über die Stärkekörner.
19. Mikosch: Über die Entstehung der Chlorophyllkörner. *Sitzungsber. Wiener Akad*—1885.
20. Mohl: Vermischte Schriften.
21. ——: The vegetable cell (Trans. by Henfrey.)
22. Munter: Über das Amylum der *Gloriosa superba* L. *Bot. Zeit.*—1845.
23. Naegeli, C.: The utricular structures in cells. *Roy. Soc. Rept. on Botany.*—1849.
24. ——: Die Stärkekörner.—1858.
25. ——: Das Wachstum der Stärkekörner durch Intussusception. *Bot. Zeit.*—1881.
26. Newcombe, F. C.: Cellulose enzymes. *Ann. of Bot.*—1899.
27. Noll, F.: Die geformte Proteine im Zellsafte von *Derbesia*. *Ber. Deutsch. Bot. Ges.*, xvii.
28. Purjewitsch, K.: Über die Wabenstructur der pflanzlichen organischen Körper. *Ber. Deutsch. Bot. Ges.*, xv.—1897.
29. Rodewald and Kattein: Über natürliche und künstliche Stärkekörner. *Zeitschr. f. Physik. Chemie*, xxxiii.
30. Rothert, W.: Einige Bemerkungen zu Arthur Meyer's Untersuchungen über die Stärkekörner. *Ber. Deutsch. Bot. Ges.*—1897.
31. Sachs, J.: Über den Einfluss des Lichtes auf die Bildung des Amylums in den Chlorophyllkörner. *Bot. Zeit.*—1862.
32. Salter: Contributions to a fuller knowledge of starch grains.
33. ——: Zur näheren Kenntniss der Stärkekörner. *Jahrb. f. wiss. Bot.*, xxxii.—1898.
34. Schimper, W.: Untersuchungen über die Chlorophyllkörner. *Jahrb. f. wiss. Bot.*—1885.

35. SCHIMPER, W.: Untersuchungen über die Entstehung der Stärkekörner. *Bot. Zeit.*—1880.

36. ——: Untersuchungen über das Wachsthum der Stärkekörner. *Bot. Zeit.*—1881.

37. SCHMITZ: Die Chromatophoren der Algen. *Verh. naturw. Ver. preuss. Rheinlande und Westfalen*—1883.

38. STRASBURGER, E.: Über den Bau und das Wachsthum der Zellhäute.

39. TIMBERLAKE, H. G.: Starch formation in *Hydrodictyon. Ann. Bot.*, xv.

40. ——: Development and function of the cell plate in higher plants. *Bot. Gaz.*, xxx.—1900.

41. VERWORN, M.: General physiology (Trans. by Lee).

42. WALPERS: Nachtrag zu dem Aufsatze über Arrow-root. *Bot. Zeit.*—1851.

43. WINKLER: Untersuchungen über die Stärkebildung in den verschiedenartigen Chromatophoren. *Jahrb. f. wiss. Bot.*, xxxii.—1898.

EXPLANATION OF FIGURES.

All figures (except Figs. 44–50) were drawn with the aid of the Abbé camera lucida.

All figures (except Figs. 17–25, 32) are from the rhizome of *Canna.*

The figures in Plates XXXVIII and XL have a uniform magnification of 875 diameters, unless otherwise mentioned. Figures in Plate XXXIX are magnified 1,220 diameters.

ABBREVIATIONS.

STAINING REACTIONS:

- V =very light violet.
- V^1=pale violet.
- V^2=violet.
- V^3=dark violet.
- V^4=very dark violet.
- O =pale orange.
- O^1=orange.
- O^2=dark orange.

- l =leucoplast.
- c =chloroplast.

PLATE XXXVIII.

EXPLANATION OF PLATE XXXVIII.

Fig. 1. Typical grain from a rhizome of *Canna*.

Figs. 2–5. Series showing development of grain of eccentric form.

Figs. 6–8. Young grains before formation of violet-staining portion.

Fig. 9. Young grains showing violet portion at center.

Figs. 10, 11. Young grains showing formation of eccentric violet-staining layers.

Fig. 12. Eccentric grain in leucoplast.

Fig. 13. Small grain in leucoplast.

Fig. 14. Young grain with leucoplast as thin uniform layer around the periphery.

Fig. 15. Young grain with two hila.

Fig. 16. Young grains with two hila each.

Figs. 17–20. Development of eccentric grain in chloroplast in stem of *Pellionia Daveauana*.

Figs. 21, 22, 24. Chloroplast in leaf of *Pellionia Daveauana*, fixed at the close of a bright day and containing large assimilation starch grains (x 1,750).

Figs. 23, 25. Chloroplasts from same plant, fixed after ten hours in darkness. Fig. 23 shows remnants of starch grains remaining. Fig. 25 shows the plastid completely freed from starch.

Figs. 26–29. Starch grains artificially corroded by diastase.

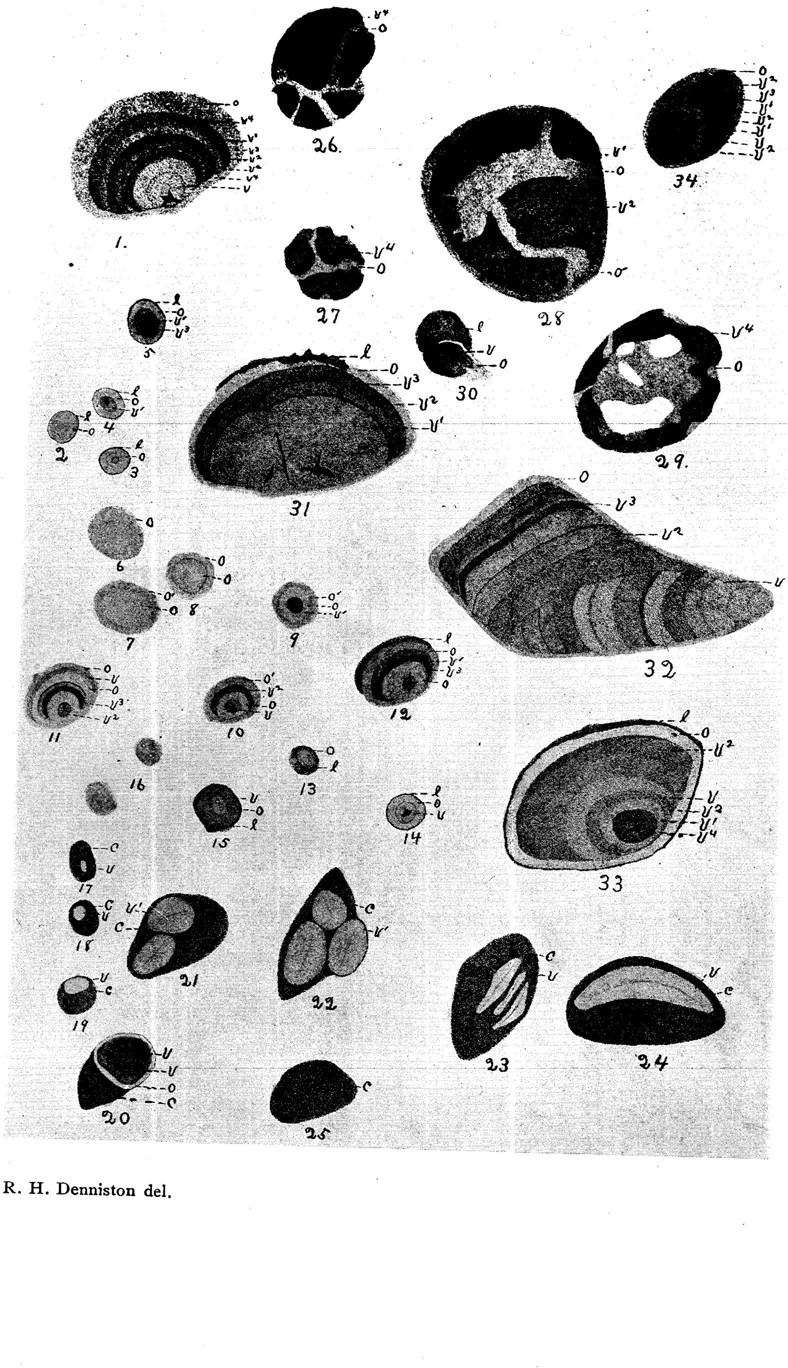
Fig. 30. Corrosion of grain in the plastid. The anterior end of the grain is reduced to a point and takes the orange stain.

Fig. 31. Compound grain showing orange-stained peripheral layer and portion of leucoplast.

Fig. 32. Grain from *Dieffenbachia seguina* showing the effects of solution and subsequent growth in a new direction, caused by shifting of plastid.

Fig. 33. Large grain showing leucoplast and orange-stained peripheral layer surrounding violet portions of the grain.

Fig. 34. Grain showing broad orange layer.



R. H. Denniston del.

PLATE XXXIX.

EXPLANATION OF PLATE XXXIX.

Fig. 35. Grain showing orange layer divided at posterior portion of grain by narrow violet layer. Grain surrounded by thin leucoplast.

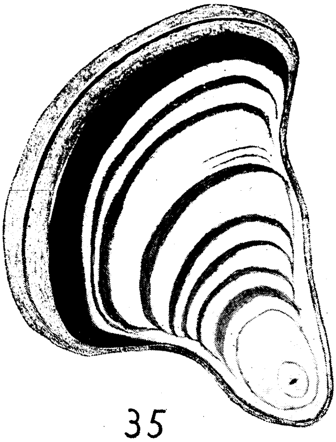
Fig. 36. Outer violet layer completely surrounding violet portions of the grain.

Fig. 37. Grain showing thin leucoplast entirely surrounding grain and broad orange peripheral layer.

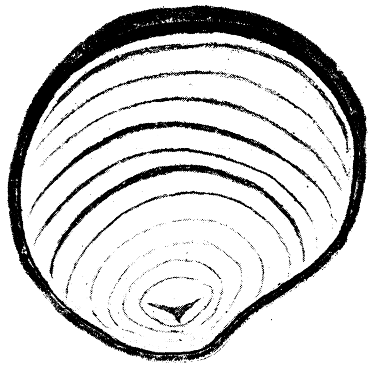
Fig. 38. Grain showing leucoplast as thin layer on periphery; a broad orange layer, separated from a pale orange layer at the posterior end of the grain by a crescent-shaped band of violet-staining starch.

Fig. 39. Grain showing the effect of normal corrosion in the plastid.

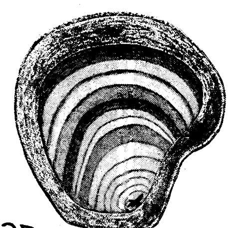
Figs. 40, 41. Corroded grains from germinating wheat.



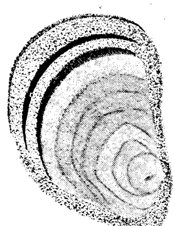
35



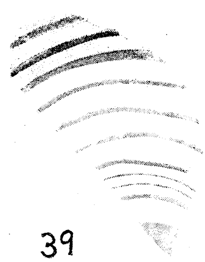
36



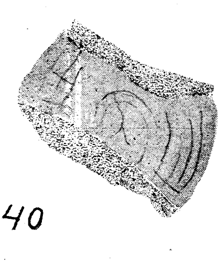
37



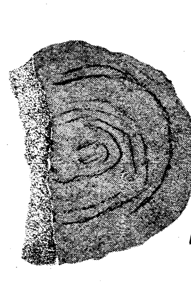
38



39



40



41

R. H. Denniston del.

PLATE XL.

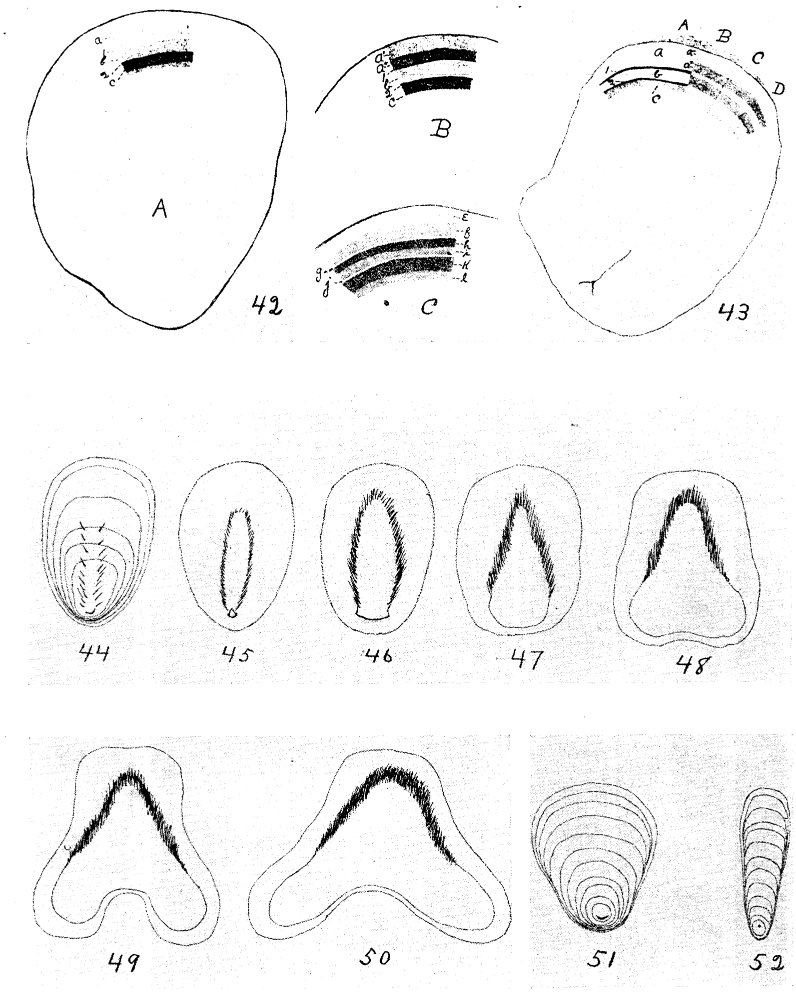
EXPLANATION OF PLATE XL.

Fig. 42. A. Grain mounted in water.
B. Same grain stained with dilute iodine water.
C. Same grain stained with gentian violet and orange G.

Fig. 43. Grain showing appearance of layers when mounted successively in water, iodine water, alcohol and Flemming's triple stain.

Figs. 44–50. *Canna* grain showing successive stages in the action of 10% potassium hydroxide.

Figs. 51, 52. Grain showing surface and edge views.



R. H. Denniston del.

TABLE ILLUSTRATING THE PROGRESS OF ROTATION IN OFFICE TO 1835.

CARL RUSSELL FISH.

The development of the spoils system was in part a response to a popular demand for rotation in office. In early colonial days, when office was a burden, it was felt to be but just that no one be called upon to serve continuously. At the time of the Revolution, it was feared that continuous office-holding would create a class imbued with undemocratic feelings; that a periodic return of the office-holders to the level of the people was necessary for the orthodoxy of the former and the safety of the latter. Finally came the mid-nineteenth century attitude, that the offices were prizes and that no one should be allowed to enjoy the monopoly for any long period.

This idea of rotation in office paved the way for the use of offices for political purposes, but was quite distinct from it, antedated it (in America), and, unlike it, found expression in legislation. The following table is intended, not as a graphic illustration, but as a condensed reference table of such legislation.

The table is arranged chronologically by states. It is divided by a double line into two parts, one treating of *elective*, and one of *appointive* offices. In the case of elective offices, rotation was obtained either by providing that the officer should hold so many years and then be ineligible for so many—which is indicated in the table by $x—y$; or by providing that he could hold so many years out of a given number—which is indicated by x: y; or by providing that he could serve so many years and not again—which is indicated by x. In the case of the appointive offices, rotation was obtained sometimes by one of

		Elective.							Appointive.								
		Governor.	Council.	Treasurer, etc.	Legislature, etc.	Justice of peace, etc.	Sheriff.	Coroner.	Judge.	Justice of peace, etc.	Sheriff.	Coroner.	Solicitor.	Clerks.	Financial officers	Administrative officers	Land officers.
Delaware	1776	3-3	Complex.														
	1792	3:6	2-3				3-3	3-3						5			
	1831																
Maryland	1776	3-4			Complex.						3-4						
New Jersey	1776								7	5	3-3		5	5			
North Carolina	1776	3:6															
	L 1827	"												4			4
	1835	4:6											4	"			"
Pennsylvania	1776	3-4	3-4						7	7	3-4						
	1790	9:12									3:6	3:6					
	L 1809	"									"	"			3:6		
	L 1820	"									"	"			"		
	L 1830	"									"	"			"	1,3	
	1831	"								2:3	"	"			"	"	
	1834	"								"	"	"			"	"	
South Carolina	1776									2							
	1778	2-4		4-4						2-4						4-4	
	1790	"	2-4	"						4-4							
	L 1794	"	"	"						"						4	
	L 1812	"	"	"						"	4		4	4	4	4	
	1822	"	"	"						"	"		"	"	"	1	
	1827	"	"	"						"	"		"	"	"	2,4,6	
Virginia	1776	3-4															
	1830	"															
Georgia	1777	1:3															
	1789																
	1798								3		2-4						
	1812								"		"						
	L 1819								"	4	"			3			

New York	1777		1:2							3	4:5	4:5					
	L 1813		"							"	"	"					
	1821					4	3	3					3	3		1	
	L 182.					"	"	"					"	"		1,3	
																1,2,3,4	
Massachusetts	1780			5-1													
	L 1811			5:6							5						
New Hampshire	1787									5							
Kentucky	1792										3:6						
	1799	4-7															
Tennessee	1796	6:8									2	2					
		"									6:8			6	6,2		
Ohio	1802	6:8									4:6						
	L 1809	"								3	"						
	L 1816	"								"	"					3	
	L 1825	"								"	"					3,5	
	L 1830	"								"	"					"	
	L 1831	"								"	"					1,3,5	
	L 1833	"								"	"				3+	1,2,3,5	
														5	"	"	
Louisiana	1812	4-4															
	L 1813	"														2	
	L 1825	"									2		2			"	
Indiana	1816	6:9							7		4:6						
Illinois	1818	4:8															
Alabama	1819	4:6											4				
	L 1819	"								3		3	"				3
	1830	"							6			"	"				"
Maine	1820	4-4		5-1						7							
Missouri	1820	4-4									2	2				4	
Mississippi	1822								6								

these methods, but more often the idea of rotation was satisfied by simply putting a limit to the term of office, instead of leaving the tenure to the pleasure of the appointing officer. That this simple limitation of term was in large measure due to the popular belief in rotation is shown in the author's "Civil Service and the Patronage," pp. 83-86.

Where the simple date is given, the change indicated was constitutional; where the date is proceded by *L*, the change was effected by ordinary legislation. Each line, from left to right, is made complete by ditto marks, and where they are not given the provision of earlier date lapsed or was repealed. Offices have been grouped in some cases where functions were similar and titles only differed. All such cases are indicated by the addition of *etc.*

The table shows the early rise of the idea and its steady development up to 1835, when it became absorbed by the dominating practice of using the offices as ammunition in party warfare. It shows also that while in some states it existed as a tenet of theoretical democracy, as for instance in South Carolina, which was the most comprehensive and steady-going disciple of rotation in legislation and yet did not debase its civil service to political uses; in others, as Pennsylvania and New York, rotation in legislation served as the handmaid of the growing spoils system, by allowing political changes without an alarming resort to actual removal.

THE INDIVIDUALITY AND VARIATION OF THE PYLORIC CAECA OF THE CENTRARCHIDAE.

ROSWELL HILL JOHNSON.

(With Plates XLI-XLV and two Text-figures.)

The object of this contribution is to establish that the pyloric caeca of the Centrarchidae are not similar, as generally assumed, but have individuality, and to describe their variation.

With the exception of eleven *Micropterus dolomieu* and eight *Micropterus salmoides*, all the fish were taken from Lakes Mendota, Monona, Wingra and Waubesa. These lakes are near Madison, Wisconsin, and are in connection with each other. The nineteen bass were from Round lake, Langlade county, Wisconsin. Record was kept of the localities, but as no significant differences have appeared, the fish of the different localities will be considered together.

The family Centrarchidae has three American sub-families, each of which is represented by species used in this investigation—the *Lepominae, Centrarchinae* and *Micropterinae*. Jordan and Evermann state that the family has five to ten caeca.

Of the Lepominae, the largest of the three sub-families, three species were investigated, *Lepomis pallidus* (blue gill), *Ambloplites rupestris* (rock bass) and *Eupomotis gibbosus* (sun fish).

Lepomis pallidus Mitchill.

This species has 6-9 caeca, with a mode of 7 and a mean of $7.4323 \pm .0294$. The frequencies are given in Text-figure 1. The variation measured by the standard deviation was $.6882 \pm .0270$. This is very high, as shown by the coefficient of variation obtained by dividing the standard deviation by the mean and multiplying by 100, which gave 8.9905. A correlation table of length of animal with number of caeca showed that the number did not increase with age. The position of the caeca with reference to the other viscera is shown in Plate XLI, Figures 1 to 8. This position determined two intervals in the circle of caeca. One broad interval, at one side of which the ductus choledochus enters the intestine, is caused by the stomach (Plate XLI, Fig. 7). The other interval on the right is caused by a loop of the intestine, the presence of which is constant. The first I propose to call the *gastric interval*, and the interval on the right the *enteric interval.* Between these two intervals there is normally but one caecum. This I will call the *pollical caecum*, from the analogy of its position relative to the other caeca with that of the thumb relative to the fingers. This caecum is seen from the right side extending parallel to, and dorsal of, the intestine. Very rarely, the pollical caecum is replaced by two caeca. This occurred four times in 229 individuals. One case is represented in Plate XLI, Figures 3, 4 and 5. Rarely the pollical caecum, instead of appearing dorsal of the intestine, is turned under the loop of the intestine so as not to be seen from the side.

Although the relative lengths of the caeca in no two individuals agree, by averaging many individuals a definite relation of the lengths of the caeca of the different positions is shown. The length of the caeca is expressed in percentage of the length of the longest caecum in the individual. This was necessary, because in much of the material the total length of the animal was unobtainable. The lengths are graphically shown in Plate XLIV, Figure 1, when there are seven caeca, and in Plate XLIV, Figure 2, when there are eight caeca. There is a regular diminution in length from the stomach towards the ventral side on each side. A cause of this diminution is probably to be found in the fact that the plane of their bases is not at right angles to the long axis of the fish, but inclines, with dorsal caeca arising more cephalad. Since they all project caudad, those which arise nearer the back will have more space in which to grow before meeting an obstacle. This cause may be inadequate, however, to account for all the difference, which is considerable in *Lepomis*.

Frequently a change in curvature in the caeca may be observed between caecum IV and caecum V, numbering the caeca from the gastric interval down the right side and up the left (the pollical caecum thus being caecum I). More rarely this change occurs between III and IV, or between V and VI. This change in curvature (Plate XLI, Fig. 3) is the result of the pressure of the pyloric portion of the stomach against the body wall. This forces the caeca to curve around the pyloric portion on each side.

A branched caecum was found in three of 229 individuals (Plate XLIII, Figs. 2, 5 and 6). This is important, in view of the fact that another of the species examined, *Micropterus salmoides*, has its caeca normally branched.

An average of twenty-one cases shows the longest caecum to be 15.0 per cent of the length of the fish. The length of the intestine from pylorus to anus is shown to be 1.14 times the length of the body in six cases. The length of the abdomen may be inferred by the length of the vent from the cephalic end of the fish. An average of eight cases showed this to be 44.4 per cent. These figures are compared with those of the other species in Table I.

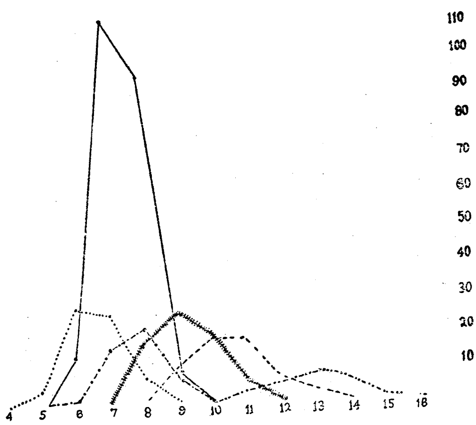
TABLE I.

Species.	Length of longest caecum.	Length of intestine.	Length to vent.
Lepomis pallidus	15.0 per cent	1.14	44.4 per cent
Ambloplites rupestris	13.2 per cent	1.02	47.5 per cent
Eupomotis gibbosus	13.1 per cent	1.21	46.4 per cent
Pomoxis sparoides	15.2 per cent	.62	40.0 per cent

Ambloplites rupestris Rafinesque.

Jordan and Evermann say of this species, "Caeca 7". The specimens examined, however, showed a mode of 8 and a range of 6-9. It thus has the same range as the previous species, but with a mode one higher. The frequencies are shown and compared with the other species in Text-figure 1. The variability seems about the same. Plate XLI, Figures 9 to 11, show the arrangement of the viscera to be essentially similar. The caeca are not as long, however, the longest averaging 13.1 per cent in sixteen cases. The abdomen is longer, the vent being 46.4 per cent of the length from the cephalic end in fourteen cases. The length of the intestine is 1.02 times the length of the fish as found in five cases. The food is dominantly crayfish of a considerable size

The relative lengths of the caeca show the longest to be those adjoining the gastric interval as before, but the shortest caecum is farther to the left than in *Lepomis* (Plate XLIV, Fig. 5).



TEXT-FIGURE 1.

The distribution of frequencies of the number of caeca in the several species.

Lepominae:

Lepomis pallidus—Continuous line beginning at 5.

Ambloplites rupestris—Broken line beginning at 5.

Eupomotis gibbosus—Line beginning at 4.

Centrarchinae:

Pomoxis sparoides—Line beginning at 7.

Micropterinae:

Micropterus salmoides—Line beginning at 8.

Micropterus dolomieu—Line beginning at 10.

Ordinate—Number of specimens.

Abscissa—Number of caeca.

Eupomotis gibbosus Linnaeus.

The number of caeca in this species is the least of those studied, the mode being 6 and the range 5-8 (Text-figure 1). The variability seems equally great. The relation of the viscera is as before (Plate XLI, Fig. 12, Plate XLII, Fig. 13).

The length of the longest caecum is about the same as in the rock bass, 13.1 per cent of the total length in ten cases. The intestine is 1.21 times the total length of the body in eight cases, being longer than in the rock bass. This is probably the result of the considerable quantity of plant food eaten by this species. The length to vent is 40.0 per cent of the length in eight cases.

The relative lengths of the caeca indicated in Plate XLIV, Figures 3 and 4, show a very decided reduction of the left side in comparison with the right. This is partly due to the frequent occurrence in this species of much reduced caeca, which are sometimes smaller in diameter as well as shorter.

One specimen of this species shown in Plate XLII, Figures 14, 15 and 16, was abnormal in the extraordinary arrangement of the viscera. The caeca were yet so typical as to suggest that some of their individuality is preformed rather than epigenetic from the pressure of other viscera, although the latter influence is clearly very strong in determining many of the conditions here described.

This species is the last of the Lepominae described. The sub-family has a range of 5-9, which will doubtless be extended when more species are examined.

Pomoxis sparoides Lacepede.

There are only three American species in the sub-family Centrarchinae, of which this alone was available. The caeca are far more numerous than those of the Lepominae, the mode being 9 and the range 8-11. With this increase comes very naturally an increase in the number of cases (16 out of 69) where two caeca replace the pollical caecum. The intestine and caeca are very slender (Plate XLII, Figs. 17, 18). An average of ten gave 15.2 per cent of the total length. The abdomen is very high and short, the vent being only 40.0 per cent of the length from the cephalic end of the body in fourteen cases. The intestine, which is far shorter than in the other species, is but 62.5 per cent of the length, the average of ten cases. This may result from the large part of the food of this species consisting of plankton. The short intestine goes with long caeca in this species.

The arrangement of the viscera differs somewhat from that in the Lepominae. The slender caeca are not spread out on the side of the stomach, but are characteristically bent ventral, then dorsal. This different position is doubtless the cause of the relative lengths of the caeca being so different from the type seen in the Lepominae. Plate XLIV, Figure 6, shows that caecum IV is longer than its neighbors, and that the left caeca lack the characteristic shortness observed in the other species.

Two cases of fused caeca were found (Plate XLIII, Fig. 7). In Figure 7 there were two lumina extending to the base. Since such fusions were not found in the other species, it seems possible that one other case of apparent branched caeca seen in this species represented a case of fusion.

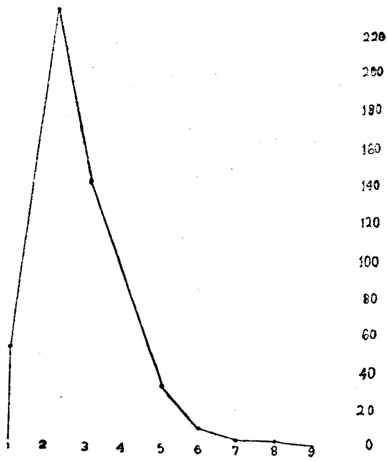
Both of the two species of the Micropterinae occur in the lakes of Madison.

Micropterus dolomieu Lacepede.

This species has the largest number of caeca of all the species examined. Gunther says of the caeca, "14 or more." The range was found to be 11-15 and the mode 13. The loop of the intestine passing the pylorus does not produce an interval, but the caeca are so pressed from their natural position that its position is evident after removal of the intestine. The number of caeca between the gastric interval and the loop of the intestine is two to four, most often three. This is to be expected, owing to the larger number of caeca. The relative lengths of the caeca are shown in Plate XLIV, Figure 9. As in *Pomoxis,* there is an increase in length from I to III. The differences in length are less, owing to the length being longer in proportion to the diameter of the intestine, which as stated above I believe to be a cause of the difference in length. Branching was met with once, as shown in Plate XLIII, Figure 9.

Micropterus salmoides Lacepede.

The relation of the viscera of the wide-mouthed black bass is shown in Plate XLII, Figures 22–25. It has the caeca branched. Holbrook says of these: "There are eleven primitive caecal appendages, which soon divide into two or three others so that as many as twenty-eight may at times be counted." The bases of these branched caeca varied from 9-13. The mode was 10-11. (Text-figure 1). Text-figure 2 shows the distribution of branches to each tip. The mode was 2, mean 2.7346 ± .0267. The standard deviation was .9166 ±



TEXT-FIGURE 2.

Frequency polygon of the numbers of tips to 535 caeca in 51 individuals of *Micropterus salmoides.*

Ordinate—Number of specimens.

Abscissa—Number of tips to each caecum.

.0177, and the coefficient of variation extraordinarily high, 35.5186. This high variability may indicate that the branched condition is relatively new and not yet fixed. This seems likely, because this is the only species of the genus having branched caeca. The distribution of these tips according to the position of the several bases is shown in Plate XLIV, Figure 8, where the numbers are averaged in individuals having ten bases. The greatest branching takes place where there is most space, that is to the left of the main portion of the stomach.

The caeca were measured to the tip of the longest branch. The result shown in Plate XLIV, Figure 7, differs from *M. dolomieu* only in having X shorter than IX. The branching is nearly always bifurcating, as shown in Plate XLIII, Figures 1 and 4, where some much-branched caeca are drawn. The few cases where the caeca apparently branch into three (Plate XLIII, Fig. 8) doubtless arise from the close approximation of two points of bifurcation.

The primary bifurcation is near the base of the caeca with a mode of 9 per cent of the length to the end of each tip from the base. Its position is not apparently greatly altered if there is further branching distal or not. The secondary bifurcation is most frequently 15-17 per cent from the base. The tertiary and quaternary bifurcations are too irregular to fall into a regular frequency polygon. As a whole, however, the branching is distinctly near the base of the caeca.

The caeca in this species are very slender and pointed in comparison with *M. dolomieu,* where they are thick and rounded. The food is fish, while that of *M. dolomieu* is primarily crayfish. The enteric interval is replaced by a deflection in the line of caeca as in the previous species. There are usually two caeca between the two intervals.

SUMMARY AND CONCLUSIONS.

1. The pyloric caeca of the six species of Centrarchidae found in the vicinity of Madison, Wisconsin, are highly variable in number. The ranges overlapped, making a range for the order of 6–15.
2. A loop of the intestine causes an interval between caeca, which, with the other interval formed by the stomach, separates a few caeca from the rest. In the Lepominae, where the caeca were less than nine in number, but one caecum has this position.
3. The lengths of the several caeca have a characteristic relation for each species.

4. The branching of the caeca, which is normal in *Micropterus salmoides,* was investigated quantitatively. Cases of fused or branching caeca were found in the other five species, although normally their caeca are unbranched.

Anatomical Laboratory, University of Wisconsin.

BIBLIOGRAPHY.

GUNTHER, 1859:
Catalogue of the fishes in the British Museum, vol. i, p. 252.

HOLBROOK, 1855:
Ichthyology of South Carolina, p. 25.

JORDAN and EVERMANN, 1896:
The fishes of North and Middle America. *Bull. U. S. Nat. Mus.*, no. 47, vol. i, p. 990.

PLATE XLI.

EXPLANATION OF PLATE XLI.

In this and the following plate, the caeca are coarsely stippled and the liver is faintly stippled. Parts hidden by the liver are drawn as if the liver were transparent. All the figures are one-half life-size.

The following abbreviations will be used for this and the following plate:

S—stomach.
I—intestines.
O—oesophagus.
Sp—spleen.
A—anus.
T—testis.
Ov—ovary.

Arrangement of viscera in *Lepomis pallidus*, specimen *a:*

Fig. 1. Right view.
Fig. 2. Dorsal view.

Arrangement of viscera in *Lepomis pallidus*, specimen *b*. This specimen was abnormal in having two pollical caeca.

Fig. 3. Left view.
Fig. 4. Right view.
Fig. 5. Cephalic view, with liver removed.

Disposition of the caeca of the specimen of *Lepomis pallidus* represented in Figures 3–5, with the liver removed:

Fig. 6. Caudal view.
Fig. 7. Caudal view with stomach removed and caeca somewhat displaced to the side.
Fig. 8. Cranial view, with stomach removed.

Viscera of *Ambloplites rupestris:*

Fig. 9. Right view.
Fig. 10. Left view.
Fig. 11. Ventral view.

Viscera of *Eupomotis gibbosus:*

Fig. 12. Left view.

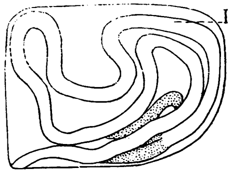


Fig. 1

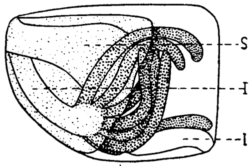


Fig. 2

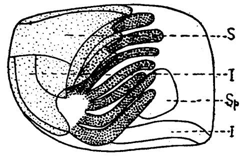


Fig. 3

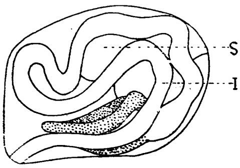


Fig. 4

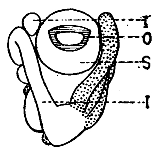


Fig 5

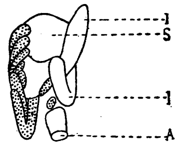


Fig. 6

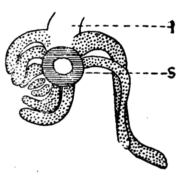


Fig. 7

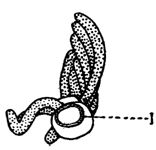


Fig. 8

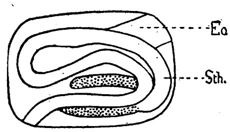


Fig. 9

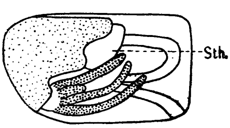


Fig. 10

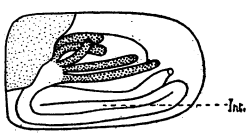


Fig. 11

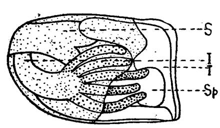


Fig. 12

PLATE XLII.

EXPLANATION OF PLATE XLII.

Viscera of *Eupomotis gibbosus:*

Fig. 13. Right view.

A case with abnormal arrangement of viscera in *Eupomotis gibbosus:*

Fig. 14. Right view.

Fig. 15. Left view.

Fig. 16. Cephalic view of pyloric region with intestine cut.

Viscera of *Pomoxis sparoides:*

Fig. 17. Right view.

Fig. 18. Left view.

Viscera of *Micropterus dolomieu:*

Fig. 19. Right view.

Fig. 20. Left view.

Fig. 21. Cephalic view, liver removed.

Viscera of *Micropterus salmoides:*

Fig. 22. Right view.

Fig. 23. Left view.

Fig. 24. Cephalic view.

Fig. 25. Cephalic view, liver removed and intestine cut close to the pylorus.

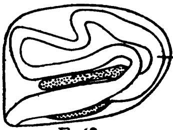


Fig.13

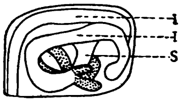


Fig.14

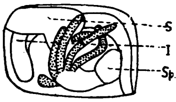


Fig.15

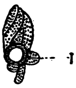


Fig.16

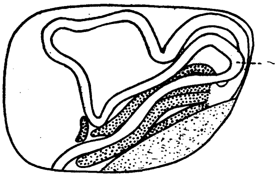


Fig.17

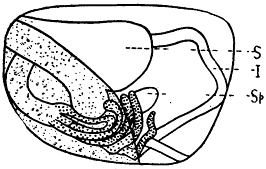


Fig.18

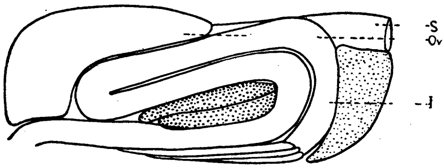


Fig. 19

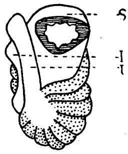


Fig.21

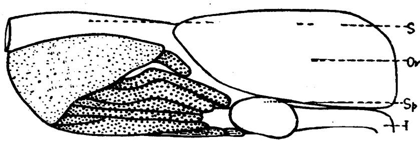


Fig. 20

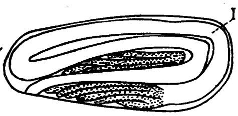


Fig. 22

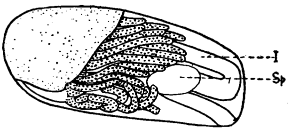


Fig 23

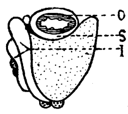


Fig 24

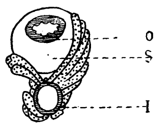


Fig.25

PLATE XLIII.

EXPLANATION OF PLATE XLIII.

Figs. 1 and 4. Much-branched caeca of *Micropterus salmoides*, to show bifurcation.

Figs. 2 and 5. Abnormally branched caeca in *Lepomis pallidus*.

Fig. 3. The caeca of a specimen of *Eupomotis gibbosus* to show an abortive caecum.

Fig. 6. Abnormally branched caecum in *Lepomis pallidus*.

Fig. 7. Fused caeca in *Pomoxis sparoides*.

Fig. 8. Unusual branching of a caecum of *Micropterus salmoides*.

Fig. 9. Abnormally branched caecum in *Micropterus dolomieu*.

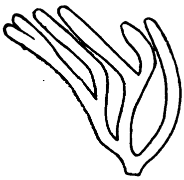


Fig.1

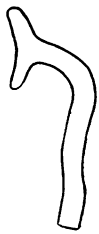


Fig.2

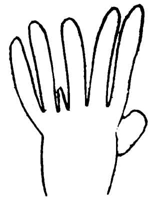


Fig.3

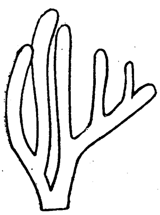


Fig.4

Fig.5

Fig.6

Fig.7

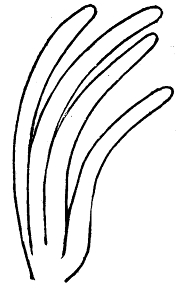


Fig.8

Fig.9

PLATE XLIV.

EXPLANATION OF PLATE XLIV.

Fig. 3. Diagram to show the average relative lengths of the caeca of *Eupomotis gibbosus* in specimens having six caeca.

Relative length of caeca in specimens having seven caeca:

Fig. 1. *Lepomis pallidus.*

Fig. 4. *Eupomotis gibbosus.*

Relative lengths of caeca in specimens having eight caeca:

Fig. 2. *Lepomis pallidus.*

Fig. 5. *Ambloplites rupestris.*

Fig. 6. Relative lengths of the caeca of *Pomoxis sparoides* in specimens having nine caeca.

Fig. 7. Relative lengths of caeca of *Micropterus salmoides* having ten caeca.

Fig. 8. Average number of tips to the caeca of the several positions in *Micropterus salmoides.*

Fig. 9. Relative lengths of caeca of *Micropterus dolomieu* having thirteen caeca.

Fig. 1

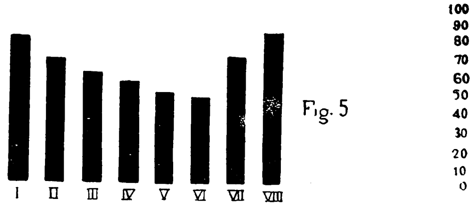


Fig. 5

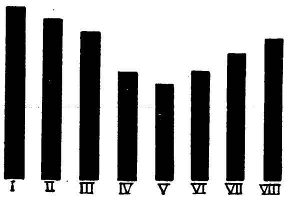


Fig. 2

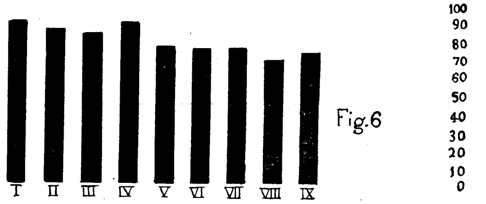


Fig. 6

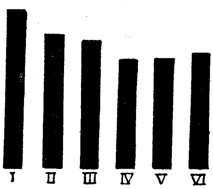


Fig. 3

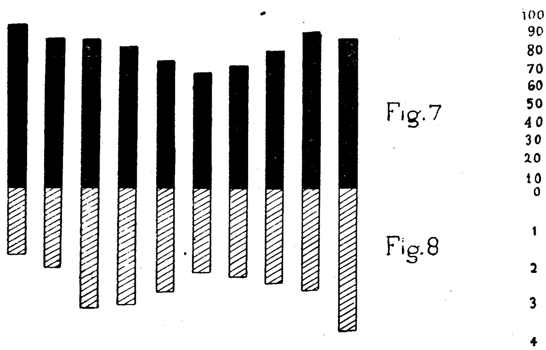


Fig. 7

Fig. 8

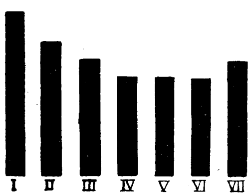


Fig. 4

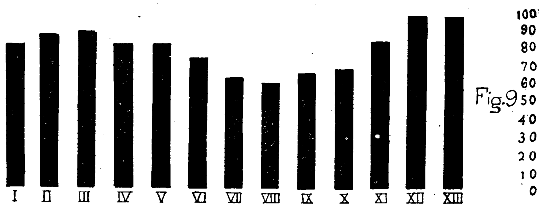


Fig. 9

PLATE XLV.

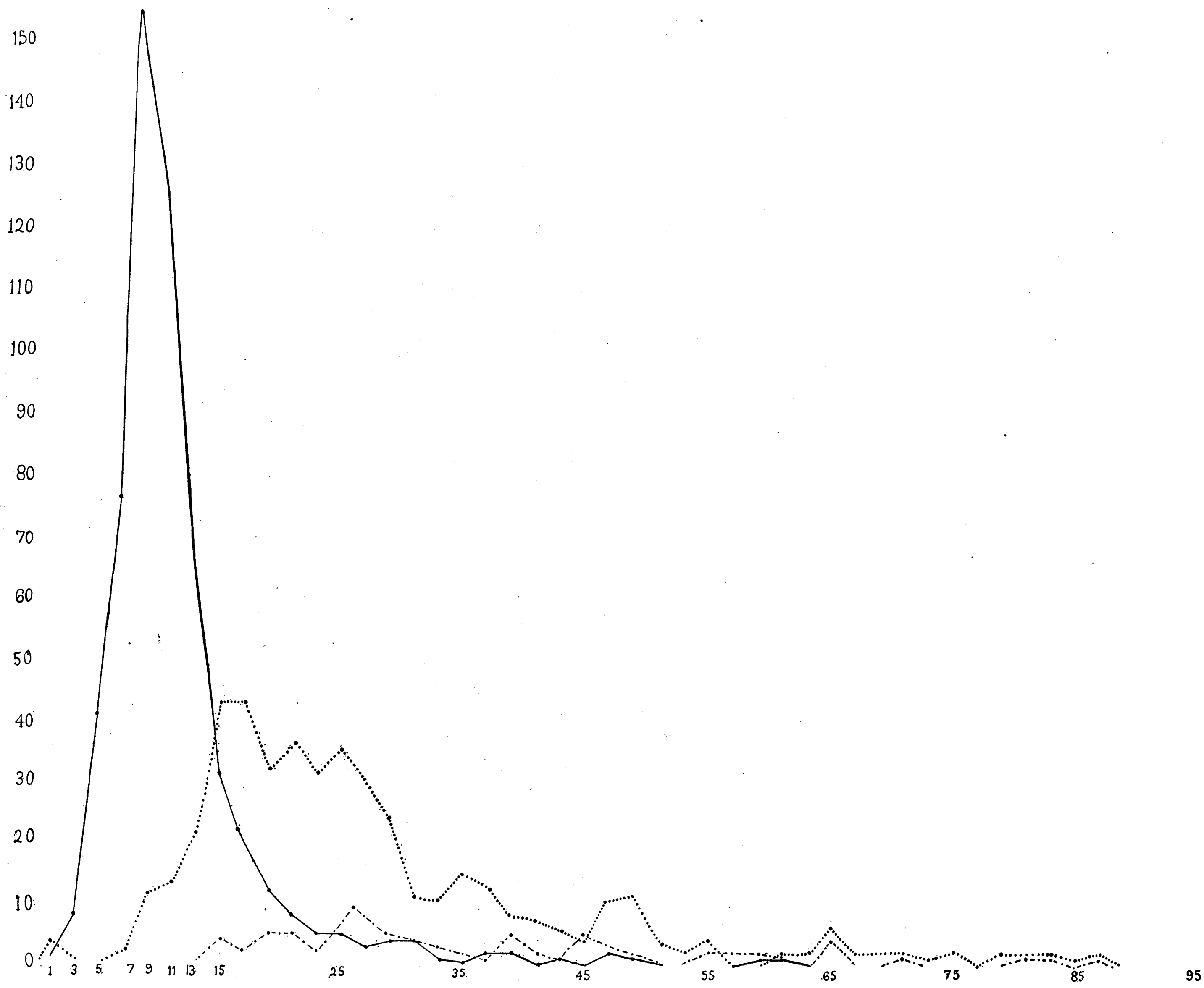
EXPLANATION OF PLATE XLV.

Micropterus salmoides.

Frequency polygon to show distance to the point of bifurcation from the base expressed in percentage of the length of the caeca.

——————Primary bifurcation.
........—Secondary bifurcation.
—.—.—.—Tertiary bifurcation.

Ordinate—Number of cases.
Abscissa—Position of bifurcation.


150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
1
3
5
7
9
11
13
15
25
35
45
55
65
75
85
95

NUCLEAR STRUCTURE AND SPORE FORMATION IN MICROSPHAERA ALNI.

M. C. SANDS.

(With Plate XLVI.)

INTRODUCTION.

The literature on the development of the ascus and its cytology has been recently and fully reviewed (4, 13), and I shall refer only to such very recent papers as touch upon the points with which I have been specially concerned.

Faull (5) describes for *Hydnobolites*, *Neotiella*, *Sordaria* and some other species, a method of spore formation which he considers essentially different from that described for the Ascomycetes by Harper (9, 11). He finds the central body by no means a permanent feature of the cell. In *Sordaria*, certain of the resting nuclei show centers, but in the other species centers with asters appear only at the time of division, disappearing in resting stages. Faull believes that the spindles are strictly intranuclear in origin, the spindle poles being the centers from which the long astral rays extend. In the last division Faull finds the same persistence and subsequent bending of the astral rays as has often been described for spore formation, but attaches no importance to the rays or their activity as far as spore formation is concerned.

The first indication of spore formation, according to Faull, is the appearance of a specialized layer of cytoplasm beginning just around the center and developing progressively outward and around the nucleus until it encloses the cytoplasm of the future spore. He compares this limiting layer to the hyaline zones found in the cleavage stages of the protospores of *Pilob-*

olus (12). It thins out from the center, stains differently from the cytoplasm, but is never clearly definable —"a hyaline zone, structureless or very finely granular." Two plasma membranes develop simultaneously on the site of the limiting layer, one about the spore-plasm, the other lining the cavity in which the spore lies. This produces no visible change in the limiting layer, although he thinks it probable that the plasma membranes result from a cleavage of the zone.

The nucleus "grows down into the center of the spore," forming a beak. Just what Faull means here by "growth" is very uncertain, especially as there is no mention of an increase in the size of the nucleus. Harper (11) has suggested several possible methods of beak formation, and seems to regard the activity of the astral rays, in bending down and exerting a pressure on the nucleus, as the most plausible. When the exospore is formed, the nucleus resumes its spherical shape by withdrawing its beak and with it the center and aster, and in this behavior Faull sees conclusive evidence that the rays take no part in the formation of the spore membrane.

Faull's figures of the beaked nucleus with its center and aster all within the spore membrane are very much like the polar or part polar views of spore formation which I have seen in *Microsphaera*, where spore delimitation is certainly accomplished by means of the astral rays. I shall discuss the significance of such polar views further on. Faull, however, regards these figures as proof that the spores are not delimited by the fusion of kinoplasmic fibers, and leaves the question without accounting in any way for the persistence and bending of the rays during the process of spore formation.

Maire's latest paper (19) describes the nuclear divisions in a number of asci, the mitoses in all of which vary only in minor details from those in *Galactinia succosa*. In this fungus, Maire (15, 19) finds that the asci arise from a filament of binucleated cells which itself arises from a large multinucleated hypha.

The nuclei of the binucleated cells show conjugate division as in the rusts (2, 3), cross walls are put in, and thus rows of "synkaryons" are formed. The end cell of each row becomes an ascus in which the two nuclei fuse. In the absence of observations concerning the origin of the entire ascocarp, it is as yet premature to draw conclusions as regards the significance of the fusion in the ascus in this case; however, one cannot avoid a suspicion that possibly antheridial and oogonial nuclei are formed but do not fuse in the oogonium, remaining separate and passing by conjugate division through the ascogenous cells until they reach the ascus where the fusion occurs. The process in this case would then at least be conspicuously similar to that in the rusts as described by Blackman (2) and Christman (3).

The first of the three nuclear divisions in the ascus is designated as heterotypic, being characterized by synapsis and a double longitudinal division of the chromosomes. The second division, in which eight protochromosomes appear which later form four double chromosomes, he regards as homoeotypic, and the last division as typic. Thus Maire agrees with the view many times expressed that the ascus is a spore mother-cell comparable to the spore mother-cell of a moss or fern.

The achromatic part of the division figures has both an intranuclear and an extranuclear origin. The center appears on the interior of the nucleus but against its membrane, at the summit of an intranuclear aster. The center divides, the two halves move in opposite directions, and a spindle is formed between them on which the chromosomes are arranged. Radiations are meanwhile formed in the cytoplasm about the elongating nucleus as a center, which become more prominent at its two ends and finally form the polar asters of the completed spindle. The asters and spindle are thus of different and independent origin. The eight nuclei become beaked, and Maire holds that spore formation is effected in the manner described by Harper.

Guilliermond (7, 8) has also investigated *Pustularia vesiculosa* and *Galactinia succosa*, studied by Maire, as well as *Peziza Catnius*, *P. rutilans* and *Aleuria cerea*, and he corroborates many of Maire's observations, differing from him, however, particularly as to the number of chromosomes and the method of their separation in the metaphases.

He accepts Maire's designation of the three divisions in the ascus as heterotypic, homoeotypic and typic. The first division is always preceded by synapsis and further characterized by a double longitudinal splitting of the chromosomes, distinguishing features of the heterotypic division. However, he holds that the half-chromosomes resulting from the second longitudinal splitting do not separate completely in the metaphase, as described by Maire, but reach the poles as V's or U's as in the Phanerogams (1).

Guilliermond (8) frequently alludes to the difficulty of determining exactly how the chromosomes divide and the halves separate, and when one considers their minute size it is not surprising that the two investigators disagree as to the details of the processes, or that the figures are not at all convincing. However, Maire's previously stated hypothesis that the Ascomycetes have but four chromosomes (16), and his later attempts to prove the doctrine, may possibly have influenced his account of the separation of the half-chromosomes in the metaphases, as well as his interpretation of the protochromosomes in the prophases of the first and second divisions.

Peziza Catnius and *Peziza rutilans* have sixteen chromosomes, *Galactinia* has four, but in *Pustularia vesiculosa* Guilliermond still holds that eight chromosomes are present, as against Maire's view that there are four.

As regards the origin of the center, Guilliermond agrees with Maire (14, 19, 8). The first indication of the formation of the karyokinetic figure is the appearance of a center just within the nuclear membrane, with abundant fibers extending in toward the chromosomes. Both the figure and the description of this stage suggest the possibility that he had before him only one-half of a spindle which was really in the equatorial plate stage, and whose other pole should appear in the next section. The center divides and the spindle is formed in the usual way. The polar asters are faint and at times cannot be seen, except in the third division, where they are always strongly developed, and later are active in the formation of the spores.

Harper has recently extended his studies on the mildews to *Phyllactinia* (13) and finds there that the development of the ascogonium from a fertilized egg, the budding out of the ascogenous hyphae, and the origin of the asci are essentially the same as in *Erysiphe* and *Sphaerotheca* (11, 10).

In *Phyllactinia*, the nuclei in every stage throughout the life history of the fungus show central bodies, and furthermore the chromatin is always oriented on the center. The center is described as a disc-shaped body lying on the periphery of the nucleus, or in a slight depression of the nuclear membrane. The chromatin is always attached to the center, but its exact arrangement cannot be made out in the vegetative hyphae and young ascogone as clearly as in the larger nuclei of the ascogenous hyphae and asci, where the number of strands which radiate from the center into the nuclear cavity can be counted. In the fusing nuclei of the ascus, the centers fuse into one, and the eight chromatin strands of each nucleus combine in such a way as to form exactly eight strands in the fusion nucleus.

The nuclear fusion is followed immediately by synapsis, in which the chromatin is drawn up in a mass against the central body. The chromatin emerges from the synaptic condition in the form of a spirem with eight distinct strands attached to the central body. Each strand of the spirem forms one of the eight chromosomes, which are still connected with the center by means of the linin threads.

The central body divides and the two daughter centers in migrating apart to form the spindle poles separate the fibers which connect the chromosomes with the center, so that each chromosome is seen to be attached to both centers. This continuous connection of the central body with the chromatin strands, and later with the chromosomes themselves, is further used as evidence that the chromosomes are permanent structures of the nucleus.

Here for the first time the fact has been established that there is a permanent connection between the center and chromosomes. The nucleus is thus shown to be a polarized structure throughout the life history of the fungus, unipolar in the resting condition and becoming bipolar in division.

The process of spore formation in *Phyllactinia* is the same as in *Erysiphe*, and, as is so frequently found in the mildews, only two nuclei are enclosed in spores, the remaining six degenerating.

OBSERVATIONS.

The mildews offer especially favorable material for the study of nuclear fusions, nuclear divisions and the very peculiar process of free cell formation which characterizes the ascus, and the following study was undertaken for the purpose of extending our knowledge of the group by an account of the development of the ascus and spore formation in the genus *Microsphaera*. I have not undertaken to work over the earlier stages in the formation of the perithecium, but have directed my attention mainly to the question of the persistence of the centers during the processes of nuclear fusion and nuclear division, and to the process of spore formation in the ascus. I have, however, observed incidentally certain stages in the development of the perithecium bearing on the account given by Neger of the structure of the mature ascocarp and its ecological adaptations, and shall describe these observations in connection with my account of the structure of the nuclei in the ascogonium and ascogenous hyphae from which are formed the nuclei that subsequently fuse in the young asci.

As is everywhere commonly observed in this country, *Microsphaera alni* DC. grows in great abundance on *Syringa vulgaris*—the common lilac—covering the leaves with a white cobwebby mycelium dotted with the dark specklike fruit bodies, and furnishes an abundance of material in all stages of development for cytological study. The fungus shows a radial growth, so that infected spots may have nearly all stages, from mature perithecia in the center to the youngest fruits on the periphery.

Small squares of leaf covered with the mycelium and perithecia were fixed in Flemming's stronger solution of chrom-osmic-acetic acid, Flemming's weaker solution, and Flemming's weaker solution diluted one-half with water. Flemming's weaker solution gave in general the best results, although the younger stages fix well in the diluted solution.

The material was collected in September and October 1904 and 1905. Sections were cut 5μ and 10μ thick and stained with Flemming's triple stain.

I shall describe the structure and the development of the ascocarp from the time when the ascogonium is completely enveloped by the perithecial hyphae, leaving the earlier stages for description later.

The young ascogonium appears as a relatively large single cell, somewhat elongated and curved, surrounded by the first hyphal envelop. This stage, in which two nuclei are present, is of frequent occurrence. The nuclei lie in the long axis of the ascogone and invariably show distinct centers and a single nucleole.

With the triple stain the centers are usually violet or dark red, and are easily distinguished from the dark blue chromatin or from the blue gray membrane of the nucleus. The nucleole is always a bright red, the nuclear sap is clear and unstained, while the cytoplasm varies from gray to a faint orange color.

The chromatin at this stage often forms a spindle-shaped mass between the central body and the red nucleole. Chromatic strands cannot be made out, but the chromatin appears rather evenly granular, though plainly connected with the central body (Fig. 4).

The ascogone grows both in diameter and length, its nuclei divide, and later cell division occurs, so that a multicellular organ is formed consisting of four or five cells. During the growth of the ascogone, the envelop becomes more complex, one or two layers of cells being formed about the first layer. The ascogone, being hemmed in on all sides by its envelop, curves and turns about as it grows, apparently expanding in whatever direction it finds least resistance, so that a much bent structure results. From just what cell or cells the ascogenous hyphae arise I have not been able to determine. It appears that many ascogenous hyphae bud out at about the same time.

These develop into multinucleated branches of the ascogone. The nuclei, however, are soon separated by cell walls, except in certain cases in which two nuclei are included in a single cell. These binucleated cells will later become the asci.

Before the young asci are formed, the perithecium begins to show some differentiation in its hyphal layers. There is an outer layer of wide-lumened cells, already showing some thickening in their walls, on the upper side of the perithecium. Within are two or three layers of thin-walled cells, smaller and more densely filled with protoplasm. The inmost layer of these is especially active; it grows and sends branches in toward the center of the fruit body, crowding against the ascogenous hyphae, intertwining among them and becoming divided to form the so-called "nurse cells." The nurse cells are uninucleated or multinucleated, and are thus seen to have been formed from centripetal branches which are at first multinucleated but are later cut up into smaller cells. This ingrowth of the perithecial cells is practically the same as described by Harper for *Erysiphe communis* (11). Certain binucleated cells of the ascogenous hyphae are meanwhile developing into asci. With their growth, the nurse cells are crowded back and flattened between the asci and the perithecial wall. Tangential sections of half-grown perithecia show these thin-walled cells as polygonal plates with two or more nuclei.

The young asci when first recognizable are little larger than the other cells of the ascogenous hyphae. They present very irregular forms, probably due to the crowded condition within the perithecium at this time, but soon round out their angles, growing at the expense of the surrounding cells which they push back. The two nuclei in the young asci, although lying very close together, at first show no tendency to fuse. They have well-defined centers to which the chromatin is attached, the strands extending back into the nuclear cavity in a typical cone (Fig. 5). The nucleole often lies near the nuclear membrane opposite the center. This antipodal relation of center and nucleole is very common throughout the nuclei of *Microsphaera.*

The ascus grows rapidly, at first mainly in the region farthest from the nuclei, so that these come to lie in the smaller end of the cell. The nuclei also increase in size, but not in proportion to the growth of the ascus. When the ascus has reached about one-third its mature size, the nuclei come in contact preparatory to fusion. They are sometimes elongated and may lie one a little above the other, or in any other position. Finally the walls between break down, and fusion occurs. A late stage in the fusion of the nuclei is shown in Figure 7. The two centers with their respective chromatin systems are still separate. (The one on the left is cut through). The nucleoli have already fused into one large nucleolus. The ascus at this stage is about half-grown. It is well rounded out except where it presses against an adjoining ascus. The fusion nucleus is about the size of the average primary nucleus.

The most frequent and conspicuous stage found in *Microsphaera* is that of the primary nucleus. It persists from the time of the relatively early fusion in the young ascus, until the ascus has reached its full development. It grows very little after fusion is complete. There is an abundance of chromatin, which readily stains a dense blue. This is at first arranged in irregular strands which occasionally appear double, and always cross and interweave in a tangled net. A large nucleolus is always present, most frequently slightly flattened against the nuclear membrane. The center is most difficult of demonstration, partly because the chromatin stains so heavily and is so abundant as to hide the center. Moreover, metachromatic bodies are particularly abundant at this stage, especially in cases of poor fixation. These bodies occur just outside the nucleus, often at a point where two or more chromatin strands touch the nuclear membrane, and may obscure the central body. Faull believes that these metachromatic bodies are normal cell products, since they are always present about the primary nucleus but disappear in later stages. However, this disappearance may indicate merely that fixation is more perfect at these later stages.

At a later stage, the chromatin appears much reduced in volume and lies massed in a ball against one side of the nuclear membrane. From this apparently synaptic mass thin chromatin strands again extend into the nuclear cavity. Finally there appears a well developed spirem plainly oriented on the central body (Fig. 6). In the uninucleated stage, it is only where the chromatin is pretty well washed out that the center appears as such. It is then a very dark, disc-shaped body pressed close against the nuclear membrane.

The perithecium has now grown to its full size, and has as many cell layers as when fully ripe. The outer layer of cells begins to show a differentiation into an upper and an under region, which is due to a thickening of the walls on the upper surface while the cells on the under side remain thin-walled and contain normal protoplasm and nuclei. The cell lumen is diminished by the thickening of the walls and is almost empty of protoplasm, while even at this stage the walls contain a brown pigment and are hard and brittle. Neger (21) first pointed out this differentiation, and described the thin flexible walls of the lower cells as caving in when the perithecium is dried out, and bulging out as the cells absorb moisture and become turgid. This alternate drying and swelling of the cells would loosen the perithecium from its mycelium. A secondary mycelium, such as is found in *Phyllactinia* (13), springs also from these lower living cells, and intertwines with the original mycelium covering the leaf.

The transition cells in the equatorial region, midway between the upper and under halves of the outer layer of the perithecial wall, give rise by the extension of their cell walls to the appendages. These grow out in a circle about the middle of the perithecium and are directed upward from the leaf surface.

The primary nucleus of the ascus undergoes three successive divisions, giving rise to two, four, and finally to eight nuclei, all of which form spores.

I find in an early prophase of the first division two centers about 90° apart, each with a large aster of long, fine rays, and a broad brush of fibers extending into the nucleus (Fig. 8).

The two centers with their asters probably originate here as elsewhere from the division of the single central body of the resting nucleus, and of a single aster developed earlier in the prophase. The two sets of fibers meet below the center of the nucleus, where they cross and interlace; some of the fibers appear to be continuous from one center to the other. At the nuclear membrane, where the broad centers are attached to the intranuclear bundles of fibers, there is a conspicuous non-staining region. Some of the peripheral fibers can be traced to the disc, but most of them fade abruptly just before reaching the central body, leaving an apparent space (Fig. 8). The so-called "achromatic" fibers at this stage stain quite as densely as the chromatic parts of the nucleus, so that the chromosomes cannot be clearly distinguished. I have not found the later stages of this division.

The binucleated stage of the ascus following the first division is easily distinguished from the binucleated condition before fusion, both by the mature size of the ascus, and by the older appearance of the whole perithecium. The two outer cell layers on the upper side of the perithecium have thick brown walls, and the appendages have nearly reached their final length.

A resting nucleus at this stage has a prominent center to which the chromatin is plainly attached; the center is always readily seen as a little cap just outside of, and closely pressed against, the nuclear membrane.

One of the most common division figures in my material is the equatorial plate stage of the second division. The spindle usually lies transversely in the ascus, with eight chromosomes arranged on the equatorial plate. The asters are inconspicuous, with fine, delicate rays that fade into the cytoplasm. Between the centers and the spindle poles, light areas are found as in the first division. The four nuclei resulting from this division do not differ from those of the two-nucleated stage, except that they are somewhat smaller (Fig. 11).

The third division is ushered in by a division of the center. Most frequently the centers are far apart—100° or 120°—when the asters and spindle fibers are well developed. The asters are particularly striking; their rays are like short, stiff bristles, and densely stained. There is the same colorless space between the center and the darkly-stained spindle fibers as in the two preceding divisions (Fig. 10). This whole stage of spindle formation bears a very close resemblance to the same stage in *Erysiphe* (6).

There are eight chromosomes on the equatorial plate and many more in the metaphases. The astral rays grow longer and become much finer, and, as the spindle often lies close to the ascus wall, they may be seen bending away from the wall toward the interior of the ascus. A small light zone still appears at each pole of the completed spindle.

The process of spore formation in *Microsphaera alni* is entirely like that described by Harper in detail for *Erysiphe communis* (11), and more recently for *Phyllactinia suffulta* (13), and corroborated by various authors (8, 19) for many other Ascomycetes.

The eight nuclei formed by the third division retain their asters; from these there continue to grow out long, fine threads which become more numerous. From the beginning the asters are turned toward the periphery of the ascus (Fig. 12). With the growth of the asters the nuclei become beaked. The center is situated at the summit of the beak, and from it chromatin strands run back into the nuclear cavity. During the process of beak formation, the nucleus with its aster shifts its position, so that it lies a little farther in from the ascus wall (Fig. 12). At this time the rays next the nucleus begin to curve back about it; more bend over in the same way, until a cone-shaped opening is formed in the midst of the aster. This folding back continues until the majority of the fibers lie in one plane, which forms a hemispherical covering over the beaked nucleus. Some of the fibers bend further, pass below this surface, and are finally enclosed within the spore (Figs. 13, 15).

As yet there is no differentiation of the protoplasm within the ascus; the fibers continue to grow in length, cutting through a homogeneous cytoplasm. That the lateral fusion of the rays begins early, as is shown by the plasmolysis of the upper end of the spore in shrunken material, has been pointed out by Harper (13). This shrinkage of the upper end of the spore often occurs long before the spore-plasm is delimited and when there is no sign of a hyaline zone or of any other differentiation in the cytoplasm to indicate the position of the future spore membrane. The cytoplasm facing the cleft made by the shrinkage is ragged and without a definite boundary, while the end of the spore is smoothly rounded off and has a continuous outline.

The fusion of the rays progresses slowly toward the interior of the ascus, following the longer fibers which have grown past the nucleus and are now converging toward a point opposite the central body and some distance below the nucleus. These advance fibers mark the path of the plasma membrane, passing into its composition as the fusion progresses. These stages look like Faull's figures of the hyaline zone, but the fibers always stain blue and do not increase in thickness.

The cleft formed by the shrinkage either of the spore or of the surrounding epiplasm narrows from the center outward along the plasma membrane which covers the upper part of the spore-plasm. When the epiplasm is shrunken, it is thickened at its inner edge simulating a membrane, so that at first glance it suggests two plasma membranes developing from the center outward, such as Faull describes. Closer scrutiny, however, proves the absence of a membrane on the surface of the epiplasm facing the opening. This cleft, of course, may almost surround the spore, or it may only cap it, according to the stage of development of the plasma membrane of the spore.

The kinoplasmic fibers finally meet at a point below the nucleus, having cut through the cytoplasm so as exactly to enclose an ellipsoidal mass of protoplasm, in the upper end of which lies the nucleus, still attached by its center to the new plasma membrane (Figs. 13, 14). The beak has been greatly elongated, but is still traversed by chromatin strands connected to the centrosome. Sometimes the nucleus is swung to one side and lies against the plasma membrane of the spore (Fig. 14).

After the fibers have completely fused, so that the spore-plasm is actually separated from the epiplasm, the center breaks away from the plasma membrane and the beak of the nucleus is slowly drawn in. There remain traces of the fibers which did not take part in the fusion, but these soon disappear (Fig. 15). While resuming its normal spherical shape, the nucleus moves down into the center of the spore mass and lies there in a resting condition, the chromatin in an irregular reticulum always oriented on the large center (Fig. 16).

Between the spore membrane and the surrounding protoplasm, a space appears in which the spore wall is finally deposited. The epiplasm is often thickened along this space, but still has no limiting membrane. The spore wall is at first a faint blue line (Fig. 16), but when completed it is a thick, dense coat, and the epiplasm is no longer drawn back from it.

With the ripening of the spores the perithecium reaches its maturity. The dark, thick walls of the cells on the upper surface have become so hard and brittle that they invariably break in sectioning, while the cells on the under side retain their thin walls and appear in normal living condition. How much this differentiation is due to the drying out of the upper exposed surface of the fruit body, while the lower cells are protected from too great loss of moisture, could only be estimated by comparison with other mildews; however, *Erysiphe* and *Phyllactinia* give no evidence on this point, and Neger's view (21, 22) as to the functional difference may be accepted for the present. The appendages grow to great length and branch profusely at their extremities. They contain protoplasm and a large elongated nucleus which lies just below the dichotomously branched end. The walls, though thin and transparent, are very brittle.

GENERAL CONCLUSIONS.

All the stages in the life history of *Microsphaera* thus far studied show that the central body is a permanent structure of the nucleus, and that it is present not only as a definitely differentiated body, but also as a point of attachment for the chromatin.

The central body is nowhere more easily demonstrated than in the nuclei of the vegetative mycelium (Figs. 1-3); it is conspicuous in the ascogone (Fig. 4) and ascogenous hyphae, and, with the exception of the primary nucleus where it is sometimes obscured by the abundant chromatin content, it is a prominent feature of the nuclei of the ascus, both in the resting condition and in division. Finally, it is present during spore formation and in the resting spores.

The chromatin is in every case plainly connected with the central body, either by direct contact or attached by means of kinoplasmic fibers. In the larger nuclei the central body lies at the apex of a cone of chromatin strands, while in the smaller nuclei, although the chromatin is plainly attached to the center, the strands cannot be made out, and it appears evenly granular.

The center is always an extranuclear body, and my observations differ radically from those of Maire and Guilliermond on this point. In polar and oblique views it may, to be sure, appear to be within the nuclear membrane, and I am inclined to suspect that, as some of their figures seem to suggest, the intranuclear centers described by Maire and Guilliermond may be accounted for in this way, or the centers may have been actually drawn into the interior of the nucleus as a result of poor fixation. Their descriptions of spindle formation, by the division and migration of the centers and the differentiation of spindle fibers, agree with the process observed in *Microsphaera*, and it is to be noted that when the spindle is complete the centers at the poles are described by them as on or very near the nuclear membrane. However, Maire's description of the formation of the polar aster from cytoplasmic fibers which radiate from the nucleus is entirely different from anything I have found in *Microsphaera*, where the asters consist of kinoplasmic rays formed about the central body just before division occurs.

The synaptic mass, as described by these authors, has no such definite position in the nucleus as in *Microsphaera*. The presence of the central body, which is in continuous connection with the chromatin, locates a polar region where the chromatin must aggregate when contracted.

Maire's further attempt to bring the divisions of the nuclei of the ascus into harmony with the latest views regarding reduction division in the higher plants has led to his adoption not only of the fusion of two spirems, as described by Allen (1) for *Lilium,* but also the pairing of protochromosomes to form the real chromosomes, comparable to the formation of Strasburger's zygosomes (23).

It is also plain in *Microsphaera* that the delimitation of the spores is accomplished by the activity of the astral rays which persist from the third nuclear division. As described, the growth and increase in number of the astral rays is accompanied by the formation of a beak on the polar end of the nucleus (Fig. 12). At the same time, the nucleus and aster move away from the ascus wall toward the interior of the ascus. The fibers bend down around the nucleus and grow in a curved line toward a point directly below the nucleus, where they finally meet. Lateral fusion of the rays begins at the polar region and progresses outward toward the base of the spore, forming a complete membrane about the ovoid mass of protoplasm, which, with the enclosed nucleus, forms the ascospore. The motion of the fibers through the cytoplasm cannot be due to crowding resulting from an outward movement of the nuclei toward the wall as Faull suggests, for at this time in *Microsphaera* the nucleus and the aster move in from the ascus wall. His other hypothesis that the "centrosome is a dynamic center and the rays an expression of cytoplasmic activity controlled by the nucleus," causing the rays "to turn toward the bulk of cytoplasm which lies centrad of the centrosome," is based on a confusion of two entirely separate views of the centrosome, first as a dynamic center, and second as a center of metabolic activity. It seems probable, however, that the rays are something more than cytoplasmic particles arranged along lines of force, since, as described above, after they have begun to fuse they can be separated from the cytoplasm by plasmolysis. Faull's further argument that the bending of the rays throws them further apart rather than brings them closer together, so that fusion is impossible, shows that he is here thinking not of adjacent but of opposite rays. The rays which fuse, of course, are those going to the same side of the future spore.

The figures of the beaked nucleus with its aster within the plasma membrane of the spore, which Faull regards as conclusive evidence that the rays take no part in forming the spores, may be explained, as noted, as polar views of spore formation by astral rays. This can be readily seen by comparing Faull's figures (5, Figs. 27, 28, 29, 34, 35) with an oblique view of a spore of *Phyllactinia* during the formation of the plasma membrane as described by Harper (13, Pl. 7, Fig. 81). Further, the mildews regularly show the presence of more or less numerous rays which lie inside the plane of fusion and so exist as free, separate fibers within the plasma membrane after the spore is delimited, but this, of course, is no evidence that the plasma membrane was not formed by the fusion of other rays of the original aster. In some cases the plasma membrane retains a ribbed appearance such as Meves (20) describes in the formation of the *"Schwanzmanchette"* in the spermatogenesis of the guinea pig. Traces of the fibers may persist even after the nuclear beak is withdrawn (Fig. 15). Faull assumes that the enclosed rays are either the entire original aster or are newly formed, a conclusion which is, of course, unjustified. His figures of this stage (5, Figs. 26, 30, 31) agree entirely with the same stages in *Microsphaera* (Figs. 13, 14, 15). That the rays do actually fuse is proved by plasmolysis such as is found in shrunken material where the spore is pulled away from the cytoplasm. A careful study of Faull's paper leads inevitably to the conclusion that the apparent disagreement of his conception of spore formation with that here described is due not so much to a difference in the figures actually observed, as to a failure on his part to analyze carefully the results of his observations.

Finally, it may be noted that the stages studied give no evidence of the existence of a series of "synkaryons" in *Microsphaera*, such as Maire describes for *Galactinia succosa* (14, 19). In the perithecium the nurse cells may have two or more nuclei, while the binucleated cells of the ascogenous hyphae become the asci.

BIBLIOGRAPHY.

1. ALLEN, C. E.: Nuclear division in the pollen mother-cells of *Lilium canadense*. *Ann. Bot.*, xix: 189. 1905.
2. BLACKMAN, V. H.: On the fertilization, alternation of generations and general cytology of the Uredineae. *Ann. Bot.*, xviii: 323. 1904.
3. CHRISTMAN, A. H.: Sexual reproduction in the rusts. *Bot. Gaz.*, xix: 207. 1905.
4. DANGEARD, P. A.: Recherches sur le développement du périthèce chez les Ascomycètes. *Le Botaniste*, 9e sér. 1904.
5. FAULL, J. H.: Development of the ascus and spore formation in Ascomycetes. *Proc. Boston Soc. Nat. Hist.*, xxxii: 77. 1905.
6. GUILLIERMOND, A.: Contribution à l'étude cytologique des Ascomycètes. *C. R. de l'Acad. des Sci.*, 1903.
7. ——: Sur la karyokinèse de *Peziza rutilans*. *C. R. de la Soc. de Biol.*, lvi: 412. 1904.
8. ——: Remarques sur la karyokinèse des Ascomycètes. *Annales Mycologici*, iii: 343. 1905.
9. HARPER, R. A.: Beiträge zur Kenntniss der Kernteilung und Sporenbildung im Ascus. *Ber. d. Deutsch. Bot. Gesell.* xiii: 67. 1895.
10. ——: Die Entwicklung des Peritheciums bei *Sphaerotheca castagnei*. *Ber. d. Deutsch. Bot. Gesell.*, xiii: 475. 1895.
11. ——: Kernteilung und freie Zellbildung im Ascus. *Jahrb. f. wiss. Bot.*, xxx: 249. 1897.
12. ——: Cell division in sporangia and asci. *Ann. Bot.*, xiii: 476. 1899.
13. ——: Sexual reproduction and the organization of the nucleus in certain mildews. *Carnegie Inst. of Washington, Pub.* 37. 1905.
14. MAIRE, R.: Recherches cytologiques sur le *Galactinia succosa*. *C. R. de l'Acad. des Sci.*, cxxxvii: 769. 1903.

15. ——: La formation des asques chez les Pézizes et l'évolution nucléaire des Ascomycètes. *C. R. de la Soc. de Biol.,* lv: 1401. 1903.

16. ——: Remarques sur la cytologie de quelques Ascomycètes. *C. R. de la Soc. de Biol.,* lvi: 86. 1904.

17. ——: Sur les divisions nucléaires dans l'asque de la morille et de quelques autres Ascomycètes. *C. R. de la Soc. de Biol.,* lvi: 822. 1904.

18. ——: La mitose hétérotypique et la signification des protochromosomes chez les Basidiomycètes. *C. R. de la Soc. de Biol.,* lviii: 726. 1905.

19. ——: Recherches cytologiques sur quelques Ascomycètes. *Annales Mycologici,* iii: 123. 1905.

20. Meves, F.: Ueber Struktur und Histogenese der Samenfäden des Meerschweinchens. *Arch. f. mikr. Anat.,* liv: 329. 1899.

21. Neger, F. W.: Beiträge zur Biologie der Erysipheen. *Flora,* lxxxviii: 333. 1901.

22. ——: Neue Beobachtungen über das spontane Freiwerden der Erysipheenfruchtkörper. *Centralbl. f. Bakt. Parasit. u. Infekt.,* x: 570. 1903.

23. Strasburger, E.: Über Reduktionsteilung. *Sitzungsber. d. Kön. Preuss. Acad. d. Wiss.,* Halbbd. i: 587. 1904.

EXPLANATION OF PLATE XLVI.

Figs. 1, 2. Vegetative cells. Nuclei showing relation of chromatin and centers.

Fig. 3. Hyphal cell from the mycelium, showing nucleus with central body.

Fig. 4. Young ascogone showing one nucleus with its center, and one of the cells of the hyphal envelop.

Fig. 5. Young ascus, with two nuclei before fusion.

Fig. 6. Primary nucleus, spirem stage.

Fig. 7. Late stage in fusion of the two nuclei; centers and chromatin systems still separate. Ascus about one-half mature size.

Fig. 8. Spindle formation, first division of primary nucleus.

Fig. 9. Spindle, second division.

Fig. 10. Formation of spindles in third division.

Fig. 11. Four-nucleated stage, two of the nuclei showing chromatin oriented on the central bodies.

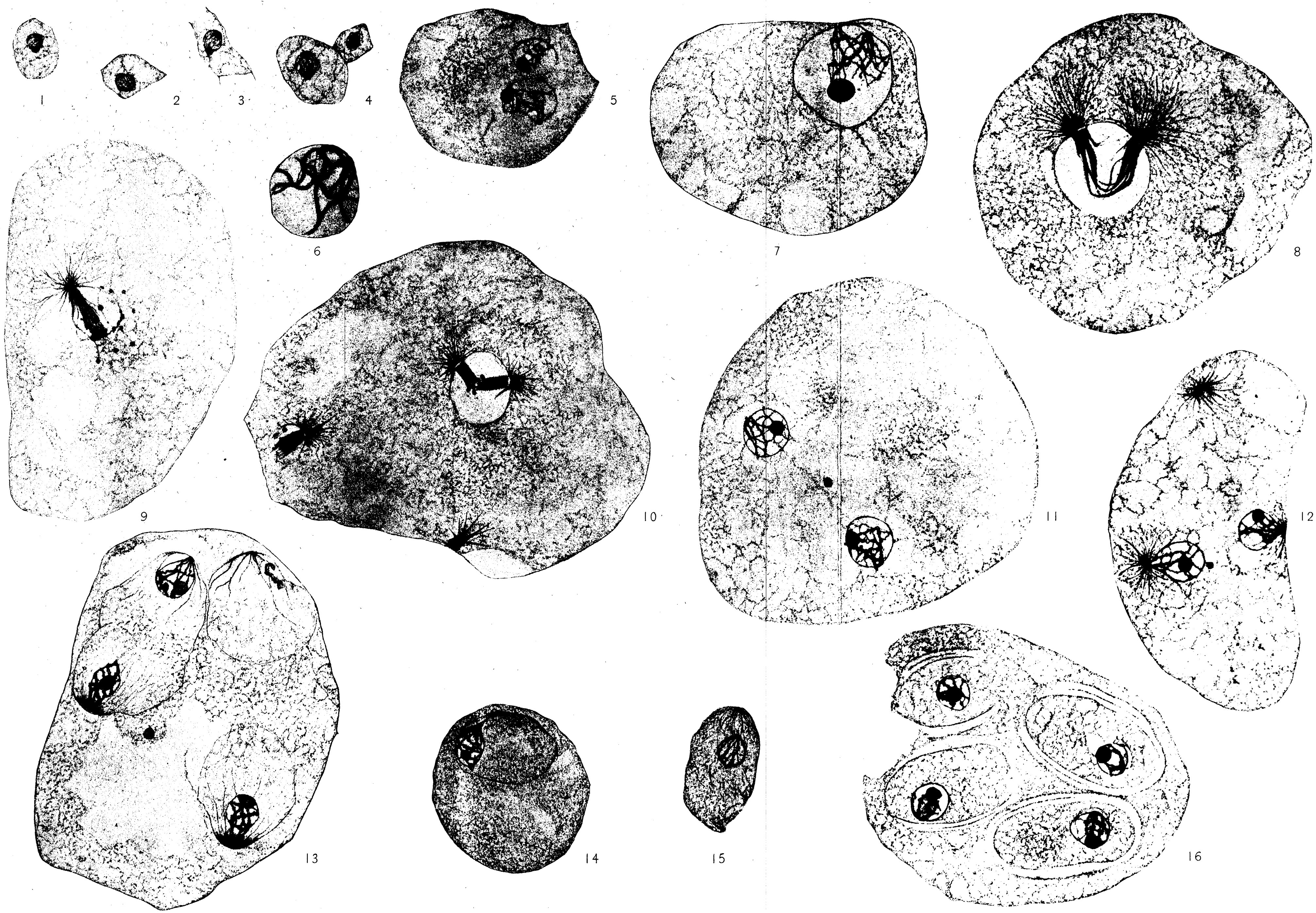
Fig. 12. Eight-nucleated stage, showing the persistent asters and the folding over of the rays.

Fig. 13. Stage in spore formation; two spores completely delimited; traces of the rays remain.

Fig. 14. Spore formation, showing extreme lengthening of nuclear beak.

Fig. 15. Nucleus resuming spherical form by withdrawal of beak. Traces of astral rays.

Fig. 16. Complete spores, wall being deposited.



M. C. Sands del.

HELIOTYPE CO., BOSTON.

CYTOLOGICAL STUDIES ON CERATIOMYXA.

EDGAR W. OLIVE.

(With Plate XLVII.)

Ceratiomyxa has long remained the sole representative of the Exosporeae among the Myxomycetes. The following investigation seeks to add certain cytological details to the admirably clear and fairly complete description of the development of the fructification of this organism by Famintzin and Woronin in 1873. The present preliminary study has led to the interesting discovery that the nuclear divisions which result in the formation of the four-nucleated spores are apparently reduction divisions. Consequently, while convinced that a sexual fusion occurs somewhere in the life cycle of *Ceratiomyxa,* I have not yet been able, however, to solve the problem as to where such a fusion occurs.[1]

As pointed out by Famintzin and Woronin, *Ceratiomyxa* was first described and figured by Micheli in 1729, and later by many other observers. Its life history and affinities were not understood, however, until the investigation of the Russian

[1] Since this article went to press, the fusion of the nuclei in pairs was found to take place toward the close of the cleavage stage; this was followed almost immediately by synapsis. A paper on the subject was read at the December meeting of the A. A. A. S., which was summarized later in *Science* (Olive, '07). The view was therein expressed that the conditions in *Ceratiomyxa* are somewhat similar to those in the rusts, in that the three morphological stages of the sexual cycle are similarly spaced; i. e., the cell fusions in both organisms are far removed from the final nuclear and chromatin fusions. A little later, Jahn ('07) published an account of nuclear fusions and division in *Ceratiomyxa*, which differs widely from that described by the writer. Jahn finds nuclear fusions as well as reduction divisions occurring at a much earlier stage than I. The two later divisions in the young spore he apparently regards merely as vegetative divisions. The shrunken, synapsis-like condition described in the present paper Jahn apparently has not seen.

authors above referred to. Famintzin and Woronin in their classic on this organism have traced its development with admirable completeness from the very first appearance of the minute plasmodial masses to the formation of the mature fructification. They were not able, however, to follow the earlier vegetative development within the woody tissues of the substratum. But they supplement their observations on the formation of the fructification with figures showing the peculiar germination of the spores, and the final formation of young myxamoebae and of larger amoeboid masses which they regard as young plasmodia.

I will review in some detail Famintzin and Woronin's account of the development of *Ceratiomyxa hydnoides,* since, with one or two exceptions, it agrees substantially with my own observations, at least so far as I have been able to carry them.

Minute, cushion-like masses of fructifying protoplasm first appear at points on the surface of the dead wood in which the organism has passed its vegetative existence. As these plasmodial masses increase in size by the addition of more protoplasm from beneath, the upper surface of each becomes more or less regularly papillated. With still further growth outward from the substratum, these papillae push out into long finger-like projections, which may remain simple or which may during their development become branched. The authors next observed that, as these projections grow outward, the protoplasm in each streams gradually to the surface, so that quite early in its development two distinct substances were noted—an inner transparent, jelly-like substance, and an outer meshwork of actively streaming, opaque protoplasm. Even the base of the fructification, as well as the middle core, is finally entirely deserted by the upward streaming, peripheral protoplasm. The outer thin zone of protoplasm is next represented as forming a more or less compact, thimble-shaped mass ("gleich dicken Schicht," p. 3), with irregular lacunae, and in this condition it becomes cut up by simultaneous cleavage into a multitude of uninucleated segments. When viewed now from the surface, the segments present an epithelium-like appearance of closely-set polygonal pieces. Viewed sidewise, they are at first much flattened, with a level outer surface. Soon, however, each uninucleated protoplast, now independent in its further movement, arches outward, becomes cylindrical, and finally is differentiated into a constricted stalk portion and a spherical swollen end. At first, the stalk as well as the spherical end is filled with protoplasm; but later, all the protoplasm appears to move out into the rounded end, leaving the stalk as a slender, apparently empty filament, two to five times as long as the spore. The end portion, which is destined to become the spore, finally cuts itself off sharply from the stalk, and changes from a globular to an oval form.

According to Famintzin and Woronin, the development of *Ceratiomyxa* takes place at definite times of the day and night. They state that the plasmodium first appears on the surface at about three o'clock in the morning. From that time on it grows rapidly, and by evening of the same day the fructification reaches its full size. The formation of the superficial plasma-zone was observed about eight or nine o'clock p. m.; the cutting up into segments about midnight; the first beginning of the formation of the spore-bearing structures about one to 1:30 o'clock a. m. In the early morning hours, they noted mature spores. Thus only about 24 to 26 hours are required for the complete formation of the fructification.

Their account of the germination of the spores of *Ceratiomyxa* shows interesting deviations from the usual type of germination seen in other Myxomycetes. According to these authors, the germination in *Ceratiomyxa* takes place after the spores have stood about thirty hours in water in which a bit of dead wood has been soaked. The naked protoplasmic contents of the spore remain for some time in one spot, showing slight amoeboid movements. It then proceeds to divide by constriction, first into two like parts, then into four, then into eight. In about an hour after casting off the spore wall, there are thus formed from each spore eight swarm-spores. After swarming for some time, these lose their cilia and become myxamoebae. The formation of plasmodia and the further vegetative development, as mentioned above, were not followed out by Famintzin and Woronin.

Lister, in his monograph ('94), added one point of interest concerning the mature spores of *Ceratiomyxa,* in that he showed that each contains four "nucleus-like bodies." Famintzin and Woronin had already shown that there was but one nucleus in each newly-formed segment; and even in the young stalked structure (see their Figs. 15, 16, Pl. 2; Fig. 12, Pl. 3), they figure but one.

Jahn ('05) has quite recently asserted that these two successive divisions in the young spore of *Ceratiomyxa* occur just after the stalk is fully formed. Jahn has also studied the later division, which occurs during the germination of the spore to form the eight swarm-spores.

The most of the material used in this investigation was fixed in various chromic-acetic-osmic acid mixtures, and sections were stained either with the triple stain or with iron-alum-haematoxylin. I am indebted to Miss A. F. Dean for some of the later stages of spore formation. The work has been done for the most part at intervals during the past three years while serving at Bonn and at Madison as a research assistant of the Carnegie Institution of Washington.

A longitudinal section through a young fructification is shown in Figure 1. This is the youngest stage which I have succeeded in obtaining, and it represents a mass of protoplasm about 175μ--200μ in thickness above the substratum. At this early stage, when the plasmodium has only just begun to creep out as rounded jelly-like masses, we see that it is made up of a very dense protoplasmic meshwork. As shown in the drawing, deep, narrow furrows cut into the outer surface; while the inner portion appears to be full of irregular lacunae, which contain a slimy substance. Numerous nuclei also are seen, scattered irregularly throughout the protoplasm.

From the dense reticulum making up the cushion-like mass shown in section in Figure 1, there are now sent up finger-like projections, which are destined finally to bear on their surface the exogenous spores. Figure 2 shows a cross section of one of these cylindrical outgrowths, when in a half mature condition.

Such a section is from an outgrowth fixed at about a similar stage of development to those shown in Famintzin and Woronin's Figures 6 and 8, in which the strands of protoplasm are seen to branch intricately and to anastomose and to form a loose reticulum. Figure 2 shows clearly that the protoplasmic portion now occupies a peripheral position, while a poorly staining material, apparently of a gelatinous, slimy nature, fills the center of the cylinder and the interstices between the plasmodial strands. In Figure 3 is shown a highly magnified portion of a plasmodium in a somewhat advanced stage of development, with four strands of protoplasm imbedded in a jelly-like, slimy matrix. Figure 10 shows a stage near the completion of the development of the sporiferous outgrowth, which has now grown to a few millimeters in height. The figure represents a median longitudinal section through the tip of one of the cylindrical projections. Obviously the protoplasm has now crept entirely to the periphery and has been cut up into numberless minute pieces—the young spores, or "protospores," as they may be termed (Harper '99)—each of which contains at this stage, as was shown by the Russian authors, a single nucleus. The middle portion of the section is filled with a formless substance—the gelatinous axis.

It is made quite apparent by a comparison of Figures 1, 2 and 10 that, as these structures develop, the jelly-like substance becomes enormously increased in amount; while, on the other hand, the granular protoplasm comes to occupy only a relatively small part of the fructification. Indeed, the whole axis of the mature sporophore is formed of slime—a dead substance apparently excreted and left behind by the protoplasm in its upward and peripheral movement.

A further point of special interest brought out by a comparison of successive stages is the fact that while at first the reticulum forms a dense mass on the substratum, with thick strands and relatively small lacunae, later the reticulum becomes loose and expanded, the anastomosing strands small and the interprotoplasmic spaces relatively large. Such a phenomenon is unique among Myxomycetes; for the formation of sporangia and aethalia is apparently attended with a continued contraction of the protoplasmic reticulum, and not by a gradual expansion of the meshwork, as in *Ceratiomyxa.*

The cleavage which has taken place to form the uninucleated cells shown in Figure 10 requires here a special discussion. It will be remembered that, as the cylindrical sporophores grow both in length and breadth, the protoplasmic meshwork in each creeps gradually to the surface, there to form, according to Famintzin and Woronin, a superficial zone of equal thickness, composed of more or less compact protoplasm, with small, irregular lacunae. They state that in this condition a simultaneous cleavage into uninucleated segments occurs. But their one figure illustrating the process (Fig. 11, Pl. 2) does not appear to warrant such an unqualified conclusion, since, while the upper portion of the sporophore is shown to be completely cut up, the lower part, on the other hand, still contains some protoplasm in process of division. In my own preparations, also, there is abundant evidence to warrant the conclusion that the cutting up of the protoplasm of a sporophore is not simultaneous, but is a progressive process. But the phenomenon in this instance undoubtedly takes place very rapidly, and probably in much less time, comparatively, than in the case of the thick masses of spore-plasm in the aethalia of *Fuligo* and in other forms.

In Figure 4 is shown a four-nucleated fragment undergoing cleavage. Surface furrows have begun to cut the mass into uninucleated pieces. Near this mass in the preparation are other fragments of varying size, which are also partially cut up; while in still other neighboring localities, in the same section, cleavage is already complete, resulting in a multitude of rounded, uninucleated cells, two of which are shown in Figures 8 and 9. Obviously the protoplasm in one part of a sporophore may be thus in a more advanced state of cleavage than in another part. Other instances point unmistakably to this conclusion. For example, in many sections the sporophores show some rounded, uninucleated fragments, apparently attached to the surface of the slimy axis; while immediately beneath these rounded cells occur irregular strands of protoplasm, imbedded in the slime. It is plain that only a part of the protoplasm has in this case reached the surface. Undoubtedly in these instances certain strands have reached the surface and have been at once cut up, while still other strands continue for a time their creeping movements, finally to reach the surface. Such observations clearly differ markedly from those of Famintzin and Woronin, who concluded that just before cleavage the protoplasm forms over the surface of the sporophore a more or less compact, thin layer, of equal thickness. Again, spherical, multinucleated masses, containing a varying number of nuclei, often occur. Probably in such instances certain strands reached the surface and ceased their streaming movement, then became cut up into pieces of irregular size, which at once proceeded to round up. I have not yet seen how such fragments are still further cut up into uninucleated pieces. Possibly creeping may again be resumed before cleavage occurs; or, it may be that cleavage furrows cut directly into the spherical mass.

Figure 5 illustrates the final constriction of a binucleated fragment of the plasmodium. Such a method of simple constriction is apparently of common occurrence, since I have observed quite frequently chains of several such *Amoeba*-like cells connected thus by means of slender isthmuses. Such a phenomenon is obviously the result of the cleavage of an extremely thin strand or filament of protoplasm, which has been drawn out to a filament only one nucleus thick. When Figure 5 is compared with Figure 4, one might at first come to the erroneous conclusion that here are represented two quite dissimilar methods of cleavage. But in reality these figures show entire similarity in the essentials of the process. In the instance illustrated in Figure 4, the protoplasmic strand is simply thicker at the time of cleavage than that shown in Figure 5. Such a thick strand could obviously result either from the failure to creep out to the extreme degree of attenuation; or from the massing, or piling up in places of the protoplasm of a filament. Further, creeping movements appear to be in progress in the late stage of cleavage shown in Figure 5, as evidenced by the two cells separating, or pulling apart, after the manner of a dividing *Amoeba*. In some cases, the attenuated strand connecting the dividing cells persists until it becomes stretched out to a length equal to two or three times the diameter of the cells. But in such a thick strand as that shown in Figure 4, the narrow cleavage furrows indicate that the creeping movements have, on the other hand, apparently ceased entirely. I have no evidence as to whether or not the furrows in such instances become broader during the later stages of the process, thus evidencing the resumption of the creeping movements before cleavage is finished.

It is apparent from the above description that cleavage occurs at the end of a comparatively long period of active upward movement of the fructifying reticulum. During this period of growth, the strands become in general more and more attenuated, and at the same time the whole reticulum moves to the periphery of the sporophore. Cleavage therefore occurs at the culmination of the upward growth of the sporophore; apparently only when the strands, either in a state of extreme attenuation (Fig. 5) or in thicker masses (Fig. 4), have reached the periphery of the gelatinous axis which forms the slimy, watery substratum through which the protoplasm has crept.

As stated above, cleavage may be at a given moment more advanced in one part of a sporophore than in another part. The process sometimes varies similarly in a group of sporophores, although, in general, contiguous sporophores are usually at about the same stage of maturity; while those farthest separated in the group are, on the other hand, apt to differ widely in their degree of advancement.

Although poorly stained in the preparation, the nuclei shown in the uninucleated cells of Figure 10 appear to be, when examined closely with high power, strikingly large and conspicuous. Such a condition is much better shown in Figures 6–9. In the preparation from which Figures 6–9 were drawn, hundreds of similar rounded cells lie in each section of the series, although there are also a few multinucleated fragments, such as are shown in Figure 4, which have not yet been completely cut up. Such a preparation represents the condition of the protoplasm near the close of cleavage; while in Figure 10, cleavage is already completed. It was the occurrence of these large cells, with their large, conspicuous nuclei, which first struck my attention some years ago and which led to this study. The chromatin of the majority of such nuclei appears contracted, as shown in Figures 7–9, and lying eccentrically in the large nuclear cavity. Such a phenomenon at once recalls the condition which has been characterized as synapsis. Frequently the mass can be seen to be joined to the nuclear membrane by means of a slender connection (Fig. 7), thus showing, presumably, its polarized character. In the binucleated cell shown in Figure 7, both of the nuclei appear to be in early synapsis. A similar condition obtains in the four-nucleated mass illustrated in Figure 4. From a comparison of these figures, we note that this synaptic condition begins either near the close of cleavage (see Figs. 4 and 7), or at about the time cleavage is completed (Figs. 8 and 9). There is as yet no indication of shrinkage of the chromatin seen in the uninucleated cell shown in Figure 6, which represents the condition of a few cells scattered here and there among those figured in Figures 8 and 9, but I am inclined to think that this indicates a stage immediately preceding synapsis.

Should these figures indeed truly represent, as I firmly believe, a synaptic state of the nuclei, we must conclude that this condition lasts only a comparatively short time; this being quite at variance with the long period which is said to characterize synapsis in certain plants (Allen, '05). Famintzin and Woronin state that from the beginning of the uninucleated condition up to the formation of mature spores takes only about five to six hours. Since part of this time, as we shall now see, must be given up to the two nuclear divisions which take place in the developing spore, it is obvious that only a few hours at best are left for the nuclei to pass completely through the condition resembling synapsis.

That this peculiar condition of the nuclei, which lasts through nearly the whole of the subsequent spore formation, is a natural phenomenon and not an artifact is indicated by the two divisions which closely follow. First, however, attention should be called to the fact that, in *Ceratiomyxa,* the division of the nuclei does not take place before spore formation, as has been described for other Myxomycetes, but rather *after* the event. I have never been able, in fact, to find any sign of nuclear division in the active fructifying plasmodium of this form previous to cleavage. After the short period of rest following cleavage, the large nucleus of each protospore proceeds to divide twice in rapid succession (Figs. 11–14). These divisions are not, according to my interpretation, of the nature of an intrasporal germination, but they are similar rather to the double division seen in spore mother-cells. These two successive divisions, occurring as they do in this place, immediately following the condition so closely resembling synapsis, furnish, to my mind, convincing evidence that we have here to do with a reduction division, following a true synapsis. The important bearing of these facts I hope to take up later; we may, however, simply observe in passing that, in my opinion, these phenomena clearly establish a nuclear fusion somewhere in the preceding life history of *Ceratiomyxa*. It should be here noted, in fact, that Prowazek ('04) has recently figured sections of the plasmodium of *Physarum psittacium*, in which he shows the nuclei fusing in pairs, but he does not explain whether this takes place in the vegetative or in the fructifying plasmodium.

After cleavage is completed, each uninucleated cell continues its creeping movement, acting now as an independent *Amoeba*. The cells lie at first closely pressed together, presenting from the surface view a honeycomb-like appearance. The creeping movement from now on is outward and at right angles from the moist, slimy surface of the sporophore on which the cells rest. Arching outward, each *Amoeba*-like cell soon forms a spherical, swollen end, borne on a slender stalk. All of the protoplasm appears finally to move out into the rounded end, leaving the stalk as a long, gelatinous filament, attached to the slimy substratum (Fig. 13). Somewhere near the close of the growth of the stalk, the single nucleus divides twice, as has been described above, so that the mature resting spore contains four nuclei (Fig. 15).

The mature fructification of *Ceratiomyxa hydnoides* is thus seen to possess a very peculiar structure. All of the protoplasm has now migrated to the ends of numberless long, slender stalks where it normally passes through a resting period as minute oval four-nucleated spores. Nothing but slime remains in the conspicuous supporting structures of the sporophore—the base, the main axis and the slender stalks. It is true that other organisms—other members of the Mycetozoa, the Labyrinthuleae, and the Myxobacteriaceae—employ slime as an important element in building up their fruit bodies, but none, so far as known, use such an inert substance in their fructifications so extensively or so successfully as does *Ceratiomyxa*.

GENERAL DISCUSSION.

It has been noted above that the process of cleavage in the plasmodium of *Ceratiomyxa* differs in an important respect from the cleavage described for other forms. Harper ('00) has pointed out that, while the division of the nuclei in *Trichia* and other genera is already completed before spore formation begins, in *Fuligo*, on the other hand, nuclear division proceeds simultaneously with the process of cleavage. *Ceratiomyxa*, as we have already noticed, presents still a third condition, in that cleavage is *completed* before nuclear division begins. From this fact result the four-nucleated spores of *Ceratiomyxa*; whereas in all other Myxomycetes, as far as is known, the spores are uninucleated. Cell division in *Ceratiomyxa* thus precedes nuclear division. Lister ('03) came to the conclusion that, "leaving aside the question of the sclerotium, whenever cell division occurs in the life history of the Mycetozoa the nuclei divide by karyokinesis" (p. 541). Since *Ceratiomyxa* reverses the usual order for Myxomycetes, by having cell division *precede*, instead of follow, nuclear division, it is evident that Lister's statement will not hold. Harper ('99, '00), Timberlake ('02), and recently Swingle ('03) have shown also for certain sporangia that nuclear division neither determines nor is in any way connected with cell division, and the writer has recently extended this discovery to certain filamentous fungi ('06). The considerable number of cases now known, where a coenocytic protoplast undergoes cell division without any immediately preceding nuclear division, shows conclusively, as pointed out by Harper, that there is, at least in such instances, no direct correlation between nuclear and cell division. In uninucleated cells, on the other hand, particularly those of higher plants and animals, a very close connection between the two processes has usually been assumed.

The habit of cutting up the plasmodium thus into uninucleated spore mother-cells, before the nuclear divisions take place, makes *Ceratiomyxa* an especially favorable form of indicating the general significance of the nuclear changes. In other forms in which cleavage occurs after, or simultaneously with, nuclear division, it would appear exceedingly difficult, if not indeed impossible, to determine whether each nucleus of the plasmodium divides but twice as do the nuclei of *Ceratiomyxa.* The stage resembling synapsis should, however, be much easier to find in such plasmodial masses, and this condition, when found, will probably have to serve as the only indication that a reduction division in connection with spore formation takes place in these Myxomycetes as well.

Another feature of special interest in the development of the fructification of *Ceratiomyxa* is the continued increase of protoplasmic surface during the growth of the sporophore above the surface of the substratum. In *Fuligo,* on the other hand, there takes place, during the development of the aethalium, a continued contraction of the protoplasmic reticulum and a reduction of surface area. In both cases there must be, of course, as in other fructifying conditions, a decrease in total volume of the protoplasm, a shrinkage due to loss of water. But the accompaniment, in *Ceratiomyxa*, of this decrease in volume by a gradual increase in surface exposure is, so far as I am aware, absolutely unique for fructifying structures, except in the later condition of cleavage. This phenomenon in *Ceratiomyxa* must not be confused, however, with cleavage, as will be shown later.

A comparison of the conditions in *Fuligo* and *Ceratiomyxa* should make clear this striking difference between the two. The cake-like mass forming the young aethalium of *Fuligo* is made up of a relatively dense, contracted reticulum, in which the strands are thick and the interprotoplasmic spaces minute (Harper, '00, p. 221). In the development of this form into a mature fructification, the protoplasmic reticulum continues to contract so that the superficial strands are withdrawn toward the center. In *Ceratiomyxa* we have a similar heaping up of the plasmodium which has crept to the surface, thus forming a tiny cake or cushion of whitish protoplasm. This mass is seen to be made up, as in *Fuligo* at a similar stage, of a dense reticulum. Obviously in both cases the plasmodium in this condition results from an aggregation, or condensation, of the vegetative reticulum. Sections of this early stage in *Ceratiomyxa* (Fig. 1) show irregular lacunae filled with slime, and deep surface furrows which separate the thick strands. Such sections, as will be readily noticed, bear a superficial resemblance to the illustrations of cleavage in the sporangia of *Pilobolus* (Harper, '99, Figs. 14–15), *Fuligo* (Harper, '00, Fig. 1) and *Phycomyces* (Swingle, '03, Fig. 21). But the surface furrows of the actively creeping plasmodium of *Ceratiomyxa* are certainly very different in origin and function from the cleavage furrows which cut into the quiescent masses of spore-plasm of sporangia.

Following the heaping up of the plasmodium on the surface of the substratum comes the further creeping out from each mass of one to several cylindrical sporophores. As shown in sections (Figs. 2–3), and even more clearly in Famintzin and Woronin's Plate I, Figures 4–8, the reticulum at this stage, although forming a much finer meshwork, has been greatly expanded as compared with the appearance in the sessile, compact mass on the surface. The spinning out of the protoplasmic meshwork into finer and finer strands and the consequent increase of the reticulation results obviously from the continued creeping out of the plasmodium to form the peripheral network, which finally spreads in a thin layer over the surface of the cylindrical sporophore. The strands in many instances ultimately become so attenuated as to be only one nucleus thick. It is clear that such an attenuation of the strands composing the fibrous network must be accompanied by a great increase of surface area of the protoplasm. A minute, compact, rounded mass, sessile on the substratum, obviously exposes in its contracted reticulum much less surface than the same plasmodium when later it has crept upward and has become spread in a fine, attenuated network over the entire surface of the cylindrical sporophore. *Fuligo* apparently ceases its creeping movements with the compact, sessile mass and forms its spores endogenously; *Ceratiomyxa*, on the other hand, similarly heaps up on the substratum, but afterward resumes its upward creeping, and finally forms its spores exogenously.

This peculiar increase of exposed surface of the fructifying protoplasm of *Ceratiomyxa* seemingly places the fructification at a disadvantage in one respect. Increased surface would apparently allow increased absorption of water from the watery, gelatinous matrix in which the protoplasmic network is imbedded, and thus counteract to a certain extent the general contraction and condensation of the mass as a whole, which is characteristic for such fructifying bodies (Harper, '00, p. 249). But it must be remembered that the plasmodial network is constantly creeping upward, away from the moist substratum, and also peripherally, away from the moist, gelatinous axis of the sporophore. The peripheral position of the attenuated strands would doubtless thus be of advantage for increased evaporation, rather than for increased absorption of water. We may indeed readily imagine that loss of water and general shrinkage of the protoplasm go on faster in the case of such a fine network than from the compact fructification of *Fuligo*.

Apparently as long as the growth of the visible part of the sporophore of *Ceratiomyxa* endures, the increase of protoplasmic surface continues. I have not traced back the condition of the vegetative reticulum as it exists in the pores of the wood. While it is indeed probable that the reticulum in this early condition may resemble closely certain expanded stages of the fructifying protoplasm, I doubt, judging from the conditions in ordinary plasmodia, that these early stages ever attain the degree of attenuation found in the advanced sporophores. At any rate, from the dense reticulum as it has just appeared on the substratum to the full-grown sporophore, the development is undoubtedly as stated above. The culmination of this gradual attenuation of the protoplasmic network is apparently reached just before cleavage. As mentioned above, some of the strands have now become so thin that they are only one nucleus thick. I believe, in fact, that the majority of the strands become thus attenuated. I cannot therefore agree with the conception of Famintzin and Woronin that the network finally forms a single, more or less fused film, with minute lacunar openings spread in a thin layer of equal thickness over the whole surface of the sporophore. The strands rather appear to retain to a great extent their individuality, as well as their attenuated character, although in some cases they apparently become fused with other neighboring strands, or become massed in places.

Cleavage finally sets in, and in a very short time the fine protoplasmic meshwork is divided into numberless rounded, uninucleated cells. Famintzin and Woronin state that this process takes place simultaneously over the whole sporophore. While I too believe that cleavage is, in this instance, a very rapid process, yet the method of development in some cases prevents the acceptance of the idea that the phenomenon is simultaneous. The protoplasm does not all appear to reach the surface of the sporophore at the same time. Some strands may frequently be seen to be elongated and evidently in a condition of movement, near regions which have already undergone cleavage, as evidenced by the presence of rounded uninucleated cells. Cleavage in *Ceratiomyxa*, as in other multinucleated masses in which the phenomenon has been carefully followed, is rather a progressive process, as explained above, although the progressive feature seems to be much less easy to demonstrate in *Ceratiomyxa* than in *Fuligo*.

Cleavage obviously at once increases enormously the surface area of the protoplasm. Whereas before we had a finely drawn out, anastomosing reticulum, spread out over the surface of the cylindrical sporophore, cleavage now cuts up this reticulum into numberless uninucleated cells. The question may here be asked, Is the gradual attenuation of the strands in the protoplasmic meshwork of the forming sporophore of the nature of a cleavage? It is true that the phenomenon is accompanied throughout by a gradual increase of exposed surface, therein resembling the process of cleavage. But the plasmodial reticulum throughout the whole creeping movement remains a connected whole; there is no cutting apart or pulling apart of portions of the protoplasm until cleavage proper sets in. The gradual attenuation of the strands is not, therefore, a true cleavage, but the process accomplishes, partially, the same end as cleavage. The final cleavage in *Ceratiomyxa* is consequently much abbreviated as compared with the phenomenon in *Fuligo* and other sporangia. The cleavage stage in *Fuligo* may in fact be said to correspond to cleavage plus the interpolated active period of attenuation in *Ceratiomyxa*.

During the period in *Fuligo* when the cake-like, sessile mass is undergoing cleavage, the protoplasm, as evidenced by general appearances, seems to be more or less quiescent. The phenomenon in general appears to take place, in fact, during a more or less quiescent stage. But almost incessant creeping movements, on the other hand, seem to characterize the fructifying protoplasm of *Ceratiomyxa*. The plasmodium piles up on the substratum and begins to form at certain points papillae. As these papillae grow out to form the cylindrical sporophores, the protoplasmic meshwork in each apparently undergoes incessant upward movement, creeping finally to the surface of the gelatinous structure. Cleavage now takes place, and even in this condition, at least in such late stages of the process as are shown in Figure 5, the creeping movements have not appeared to cease entirely, for the cells seem to pull apart after the manner of a dividing *Amoeba*.

It is well known, however, that the *Amoeba* and other unicellular organisms, when ready to divide, withdraw their pseudopodia, and, at least at the beginning of the process, cease their active movements; and this is probably the case also in *Ceratiomyxa*. Undoubtedly such masses as are shown in Figure 4 remain more or less quiescent during cleavage, as evidenced by the appearance of the narrow furrows which cut into the fragment. As was mentioned above, the protoplasm in such instances has apparently become massed in places on the surface of the sporophore, instead of becoming drawn out into narrow strands as seems usually to be the case. Finally, the uninucleated segments themselves continue the outward movement, with probably little if any interruption, as single, independent, amoeboid cells until each forms finally a stalked resting spore.

No advance has been made in this study in the problem as to what forces initiate and direct the process of cleavage in *Ceratiomyxa.* I can therefore add nothing definite to the view that cleavage results probably from tensions produced by contractions due to loss of water (Harper, '00); or to the idea that the phenomenon comes from local contractions in the cytoplasm (Swingle, '03).

A comparison of various low organisms with respect to their use of mucus, or slime, in building up their fructifications is of some interest. Those four groups of organisms—the Myxomycetes, Acrasieae, Labyrinthuleae and Myxobacteriaceae—which unite in colonies to form their fungus-like fructifications, excrete in some cases large quantities of slime, which may be utilized in various ways to assist in raising the fruit-body above the substratum.

It will be remembered that in the fructification of *Ceratiomyxa,* the entire supporting structures of the sporophore—the base, the main axis and the numberless stalks borne on the surface—are wholly composed of a gelatinous, slimy substance. No protoplasm is left in these regions, since all of the living material migrates to the tips of the slender stalks. Some of this slimy substance may be seen in the lacunae and furrows of the young fructifying reticulum (Fig. 1). As the plasmodium creeps upward, slime is gradually added to the mass left behind on the substratum (Figs. 2, 3, 10). The slimy matrix in which the creeping reticulum is enclosed, and the slimy central axis, which is finally entirely deserted by the protoplasm, thus serve as a semi-solid substratum on which the climbing movements take place. Even the amoeboid cells formed finally by cleavage on the periphery of the sporophore, after they have become erected at right angles to the surface on which they rest, at last cut themselves off entirely from the long gelatinous stalks by means of which they have crept outward. The latter phenomenon is quite similar to the formation of the simple fructification of *Sappinia,* a genus of dung-inhabiting amoebae (see Olive, '02). During the fructifying stage of this organism, the amoebae seek drier situations, hence each erects itself at right angles to the moist substratum, thus forming a stalked, pear-shaped body. In some instances, the stalk, as in *Ceratiomyxa,* is entirely deserted by the protoplasm, which thus forms an oval spore on the end of the slender gelatinous support.

Other members of the Mycetozoa apparently do not utilize slime so extensively or so successfully as does *Ceratiomyxa.* In the majority of forms with stalked sporangia, the stalks are apparently hollow and composed mainly of dried slime. In *Arcyria,* the tubular stalks are filled with rounded, spore-like cells (see MacBride, '99); apparently in this instance some of the ascending protoplasm failed to reach the summit before the maturity of the sporangium.

In the higher Myxobacteriaceae, according to Thaxter ('92), the stalk of the fructification is likewise a tubular gelatinous structure, and the fructifying mass ascends this tube as through an open funnel. Besides serving thus as a supporting structure for the ascent, as well as to bear the final resting bodies, the excreted slime is also utilized by the cyst-forming group of these organisms as a protecting medium to enclose the mass of encysted bacterial rods.

The sessile fructifications of the simpler members of the Acrasieae (Olive, '02), like the simpler Myxobacteriaceae, employ slime only as an intrasporal medium for holding in a mass the sorus of spores; while in some of the more highly differentiated fructifications, it serves in addition as a gelatinous stalk to support the globular sorus of spores at its top. Likewise in *Diplophrys,* a member of the Labyrinthuleae, the sorus is upheld by a gelatinous stalk. In the higher representatives of the Acrasieae, for example in *Dictyostelium* and *Polysphon-*

dylium, a still more complicated method of raising the spores above the substratum has been evolved. Certain cells in the center of the mass become vacuolated and otherwise modified to form a supporting column. As the colony ascends this stalk, the latter grows in height by the addition of more modified cells on the top of the column. The ascending colony leaves behind a mucous substance which thus forms a thin, slimy sheath, which encloses and greatly strengthens the parenchymatous stalk, as well as provides a cementing substance to bind the expanded base of the stalk fast to the substratum.

SUMMARY OF CONCLUSIONS.

The principal points brought out in the foregoing paper may be summarized as follows:

1. Sexual reproduction is without doubt present in *Ceratiomyxa*, since there occurs in connection with spore formation what appears to be a reduction division of the nuclei. A stage resembling synapsis, in which the chromatin lies in a shrunken mass at one side of the large nuclear cavity, is followed after a short period by two rapidly recurring nuclear divisions. The young spores, or more properly speaking, the spore mother-cells, contain thus at first but one large nucleus; while the mature resting spores, as a result of the subsequent double division, come to contain four smaller nuclei. This indication of a reduction division at the time of spore formation is made the basis of the conclusion that, in addition to the multiple cell-fusions to form the plasmodium, there must occur necessarily a union, probably in pairs, of the nuclei, somewhere in the previous life-history of the organism.

2. The cleavage of the plasmodium of *Ceratiomyxa* to form spores is a progressive process, and not simultaneous, as maintained by Famintzin and Woronin, since the attenuated reticulum, which spreads in a thin, delicate network over the surface of the cylindrical sporophore, is first cut up into multinucleated segments which later are still further cut up into uninucleated cells. By the time cleavage sets in, the strands of the reticulum generally appear to have become greatly attenuated, so as to show frequently only one nucleus in optical cross

section; in still other instances, however, they appear to form small masses of varying size and shape on the surface of the sporophore, and in this condition are cut up by means of surface furrows. The close resemblance of the process of cleavage in this form to simple constriction, such, for example, as takes place in *Amoeba* or in certain algae and fungi, is particularly apparent in the method of cleavage of a thin, filamentous strand of the plasmodium, in which furrows come in from opposite sides, midway betwen the nuclei, and constrict the filament into uninucleated pieces.

LITERATURE CITED.

ALLEN, C. E., '05: Nuclear division in the pollen mother-cells of *Lilium canadense*. *Ann. Bot.*, xix: 189.

FAMINTZIN, A., and WORONIN, M., '73: Ueber zwei neue Formen von Schleimpilzen: *Ceratium hydnoides* und *Ceratium poroides*. *Mém. acad. imp. sci. St. Petersbourg*, xx: 1.

HARPER, R. A., '99: Cell division in sporangia and asci. *Ann. Bot.*, xiii: 467.

———, '00: Cell and nuclear division in *Fuligo varians*. *Bot. Gaz.*, xxx: 217.

JAHN, E., '05: Myxomycetenstudien, IV. Die Keimung der Sporen. *Ber. deut. bot. Ges.*, xxiii: 489.

———, '07: Myxomycetenstudien, VI. Kernverschmelzungen und Reduktionsteilungen. *Ber. deut. bot. Ges.*, xxv: 23.

LISTER, A., '93: On the division of nuclei in the Mycetozoa. *Linn. Soc. Jour.*, xxxix: 529.

———, '94: Mycetozoa. London.

MACBRIDE, T. H., '99: North American slime-moulds. New York.

OLIVE, E. W., '02: Monograph of the Acrasieae. *Proc. Boston Soc. Nat. Hist.*, xxx: 451.

———, '06: Nuclear and cell division of *Empusa*. *Bot. Gaz.*, xli: 229.

———, '07: Evidences of sexual reproduction in the slime-molds. *Science,* N. S., xxv: 266.

PROWAZEK, J., '04: Kernveränderung in Myxomycetenplasmodien. *Oesterr. bot. Zeitschr.,* liv: 278.

SWINGLE, D. B., '03: Formation of the spores in the sporangia of *Rhizopus nigricans* and of *Phycomyces nitens. U. S. Dept. Agric., Bur. Plt. Ind., Bull.* 37.

THAXTER, R., '92: On the Myxobacteriaceae, a new order of Schizomycetes. *Bot. Gaz.,* xvii: 389.

TIMBERLAKE, H. G., '02: Development and structure of the swarm-spores of *Hydrodictyon. Trans. Wis. Acad. Sci., Arts and Letters,* xiii: 486.

EXPLANATION OF PLATE XLVII.

The drawings were made with the aid of an Abbe camera lucida, together with the Zeiss 2 mm. apochromatic objective N. A. 1.30, combined with various compensating oculars.

Fig. 1. A young fructification, showing in section the protoplasmic reticulum (× 250).

Fig. 2. Cross section of a half mature cylindrical outgrowth, showing sections of the irregularly anastomosing and branching strands of peripheral protoplasm, and the central axis of slime (× 250).

Fig. 3. A small portion of a developing fructification, showing cross sections of four strands of peripheral protoplasm, imbedded in a jelly-like matrix (× 1000).

Fig. 4. Cleavage in a four-nucleated fragment of plasmodium. The nuclei appear to be entering synapsis (× 1500).

Fig. 5. Cleavage of two-nucleated fragment (× 1500).

Fig. 6. A young spore showing the nucleus in a pre-synaptic condition (× 1500).

Fig. 7. A rare condition, in which the fragment is binucleated with both nuclei in synapsis (X 1500).

Figs. 8, 9. Young spores, each with its nucleus in synapsis (× 1500).

Fig. 10. Longitudinal section through the tip of an older, almost mature outgrowth. The protoplasm is now in a thin, peripheral, thimble-shaped layer, and has been entirely cut up into small cuboidal or oblong segments, each with a single, comparatively large nucleus. The slime in the middle appears somewhat fibrous in the preparation (× 250).

Figs. 11, 12. The first division which immediately follows synapsis (× 2250 and 1500).

Fig. 13. A young spore on its stalk, with the two nuclei entering upon the second division (× 1500).

Fig. 14. Tne second division following synapsis (× 1500).

Fig. 15. A mature spore, showing the four nuclei, stained with methyl green (× 1500).

E. W. Olive, del.

MYCOLOGICAL NARRATIVE OF A BRIEF JOURNEY THROUGH THE PACIFIC NORTHWEST.

J. J. DAVIS.

In July 1905 I made a hasty journey to the north Pacific coast. The trip was primarily a business one, with the meeting of the American Medical Association and the Lewis and Clark Exposition at Portland as additional incentives. As I was to make a few short stops on the way, I took a few sheets and driers, a couple of pieces of stiff binder's board and a bit of twine, and improvised a press that was light and packed readily into my traveling bag. I found this to answer my purpose admirably while it did not add to my *impedimenta*.

At Portland I met Mr. M. M. Gorman and profited much from his kindness and knowledge of the local botanical field. Mr. Thomas Howell, author of the "Flora of the North Pacific States," kindly looked over my small collection and identified the hosts. Specimens of the forms that I was unable to determine after my return were submitted to my friend, Mr. C. L. Shear, of the Bureau of Plant Industry, who examined them with the facilities which the city of Washington affords.

Leaving Racine on the first day of July, the first stop was made at Missoula, Montana, on the third, where I found it necessary to remain over night to make train connections. As there was still daylight, I walked out to the buildings of the University of Montana on the edge of the city. Finding no one about the laboratories, I scaled the back fence and spent a few minutes on the steep side of the foothill beyond. Here I found *Puccinia plumbaria* Pk. III on *Collomia gracilis* and *Gilia* (*bolanderi?*); *Puccinia menthae* Pers. var. *americana* Burr. I, II, III on *Monarda scabra*; *Sphaerotheca humuli* (DC.)

Burr. on *Collomia* (*linearis?*); and a smut on a depauperate grass which Dr. G. P. Clinton identified as *Ustilago mulfordiana* E. & E. on *Festuca tenella.* The next day, an enjoyable ride over the Bitter Root mountains brought me to Wallace, Idaho. A short walk up one of the gulches that debouch into the little valley that affords scant room for the town showed *Septoria cerastii* Rob. & Desm. on *Cerastium arvense; Septoria rubi* West. on *Rubus parviflorus; Septoria grossulariae* (Lib.) West. on *Ribes cereum*—the distinctions between this species and *Septoria ribis* Desm. are not clear to me; *Septoria silenicola* Sacc. on *Silene menziesii;* and *Septoria salicifoliae* (Trel.) E. & E. on *Spiraea* (*corymbosa?*). The latter fungus was quite abundant on the *Spiraea* leaves, and the sporules are longer than in Wisconsin specimens on *Spiraea salicifolia,* having a maximum length of at least 100 microns. Here also was found a fungus on the leaves of *Ranunculus lyalli* that seems to be the same as that which occurs in Wisconsin on *Ranunculus abortivus* and is referred to *Septocylindrium ranunculi* Pk.; also *Puccinia cirsii* Lasch. II on *Cnicus edulis,* and *Puccinia recedens* Syd. on *Senecio balsamitae.*

The evening of July 5th found me in Spokane, Washington. The next morning, finding that I had an hour to spare, I took a street car to the end of the line, where I had ten minutes between cars. The herbal flora consisted mostly of three species of *Lupinus,* and each species yielded a fungal parasite. On one was found *Phyllostica ferax* E. & E. The second lupine had curled and partially dried leaves, giving the appearance of having been scorched. The leaves were so hairy that I did not see the fungus at the time, but on examining them after my return home I found it to be the same that I had collected on *Lupinus stiversi* in California in 1895 and that was described as *Ovularia* (*?*) *globifera* E. & E. (*Bull. Torr. Bot. Club,* xxiv: 471—1897). I am indebted to Dr. Farlow for the information that the herbarium name *Tuberculina lupini* Farl. (*Bull. Iowa Agric. Coll.,* 1886) was applied to the same plant, but that it is really an *Hadrotrichum* and probably *H. lupini* E. & E. (*Bull. Torr. Bot. Club,* xxvii: 59—1900). Under the rule of priority it becomes necessary to use the name

HADROTRICHUM GLOBIFERUM (E. & E.) n. comb., *Tuberculina lupini* receiving no description. On the leaves of the third species of *Lupinus* was a *Ramularia* from which the following notes were made: Spots pallid with a brown border, roundish, 4–7 mm. in diameter; hyphæ amphigenous, tufted, straight or slightly flexuose, hyaline, 20–40 x 3½–5 microns; conidia hyaline, cylindrical, obtuse, becoming 1-3 septate, 25-55 x 4-6 microns. I have placed this in my herbarium as RAMULARIA LUPINI n. sp.

In the afternoon I inquired for a suitable collecting ground and was referred to a park. Getting off the street car, I looked at the park on one side and a steep hillside on the other and chose the latter. Here I found, on July 6th, on a narrow-leaved species of *Agropyrum*, what I had often searched for in vain, the perithecia of *Erysiphe graminis* DC. The asci were fully formed, but not, of course, the ascospores. I found also *Erysiphe cichoracearum* DC. (?) on *Galium aparine*, much infested with *Ampelomyces quisqualis* Ces.; *Phragmidium subcorticium* (Schrank) Wint. in its different stages on *Rosa fendleriana; Puccinia crepidis acuminatae* Syd. on *Crepis acuminata;* and *Uromyces eriogoni* Ell. & Hark. II on *Eriogonum heracleoides.* On the latter host was also a *Ramularia*(?) forming minute white tufts from tubercular bases on reddish-brown spots 5-8 mm. in diameter. The hyphæ are 30-40 x 3 microns, but the material is too scanty and immature to warrant a description. Here also were found on *Smilacina racemosa* specimens from which the following notes were made: Spots pale yellow or whitish with a narrow reddish-brown border, round to oblong, mostly 5-10 mm. in diameter; hyphae forming white tufts on the lower surface of the spots, 10–16 x 3 microns; conidia hyaline, cylindrical, continuous, catenulate, 18-30 x 3 microns. An immature *Phyllosticta* (?) is sometimes found on the upper surface of the spots. I have placed this in the herbarium as RAMULARIA SMILACINAE n. sp. Because of the aseptate conidia this would be placed by some authors in *Ovularia.* Here also *Puccinia balsamorrhizae* Pk. III occurred in abundance on *Balsamorrhiza deltoidea.*

The next stop was made at North Yakima, Washington, where a delayed train gave me an hour to spend in a moist locality on the edge of the city. The leaves of the aspen were here found to be spotted by a fungus which gave the following notes: Spots roundish angular, determinate, immarginate, dark brown above, much paler beneath, mostly 3-6 mm. in diameter; acervuli innate, about 75 microns in diameter; sporules straight or somewhat curved, 35-55 x 2-3 microns. On leaves of *Populus tremuloides*. North Yakima, Washington, July 8, 1905. At first I took this to be an undescribed *Cylindrosporium*, but on re-examination concluded that it is a *Septoria* in which the perithecia are not well developed and referred it to *Septoria musiva* Pk.

Aecidium clematidis DC. was found on *Clematis ligusticifolia*; *Erysiphe polygoni* DC. was abundant on *Polygonum aviculare*, as was *Actinonema rosae* (Lib.) Fr. on *Rosa fendleriana*. On *Ribes tenuiflorum* there was a *Cercospora* regarding which these notes were made: Spots wood-color, oval, determinate, 5-10 mm. in diameter, longer, paler and less angular than those of *Cercospora ribicola* E. & E.; hyphae tufted, amphigenous but more abundant beneath, 20-35 x 3-5 microns; conidia 70-100 x 5-6 microns. To the description of *Cercospora ribicola* E. & E. is appended the statement, "well characterized by its red-brown spots and sphaeriaeform tufts of hyphae," well shown in *Fungi Columbiana* 1714. As remarked above, the color of the spots is quite different in these specimens on *Ribes tenuiflorum*, while the hyphal tufts are of quite ordinary size. Mr. Shear informs me, however, that he finds specimens of *Cercospora ribicola* E. & E. in the herbarium at Washington that he does not think distinct from mine. Perhaps difference in host accounts for the difference in characters.

No further opportunities for collecting were found until Portland was reached, when I was introduced to Macleay park by Mr. Gorman. Macleay park is a canyon that has been preserved in its natural condition through the enterprise of the nature lovers of Portland and which reflects credit on their zeal and sagacity. After having made one or two short incursions, I spent half of my last day in Portland in ascending it from end to end and collected specimens of the following fungi: *Sphaerotheca mors-uvae* (Schw.) B. & C. on the leaves (veins) and petioles of *Ribes bracteosum* and in small quantity on a single leaf of *Leptaxis menziesii; Septogloeum nuttalii* Hark. on *Osmaronia cerasiformis.* This was very abundant in the upper part of the park and beyond. It reminds one of *Cylindrosporium padi* Karst. On *Spiraea aruncus* occurred a *Cercospora* having the following characters: Spots pale brown, indefinite, inconspicuous; hyphae hypophyllous, clustered, brown, 20-30 x 3-6 microns; conidia subclavate-cylindrical, 60-150 x 3-4 microns. This is perhaps to be referred to *Cercospora rubigo* Cke. & Hark., with specimens of which it has not been compared. On leaves of *Ranunculus greenei* was a parasite of which these notes have been made: Spots round to oval or angular, yellow and indefinite becoming brown with age, white with the dense growth of hyphae and conidia beneath, 1-5 mm. in diameter; hyphae densely fasciculate from a tubercular base, rather lax, hyaline, 25-40x1½-2½ microns; conidia fusiform, nucleolate, 12-16 x 3 microns. Mr. Shear informs me that this agrees with *Ramularia aequivoca* (Ces.) Sacc. as figured in *Fungi Italiani*, Plate 994. There was found also *Phragmidium rubi-idaei* (Pers.) Wint. II and III on *Rubus parviflorus; Septoria corylina* Pk. on *Corylus californica; Puccinia hydrophylli* Pk. & Clint. on *Hydrophyllum virginicum; Puccinia violae* (Schum.) DC. II and III on *Viola glabella; Gloeosporium ribis* (Lib.) Mont. & Desm. on *Ribes bracteosum*, with sporules longer and narrower than usual (16-24 x 4-6 microns); *Sphaerotheca humuli* (DC). Burr. on *Rubus ursinus; Puccinia asari* Kze. on *Asarum caudatum; Ovularia vancouveriae* E. & E. on *Vancouveria hexandra; Melampsora bigelowii* Thurn. II on *Salix flavescens; Microsphaera alni* (Wallr.) Wint. on *Vicia americana.* On *Ribes bracteosum* was a fungus yielding the following notes: Spots reddish-brown above with a narrow dark border, paler beneath, round or angular, 3-8 mm. in diameter, sometimes confluent; hyphae hypophyllous, sub-hyaline, continuous, straight or somewhat flexuose, forming minute gray or brownish-gray tufts; conidia hyaline, continuous, cylindrical, 20-40 x 3 microns. I label this CERCOSPORA COALESCENS n. sp. Possibly material of greater maturity would show longer and septate conidia. On the leaves of *Bromus breviaristatus* was a *Uredo* which has not yet been identified. Returning from the park, *Cercospora montana* Speg. on *Epilobium angustifolium,* and *Coleosporium madiae* Cke. II on *Madia sativa* were found on the roadside. Then a continuous journey home, and July 16th found me in Racine.

STUDIES ON SOME LAKES IN THE ROCKY AND SIERRA NEVADA MOUNTAINS.

CHANCEY JUDAY.

(With Plates XLVIII—L).

Many beautiful bodies of water which vary in size from mere pools or tarns to bodies of considerable size, are found in the higher portions of the Rocky mountains in Colorado and of the Sierra Nevada mountains in California. From some high vantage point, a dozen or more of these mountain "gems" may often be seen dotting the landscape below. The climatic conditions to which these lakes and lakelets are subject make them very interesting objects for study from a biological standpoint. During the summers of 1902, 1903 and 1904, some investigations were made on a few of these lakes for the United States Bureau of Fisheries. It is the purpose to present here a brief account of some of the results of the investigation.

TWIN LAKES, COLORADO.

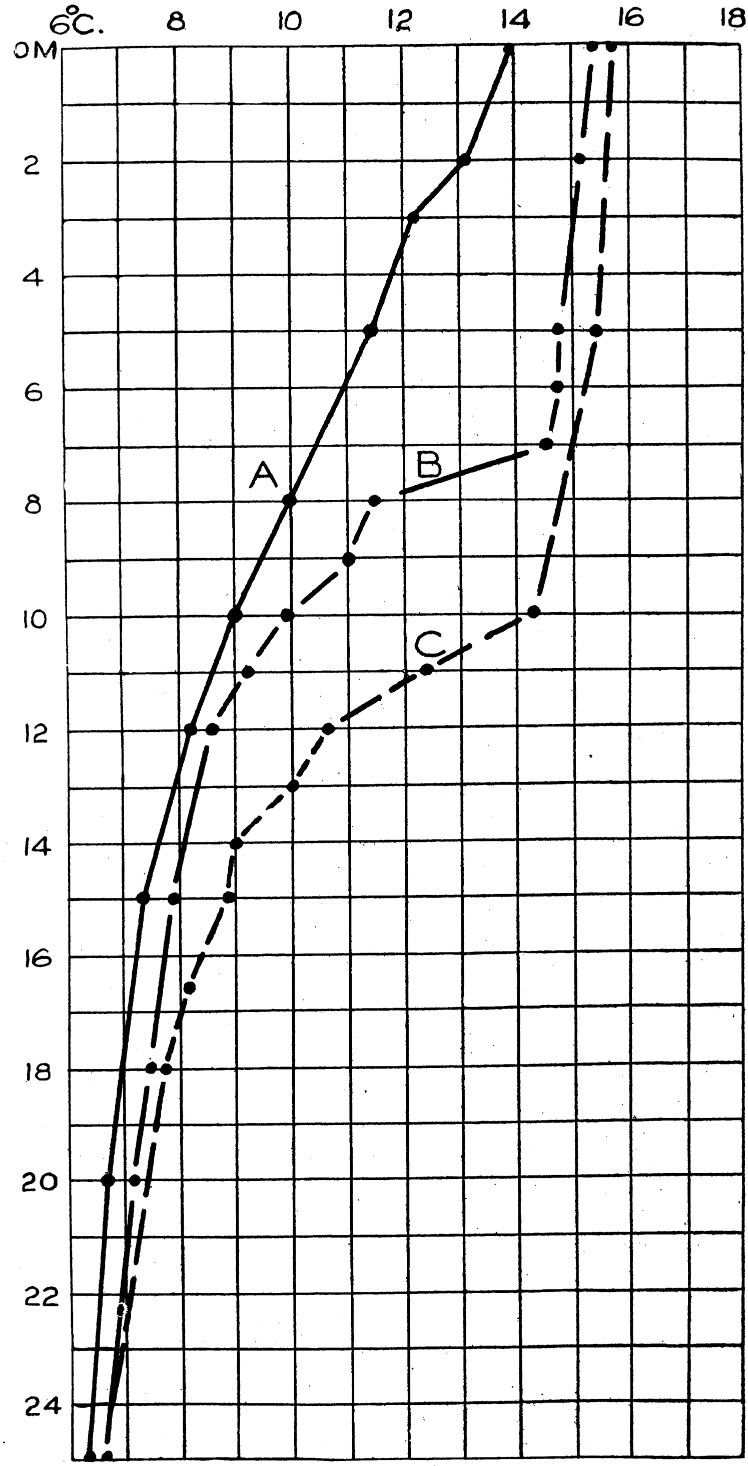
These two beautiful sheets of water are situated in the southern part of Lake county, Colorado, on the west side of the valley of the Arkansas river. They lie in the highest part of the Rocky mountains of Colorado. A short distance to the west of them are three mountain peaks whose altitudes range from 4,371 to 4,395 meters, while the lakes themselves are 2,800 meters above sea level. They lie a short distance below the mouth of Lake Creek canyon, and the basins which they occupy were doubtless scooped out by the glacier which at one time flowed down this canyon. As the glacier receded, two terminal moraines were formed, one of which maintains the water in Lower Twin lake, and another, about 200 meters wide in its narrowest place, which maintains the water in Upper Twin lake. The lakes are entirely surrounded by morainal detritus with no bed rock exposed except for a short distance along the north side of Lower lake.

Upper lake at its usual stage about midsummer has an area of about 192 hectares, and Lower lake about 582. The maximum depth of the former was found to be 25 meters, and of the latter 22.5 meters. Both size and depth, however, are subject to considerable variations, as the lakes are now used as a storage reservoir by the Twin Lakes Reservoir company. The dam maintained in the outlet makes it possible to raise the water of the lakes about 7.8 meters above extreme low water mark. While the maximum depth of Lower lake is only 2.5 meters less than that of Upper, its average depth is much less, since most of the eastern portion of Lower lake is comparatively shallow (see Plate L). In the shallower portions of both lakes, the bottom is sandy and gravelly for the most part, with pebbles and boulders of various sizes in some places. In the deeper water, the bottom consists of a marly deposit.

The principal affluent is Lake creek, which flows into the west end of Upper lake from Lake Creek canyon. About a dozen other streams of various sizes contribute their quota of water to the lakes.

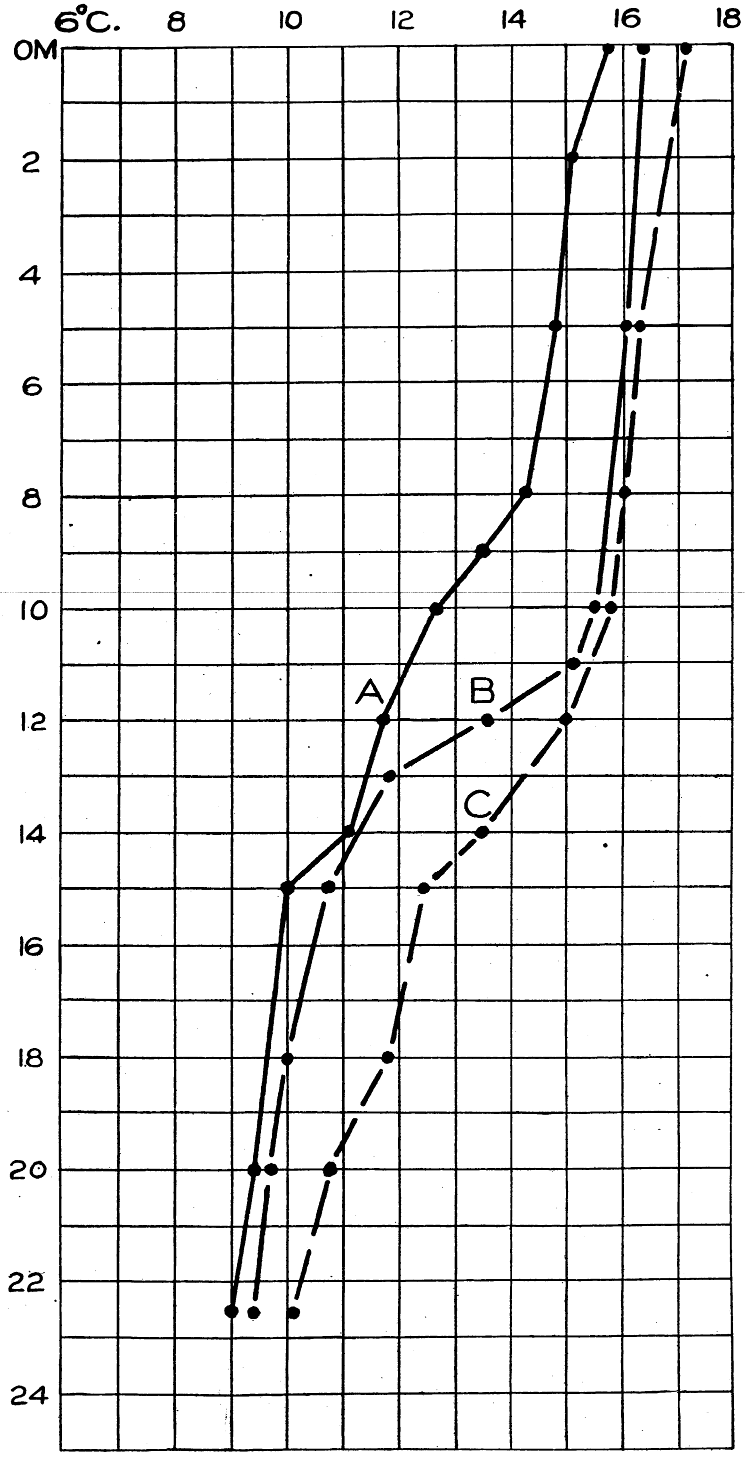
As might be expected, the climatic conditions at the altitude of the lakes, 2,800 meters, are such as to give them an alpine character. Records obtained from Mr. Charles L. Willis show that for four years Upper lake was entirely covered with ice for 138 to 149 days each winter. Mr. John J. Hartman reported that Lower lake was completely covered with ice for 142 to 155 days each winter during the five years that he had made observations on it. The maximum thickness of ice on Upper lake for the winter 1902-3 was 71 centimeters, and on Lower lake 86 centimeters.

Several sets of temperature observations were made on these two lakes during the months of July and August, both in 1902 and in 1903. In general, the temperature conditions during



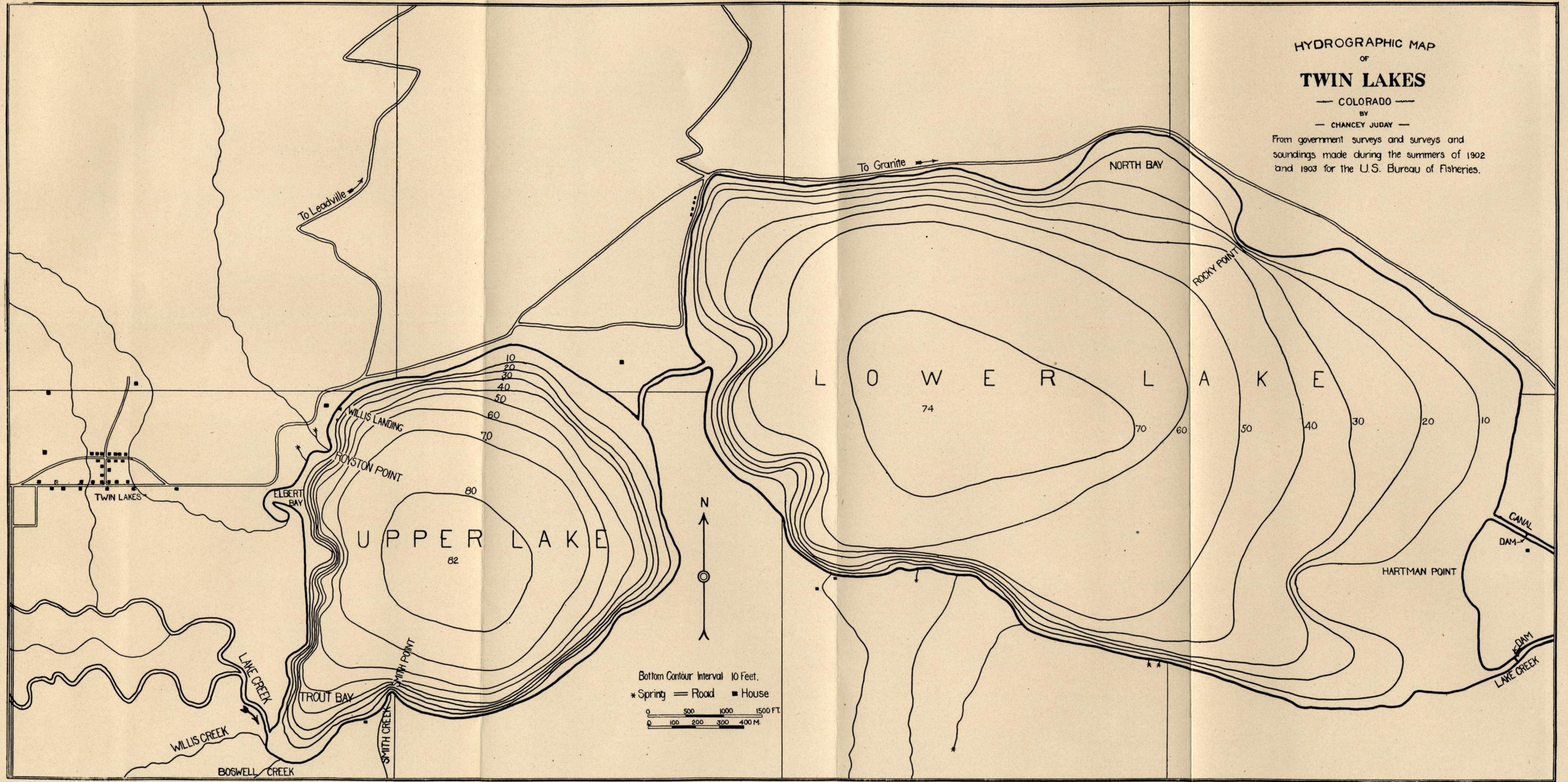
Temperature curves for Upper Twin lake, Colorado.

A. July 14, 1903.
B. August 28, 1903.
C. August 26, 1902.



Temperature curves for Lower Twin lake, Colorado.

A. July 16, 1903.
B. August 28, 1903.
C. August 21, 1903.


HYDROGRAPHIC MAP
OF
TWIN LAKES
COLORADO
BY
CHANCEY JUDAY
From government surveys and surveys and soundings made during the summers of 1902 and 1903 for the U.S. Bureau of Fisheries.
To Leadville
To Granite
NORTH BAY
ROCKY POINT
LOWER LAKE
74
70
60
50
40
30
20
10
UPPER LAKE
82
80
WILLIS LANDING
ROYSTON POINT
ELBERT BAY
TWIN LAKES
TROUT BAY
SMITH POINT
SMITH CREEK
LAKE CREEK
WILLIS CREEK
BOSWELL CREEK
CANAL
DAM
HARTMAN POINT
N
Bottom Contour Interval 10 Feet.
* Spring
Road
House
0 500 1000 1500 FT.
0 100 200 300 400 M.

the summer were found to be similar to those that have been observed in lakes of corresponding size and depth at much lower altitudes, that is, the same three regions were noticeable. There was an upper stratum of water, or superthermocline region, whose temperature increased materially during the summer, a bottom stratum, or subthermocline, whose temperature changed very little during the summer, and a more or less distinct transition zone or thermocline between these two strata. The thermocline region is always characterized by a considerable change in the temperature of the water within a comparatively thin stratum. This stratum was found to be from three to four meters thick in these lakes, and the water in the lower portion of it was about 5°C. colder than that in the upper portion. The decrease in temperature with increasing depth both above and below this region was much more gradual. This transition zone was not nearly so pronounced, however, in these lakes in late summer as has been found by the writer in lakes in southeastern Wisconsin and northern Indiana, but it agrees very closely with this zone in the latter lakes when their upper stratum of water has a corresponding temperature early in the summer. During these observations, westerly winds blew with considerable regularity, beginning usually about 10 a. m. and lasting till late in the afternoon. As a result of this, the water of the superthermocline region was kept pretty thoroughly stirred up so that its temperature was tolerably uniform. This produced a fairly distinct thermocline. The superthermocline was considerably thicker in Lower than in Upper lake. This was due to the fact that the wind was more effective in disturbing the upper water of the former because of its much larger size. On August 7, 1903, for instance, this upper stratum was eight meters thick in the former and only three meters in the latter lake. Plates XLVIII and XLIX show the results of three sets of temperature observations on each lake.

During both summers the temperature of Lower lake was somewhat higher than that of Upper. Most of the affluents flow into the latter lake, and it was found that the water of all except one was colder than the surface water of Upper lake, so that these affluents would help somewhat in keeping down the temperature of this lake. As stated above, also, the average depth of Lower lake is considerably less than that of Upper, so that the latter has a greater mass of water in proportion to its area. In the shallower parts of Lower lake the sun will be more effective in warming the water, for the light that is not absorbed by the water will be changed to heat when it reaches the bottom, and most of this heat will be absorbed by the stratum of water above. Where the water is deep, the light will pass to a much greater depth, and thus the sun's energy will be distributed through a much larger quantity of water.

In 1902, the surface water in Upper lake reached a maximum of 16.6° on August 4th, remained practically the same for ten days, and then gradually decreased. In 1903, a maximum of 16.1° was noted on August 7th. The highest temperature noted for Lower lake in 1903 was 17° on August 7th.

The transparency of the water varied somewhat. Both summers it was found that a Secchi's disk just disappeared from view at a depth of about 5.5 meters in July, and the water gradually became more transparent as the season advanced, reaching a maximum of nine meters about the middle of August. The lower degree of transparency early in the season was due to the fact that the snow on the surrounding mountains was melting rapidly, and as a result of this, the affluents were bringing large quantities of roily water into the lakes. As summer advanced, the streams became smaller and their waters were clear.

AQUATIC VEGETATION.

The larger aquatic plants consisted chiefly of *Potamogeton*. Three different species and one variety were found. They occurred in considerable abundance in both lakes. The following were noted:

Potamogeton nuttallii Ch. & Schl.
Potamogeton perfoliatus L.
Potamogeton perfoliatus richardsonii Bennett.
Potamogeton praelongus Wulf.

One or two species of *Carex* were found in the pools of the swampy meadow west of Upper lake and in a few places along the edges of the lakes. Also *Batrachium trichophyllum* grew in some of the pools of the swampy meadow as well as in a few places in the lake.

There was a comparatively small amount of phytoplankton. It consisted chiefly of diatoms, such as *Fragilaria, Asterionella* and *Melosira.* A small portion of it was made up of *Protoccoccus* and *Staurastrum.*

ZOOPLANKTON FORMS.

The following animal forms were found in the plankton of the lakes:

Rotifera.

Anurea cochlearis Gosse.
Anurea aculeata Ehr.
Notholca longispina Kell.
Triarthra longiseta Ehr.
Polyarthra sp.
Asplanchna sp.

Copepoda.

Diaptomus judayi Marsh.
Cyclops pulchellus Koch.
Cyclops serrulatus Fischer.
Cyclops albidus Jurine.
Cyclops viridis americanus Marsh.

Cladocera.

Daphnia hyalina richardi Burckhardt.
Latona setifera O. F. Müller.
Drepanothrix dentata Euren.
Eurycercus lamellatus O. F. M.
Camptocercus rectirostris biserratus Schoedler.
Alona affinis O. F. M.
Alona guttata Sars.
Graptoleberis testudinaria Fischer.
Pleuroxus procurvatus Birge.
Chydorus sphaericus O. F. M.

The following Cladocera were obtained from pools in the swampy meadow west of Upper lake:—

Daphnia pulex DeGeer.
Scapholeberis mucronata O. F. M.

Simocephalus vetulus O. F. M.
Ceriodaphnia pulchella Sars.
Eurycercus lamellatus O. F. M.
Camptocercus rectirostris biserratus Schoedler.
Pleuroxus procurvatus Birge.

Some plankton material was collected in a small lake on the side of Mount Elbert. This lakelet has an altitude of about 3,000 meters. The Cladocera were represented by *Daphnia pulex, Simocephalus vetulus, Pleuroxus procurvatus* and *Chydorus sphaericus.*

Also some material was obtained from Willis lake, which is a tarn near the head of Willis gulch, a little southwest of Twin lakes. This lakelet is situated at an altitude of about 3,660 meters. The water was very cold. *Gammarus* was plentiful, and the Cladocera were represented by two forms, *Macrothrix hirsuticornis* Norman and Brady and *Eurycercus lamellatus* O. F. M.

The plankton observations on the two lakes were few in number and consisted only of vertical hauls. In 1902, the observations on Upper lake consisted of two series of catches in July and four in August. A single set of catches was made on Lower lake in 1902. In 1903, three sets of catches were made on each lake. The observations covered such a brief period of time each year that they give only a very fragmentary notion of the plankton life of the lakes. Likewise, the vertical haul method is by no means a satisfactory one, so that both of these factors must be taken into consideration in the following results. The following table shows the number of thousands of individuals per square meter of surface. Hence, to determine the number of individuals per square meter, these figures must be multiplied by a thousand. With the exception of a few figures for the rotifers, the numbers represent averages of either two or three hauls. The rotifers were not counted in all the catches, so that, in a few instances, the numbers given for them represent the individuals of a single catch.

	Upper lake.									Lower lake.			
	1902.						1903.			1902.	1903.		
	July.		August.				July	August.		Aug.	July	August.	
Day of month	14	20	4	14	18	26	14	7	28	21	16	8	28
Anurea cochlearis	3.7	1.0	2.7	1.6	4.0	2.0	1.0	1.6	2.0	.....	38.1	40.2	12.4
Anurea aculeata..	7.5	18.0	14.0	0.4	6.0	7.0	35.8	28.0	.....	1.1	52.4	8.5	.....
Notholca longispina......	26.2	37.5	10.7	7.5	5.3	5.9	19.7	33.4	31.2	30.0	37.0	32.5	30.4
Triarthra longiseta........	76.0	66.9	30.0	18.2	10.2	5.5	101.0	96.0	30.0	.....	30.5	17.1	1.0
Polyarthra sp.....	.....	.....	.....	.....	.....	.....	8.5	8.0	3.8	.....	9.0	24.0	2.7
Asplanchna sp....	7.5	8.1	24.2	34.7	26.3	33.8	7.5	9.6	5.3	9.6	1.5	7.5	13.9
Diaptomus judayi	47.0	25.1	27.8	15.0	18.4	22.5	20.3	107.6	77.7	57.6	99.5	68.9	52.6
Cyclops	71.9	47.1	35.3	51.3	52.6	101.8	40.1	33.2	47.1	45.4	88.4	54.6	55.0
Nauplii	300.0	237.5	175.5	145.5	122.4	104.0	202.0	201.0	84.0	84.5	181.0	142.3	51.3
Daphnia hyalina, young and adult	157.9	130.5	58.2	48.3	25.0	30.4	27.8	96.3	64.2	28.2	151.0	68.0	64.6
Daphnia hyalina, adult............	37.0	19.3	12.4	16.3	5.3	6.4	9.0	21.8	30.3	12.2	58.4	27.8	28.0

With respect to vertical distribution, *Anurea cochlearis, Notholca longispina* and *Asplanchna* were confined to the upper ten meters. *Anurea aculeata* and *Triarthra longiseta* rarely occurred in the upper ten meters, being found almost entirely below this stratum. *Polyarthra* was rather evenly distributed throughout the entire depth of both lakes.

There was no diurnal movement of *Diaptomus, Cyclops* and *Nauplii. Daphnia hyalina* showed a diurnal movement of half a meter in July and one meter in August.

The phytoplankton made up a comparatively small portion of the total plankton and remained practically uniform in quantity during the two periods of these observations. The Crustacea made up by far the greater bulk of the total plankton.

FOOD OF THE TROUT.

Six species of trout are found in the lakes, and specimens of all except one species were obtained for the purpose of studying their food. In all, 394 stomachs were obtained, of which 24 were empty, leaving 370 for study. An examination of the contents of these was made in order to determine what the trout had been feeding on, as well as to determine the relative amounts of the various elements of the food. Only a very general classification of the stomach contents was attempted, so that, in all, the constituents were grouped under twenty-two different heads. *Chironomus* and *Simulium* were noted separately from the other Diptera because they were represented chiefly by their aquatic larvae. The term "insect fragments" includes all fragments that were too small to be identified positively. The other terms used in the table below are self-explanatory.

In recording the contents of a stomach, the relative amount of food it contained was noted, that is, whether it was well filled or contained but little. Then the various constituents were sorted out, and the percentage of the entire quantity which each element constituted was carefully estimated.

The specimens from which the stomachs were obtained were of various sizes. Twenty-five were so small, not exceeding three centimeters in length, that it was impossible to identify them, so they are given in a separate column in the tabulations. Likewise a number of small brook trout (*Salvelinus fontinalis*), ranging in length from 2.5 to 5 centimeters were obtained, and their food differed so much from that of the larger specimens of brook trout that they have been given in a separate column also. The majority of the other specimens from which stomachs were obtained were from 15 to 40 centimeters long.

The following table shows the average per cent of the different elements constituting the stomach contents of all the specimens of each species. The averages are based on the following numbers of food-containing stomachs:—land-locked salmon (*Salmo sebago*), 19; greenback trout (*S. stomias*), 64; rainbow trout (*S. shasta*), 106; small brook trout (*Salvelinus fontinalis*), 29; large brook trout, 126; fry, 25.

	Salmo sebago.	*Salmo stomias.*	*Salmo shasta.*	Small *Salvelinus fontinalis.*	Large *S. fontinalis.*	Fry.
Mammal remains			0.04			
Fish remains	36.84	4.40	26.55		1.48	
Araneida (spiders)			0.10		0.80	
Hydrachnidae (water-mites)					0.46	
Ephemerida				22.61	0.54	2.00
Odonata			0.50			
Plecoptera				0.86		
Orthoptera		6.55	0.12	1.55	3.80	2.40
Hemiptera		0.20	0.27		0.87	
Neuroptera					0.16	
Trichoptera	10.00	0.16	0.13		0.72	
Lepidoptera	2.11	9.20	3.46	0.69	1.18	3.20
Diptera	5.53	13.95	2.93	11.60	2.00	14.40
Chironomus (larvae, pupae)	0.11	2.80	1.17	7.60	3.75	4.40
Simulium (larvae)	5.26		1.93	6.48		
Coleoptera	15.31	16.68	7.75	0.17	5.40	
Hymenoptera	1.06	1.52	1.18		9.15	
Insect fragments	1.57	23.44	31.70	48.10	31.10	73.60
Crustacea	0.27	16.90	5.62		0.07	
Mollusca	0.06		0.38			
Vegetable debris	13.05	4.20	8.70	0.34	36.05	
Sand and gravel	8.83		7.47		2.47	

Of the twenty-two items which appear in the table, all except one (sand and gravel) may be regarded as sources of nourishment. While much of the vegetable debris had no food value and was probably taken very largely by accident, still in a considerable number of cases it consisted of digestible material and was present in such quantities as to indicate that it had been eaten purposely.

It will be noted that there was considerable difference in the diet of the various species of trout. The landlocked salmon had partaken of 12 out of the 22 items of food; the greenback trout of 12; the rainbow trout 17; small brook trout 10; and large brook trout 16. These four species differed very widely also in the relative amount of fish consumed. The landlocked salmon had partaken most freely of this kind of food, fish remains constituting an average of more than a third of the stomach contents. The rainbow trout ranked second in this respect, while the brook trout had eaten most sparingly of this kind of food. All the fish remains that could be positively identified, however, were found to be young suckers (*Catostomus commersonii.*)

Insects played a very important role as an article of food. With the exception of the small brook trout and the fry, by far the greater part of the insect material found in the specimens consisted of non-aquatic forms. Both adult aquatic insects and aquatic larvae of insects were important factors in the food of the small brook trout and the fry.

Thirty-three specimens in all had eaten Crustacea. Of this number, twenty-six had eaten only *Daphnias*, one only Copepods, four both *Daphnias* and Copepods, and two only *Gammari*. The stomach of a greenback trout 30 centimeters long contained about 4,500 *Daphnias*; another contained 2,250; and the stomach of a rainbow trout 38 centimeters long also contained about 1,300 *Daphnias*. A little more than sixteen per cent of the specimens examined which belonged to these two species of trout had eaten *Daphnias*, the number eaten in each case varying from about 50 or 75 to 4,500. It is evident that they were very important factors in the destruction of the *Daphnia* population of the lakes, for the lakes were well stocked with both of these trout, and the above figures represent only the number of *Daphnias* consumed by each trout at a single meal.

Two Mackinaw trout (*Cristivomer namaycush*) were obtained. One of the specimens was 75 centimeters long, and its stomach contained a trout 17.5 centimeters long and a few insect fragments. The stomach of the other specimen was empty.

LAKE TAHOE.

Lake Tahoe lies in eastern California and western Nevada. The boundary line between the two states passes through it in a north-south direction near its eastern shore, so that a little more than two-thirds of its area lies in California. The thirty-ninth parallel of latitude crosses the southern end of the lake.

The lake occupies an elevated valley between two ranges of the Sierra Nevada mountains. Its surface is about 1,900 meters above sea-level. The greatest length is about 36 kilometers and greatest width 20 kilometers. Its area is about 500 square kilometers. Comparatively few soundings have been made in the deeper water, and the greatest known depth is 500 meters. The lake is surrounded by an amphitheater of snow-clad mountains. Affluents are numerous, especially during the early part of the summer when the snow is melting rapidly. The largest of the affluents is the Upper Truckee river. The outlet of the lake is known as the Truckee river.

No attempt was made to get temperatures in the deeper water. On June 27, 1904, the temperature of the surface water was 16° C. and of the bottom water where the depth was only 130 meters, 4.9°. In September 1873, LeConte found the temperature of the surface water to be 19.4° and of the bottom water at a depth of 460 meters 4°. The winters in this region are usually pretty severe, so that the air probably remains far below the freezing point for a considerable period each year. Notwithstanding this fact, however, ice never forms on the lake except in the shallow bays.

The water is very transparent. A Secchi's disk just disappeared from view at a depth of 20 meters. Later in the season, however, when the greater portion of the snow has disappeared and the affluents are no longer bringing vast quantities of roily water into the lake, the transparency is said to be much greater, white objects being easily seen at a depth of more than 30 meters.

The larger, shallow-water forms of aquatic plants were found to be comparatively scarce. In the more favorable localities such forms as *Scirpus, Batrachium, Potamogeton* and *Carex* were noted. Diatoms constituted the chief portion of the phytoplankton.

ZOOPLANKTON FORMS.

Copepods made up at least three-quarters of the bulk of the plankton. The limnetic members of this group were *Epischura nevadensis* and a species of *Diaptomus*. The following Cladocera were noted:—

Daphnia pulex pulicaria Forbes.
Daphnia hyalina richardi Burckhardt.
Simocephalus serrulatus Koch.
Ilyocryptus acutifrons Sars.
Eurycercus lamellatus O. F. Müller.
Acroperus harpae Baird.

Alona affinis Leydig.

Chydorus sphaericus O. F. M.

Epischura and *Diaptomus* showed a diurnal movement of one and a half meters, *Daphnia hyalina* at least twelve meters, and *D. pulex* fifteen meters.

THE TROUT.

The Tahoe trout (*Salmo henshawi*) was the one most generally caught by the fishermen. The second in point of numbers obtained was the silver trout (*Salmo tahoensis*). The former was caught chiefly in the western and southern portions of the lake, while the latter was found chiefly in the northeastern portion. The stomachs of a dozen Tahoe trout were obtained for a study of their contents, but only three of them contained food material of any consequence. The other nine contained only insect fragments that were too small to be identified. Each of two stomachs, from trout that were 40 centimeters long, contained from 50 to 75 *Daphnias* and fragments of Chironomid pupae and adult *Chironomus*. The third stomach, from a male 38 centimeters long, contained over 1,700 *Daphnias*, about two-thirds of which were *Daphnia pulex* and the remainder *D. hyalina*. Four Tahoe trout were obtained from some small lakes lying south of Lake Tahoe. One of these specimens was 25 centimeters long, and the other three about 18 centimeters each. The stomach of the largest one contained the elytra of two beetles and fragments of 25 or 30 ants. One of the other three contained 32 damsel-fly nymphs; another 6 damsel-fly nymphs, 4 water tigers (larval Dytiscidae), and many Chironomid larvae; the third contained 4 water tigers and many Chironomid larvae. No specimens of the silver trout were obtained for a study of their food.

HOCKETT LAKES.

These small lakes are situated in the southern part of the High Sierras, in the valley of the South fork of the Kaweah river. Some plankton material was obtained from two of these lakelets on July 16, 1904. The following Crustacea were found in this material:

Diaptomus signicauda Lilljeborg.
Cyclops serrulatus montanus Brady.
Cyclops albidus Jurine.
Diaphanosoma leuchtenbergianum Fischer.
Daphnia longispina O. F. Müller.
Scapholeberis mucronata O. F. M.
Simocephalus serrulatus O. F. M.
Ceriodaphnia pulchella Sars.
Streblocerus serricaudatus Fischer.
Eurycercus lamellatus O. F. M.
Alona affinis Leydig.
Chydorus sphaericus O. F. M.
Polyphemus pediculus Linnaeus.

THE DETERMINATION OF THE VALUE OF THE RIGHT OF WAY OF WISCONSIN RAILROADS AS MADE IN THE APPRAISAL OF 1903.

ERNEST BROWN SKINNER.

INTRODUCTION.

In 1903, the Wisconsin legislature passed an act providing for the taxation of the franchises and property of railroad companies by the *ad valorem* method in place of the tax upon gross earnings which had been collected during the years immediately preceding 1903. For the purpose of administering this law, the members of the tax commission, serving as a state board of assessment, were required to ascertain and make a formal determination of the "true cash value" of such property and franchises. As one of the things deemed needful to aid the board in arriving at a final result, it was determined to make an actual inventory and appraisal of the physical property used by each railroad company in operating its road, apart from any considerations of earning power or other general factors affecting the commercial value of the road in its entirety as a chartered going concern.

This appraisal, the second of its kind attempted in this country,[1] was begun in the early summer of 1903 and completed by the end of the year. The work was divided into three parts: (1) The appraisal of the right of way; (2) the appraisal of the roadbed, ties, rails and structures; (3) the

[1] An appraisal of the physical property of the railroads was made in Michigan a few months before the Wisconsin appraisal was undertaken.

appraisal of the rolling stock. The writer was for some months in charge of the appraisal of the right of way, and although other duties made it necessary to place the work in other hands before it was completed, he followed the progress of the work with great interest until the final results were handed in. It is the method of determining the value of the right of way alone that is here discussed.[2]

The appraisers were directed, in the first place, to find the *cost of reproduction* of the physical property of a given railroad by assuming the entire road to be eliminated and its right of way, yards, station and terminal grounds to be "occupied by just such woodlands, waste lands, farms, industries and residences as those now existing in and on the adjoining country and property." In the second place, they were directed to find the present value of this physical property, and "present value" was understood to mean the cost of reproduction less an amount covering all items of depreciation whatever. The matter of depreciation does not, of course, enter into the determination of the value of the right of way, since the right of way is practically the only item among all the things that go to make up the physical property of a railroad that suffers no depreciation. But the fact that it was cost of reproduction that was required must be kept clearly in mind in order to understand the significance of the results obtained.

Only the acre value of the right of way was determined by the land inspectors. The determination of the acreage was made by men, other than the land inspectors, who had at their disposal blue prints furnished by the officers of the various roads showing the exact situation of the lands used for right of

[2] The force employed in determining the value of the right of way was organized early in July 1903, with the writer as chief land inspector, Mr. John Marston, Jr., as engineer inspector, and a corps of ten assistants. This force of men worked under the direct supervision of Mr. W. D. Taylor, then professor of railway engineering in the University of Wisconsin, now chief engineer of the Chicago and Alton railway, who, as engineer for the state board of assessment, drew up the admirable and comprehensive plan under which the work was done.

way. The areas of all irregularly shaped pieces were determined by planimeter measurements.

The range of methods available was somewhat restricted by the state board of assessment when it decided that the appraisal should be based on sales of land near the right of way made within the five-year period ending June 30, 1903. The instructions upon this point issued by the engineer of the board and approved by the board in June 1903 are as follows:

"In this appraisal the value of the land for other purposes must be determined as accurately as is reasonably possible, the average value, at the various county seats, as shown by the records of the transfers of property for the five-year period ending June 30, 1902, in the section traversed by the road, and by consultation with disinterested, reliable local real estate and business men, bank cashiers, etc."

The problem set before the men charged with the duty of appraising the right of way of the various roads was, therefore, to carry out as economically as possible under the circumstances the plan outlined by the board. As a matter of fact, the carrying out of this plan, which was so clearly outlined and which is a model of its kind, was attended by many practical difficulties.

In what follows, it is proposed to discuss briefly the plan outlined for the appraisal of the right of way of the railroads and the problems that arose in carrying out the plan, and finally to make a brief criticism of the methods employed.

THE RATIO OF RIGHT OF WAY VALUE TO ORDINARY VALUE.

Before going on to describe the actual methods employed in making the appraisal, it is advisable to take up in some detail another matter which was the occasion of long and earnest discussion between the representatives of the various roads and the representatives of the state board of assessment. It is, namely, the relation between the value of the land for ordinary purposes and its value as railroad right of way. It may well be doubted whether the land occupied by the right of way is more valuable than the land belonging to the farm or the lot from which it was taken, simply because it has been put to a different use. But when the appraisal is made to determine the cost of reproduction, the matter is quite different. It is true that the price paid by the railroad company building through an ordinarily well-settled region is very considerably in excess of the value of the land for other purposes—in some cases several times this value. Without assuming to settle the more difficult question, the term "right of way value" will in what follows be used as synonymous with the cost of reproduction. *This being the case, the "right of way value" will necessarily differ very materially from the ordinary value.*

Some of the reasons why the right of way value thus defined differs from the ordinary value are as follows:

1. The shape of the right of way makes it impossible to purchase land for right of way at the same price for which the land could be purchased were it purchased simply as city lots or as quarter-sections of farm land.

2. There are frequently consequential damages to farms and to other property across which the railroad runs. For example, the road may cut off a relatively small corner of a farm, which cannot be reached except by crossing the track, or it may cut off a part of a city lot which is too small to build upon economically. In both cases, the railroad must pay not only full value for the land actually needed, but practically full value for the portion whose value is decreased. It may be also that valuable improvements must be destroyed before the road can be built. The idea of taxing any corporation upon the value of improvements that were destroyed seems repugnant to our sense of justice. It must be remembered, however, that the appraisal was primarily for the purpose of finding the cost of reproduction of the road. Such being the case, every item entering into the first cost must be taken into account.

3. It is usually known before the right of way is bought that the road will probably be built, and there is usually a marked tendency on the part of property owners to ask excessive prices, knowing that the railroad company must have the land.

4. Frequently property owners refuse to sell at a reasonable price, and it becomes necessary to resort to condemnation proceedings which not only add greatly to the immediate cost of the land but involve costly delays. For this reason, it is sometimes more economical to give a stubborn land owner many times the value of his property rather than to resort to legal process.

Fortunately, it was possible to investigate the relation of right of way to ordinary value for three lines of road built within the state during the five-year period, by different companies and under widely different conditions. These lines are as follows: (1) A branch of the Chicago, Milwaukee and St. Paul railway about 32 miles in length, extending from Janesville, Rock county, to the southeast and leaving the state near the southwest corner of the town of Bloomfield in Walworth county; (2) a branch of the Chicago and Northwestern railway 93.7 miles long, extending from Princeton, Green Lake county, to Marshfield, Wood county; (3) a branch of the Chicago, St. Paul, Minneapolis and Omaha railway, 28 miles long and extending from Chippewa Falls, Chippewa county, to Holcombe, in the same county.[3]

The first of these lines was built through a fine agricultural district which was already well supplied with railroad facilities; it cut nearly every farm it touched at such an angle as to damage the farm seriously, and moreover some of the contractors were already on the ground before all the right of way had been secured. In short, the case could scarcely have been more unfavorable for the railroad company.

The second line named was built through a region occupied by farms of much less value than the first, and, for a considerable portion of its length, remote from existing railroads. However, that portion lying between Grand Rapids and Marshfield lies alongside the Wisconsin Central railroad so closely

---

[3] This line extends some 25 miles beyond Holcombe to Hannibal, Taylor county, but owing to the extremely small number of sales of land along the line between Holcombe and Hannibal no attempt was made to determine the ratio for this portion of the line.

that the two rights of way over most of this distance are practically a single strip of land.

The third line extends into a region which was throughout its whole length without convenient transportation facilities. At the time the right of way was purchased, there was still much valuable timber along the line, and most of the district already gave promise of becoming a rich agricultural district. Of the three cases mentioned, this line was unquestionably the most favorable to the company building the road.

A careful man[4] was set to work upon these lines to determine the relation existing between the ordinary value and the right of way value. The method used to determine the market value of adjacent property was exactly the same as that described in detail below for the determination of the value of the right of way for all lines in the state, and in all three cases extra care was taken to prevent errors creeping into the work. The amounts paid for the pieces of right of way and their acreage were determined from the offices of the registers of deeds in the counties through which the lines run, and the acreage was carefully checked by comparison with the maps in the offices of the several companies.

In order to place the results of these investigations beyond all question, Mr. H. E. Brandt was directed to secure data regarding the cost of the right of way of a branch of the Chicago and Northwestern built from Dixon, Illinois, to Peoria, Illinois, in the year 1900. This line, which is about 41 miles long, runs nearly due north and south through some of the best farming land in the state. The right of way was purchased under conditions favorable to the company. The methods employed in this investigation were substantially the same as those employed in the other three cases. However, for a part of this line the sales of land near the right of way were so few that it was deemed advisable to determine the ordinary value of the right of way indirectly. To obtain this value through one township in each of the counties of Stark and Marshall,

[4]This work was done by Mr. C. M. Larson, a recent graduate of the civil engineering course in the University of Wisconsin, and under the direct supervision of Mr. W. D. Taylor, engineer of the board.

thirty-two transfers, representing a value of $399,937 in Stark county, and twenty-one transfers, representing a value of $224,421 in Marshall county, were examined. The ratio of the assessed value to the selling price of the land described in the transfers was found to be .77 in the one case and .79 in the other. The market value of the land lying near the right of way was then found by means of the assessed value and these ratios. Had the market value been determined directly, the ratio of the right of way value to the ordinary or market value would have been 2.71.

The main results of the investigations in these four cases are given in the following table:

Table showing data concerning transfers of land on and near rights of way of roads built in Wisconsin and Illinois, between 1898 and 1903.

Name of Road.	Terminal points.	Length	Number of transfers of farm lands within one mile of right of way.	Acreage of farm lands transferred.	Ordinary value per acre.	Number of transfers of right of way.	Acreage of right of way transferred.	Amount paid per acre for right of way.	Ratio of right of way value to ordinary value.
		Miles.							
C., M. & St. P..	Janesville to state line.	32	74	5,604.50	$54 30	116	382.57	$284 16	5.23
C. & N. W.....	Princeton to Marshfield.....	93.7	488	39,155.70	11 55	239	971.37	36 54	3.16
C., St. P., M. & O............	Chippewa Falls to Holcombe...	28	90	9,815.00	10 59	49	232.94	42 50	4.01
C. & N. W	Dixon, Ill., to Peoria, Ill	41	53	*	78 01	*	672.77	213 00	2.73

* Record not preserved.

In each case, the ratio was computed separately for each township through which the road passes, or for at most two adjoining townships. For the first-named piece of road, the sales are remarkably evenly distributed along the line of the road, and the ratio is quite uniform throughout its whole extent. In the case of the Chicago and Northwestern, the sales are much denser at some points than at others, being notably dense along the 15 miles of road between Marshfield and the village of Vesper, and again through township 21 north, range 8 east. The ratio varies greatly also, the lowest value being 1.37, found in township 21 north, range 9 east, and the highest being 6.27, found in townships 22 and 23 north, range 5 east. These two extremes are found in two districts in which the number of transfers of farm land is very small. This may indicate, as one might expect, that at least part of the fluctuation in the ratio is due to the fact that the number of sales does not give sufficient data upon which to base accurate conclusions. In the first case, there were thirteen sales, aggregating 1,044 acres and distributed along about six and one-half miles of road, and the average value of the land was determined to be $24.66 per acre. In the second case, there were twenty-one sales, aggregating 1,429.66 acres and distributed along about seven and three-quarters miles of road, and the average value of the land was determined to be $12.36 per acre. On the other hand, that this fluctuation is not wholly due to lack of sufficient data is shown from the fact that along the nine miles of road adjoining the section just mentioned to the northwest there were *one hundred and five* sales aggregating 9,049.50 acres for which the average price was determined to be $12.61 per acre. For this district the ratio was determined to be 1.54. The character of the land is quite similar in the two districts, being mostly new lands upon which the value of the improvements is small. This fact would seem to indicate that the determination of the market value of the farm lands may be, after all, not much less accurate in the region of sparse sales.

In the third case, the ninety sales, though at no point dense, were quite evenly distributed along the line. The land is, for the most part, new, and the value of improvements would constitute a relatively small part of the value.

In determining the results presented in the foregoing table, no account was taken of the cost of purchasing the right of way. The salary and expenses of a competent right of way man would certainly range from $1.00 to $5.00 per acre according to the character of the land purchased.[5]

---

[5]By the Michigan board of appraisal this amount is put at figures ranging from $1.00 to $8.50 per acre according to location and value. M. E. Cooley: Instructions as to right of way, adopted January 9, 1901.

The addition of each dollar per acre for this charge would increase the ratio in the first three cases as follows:

Chicago, Milwaukee and St. Paul, Janesville to state line, .019.

Chicago and Northwestern, Princeton to Marshfield, .09.

Chicago, St. Paul, Minneapolis and Omaha, Chippewa Falls to Holcombe, .10.

It must be admitted that where the line is constructed by a company whose business is of sufficient magnitude to keep right of way men employed regularly, the cost of securing the right of way would be materially diminished, but it cannot be wholly eliminated.

The amount of land donated to the railroad companies does not seem to be large enough to have made any great difference in the foregoing figures. Just how much, would be a matter very difficult for the roads themselves to determine, but the officials of the three companies that have built these lines are agreed in saying that the amount of land donated was relatively small.

It is possible to put a partial check upon the figures of the state board for one of the lines—that of the Chicago, St. Paul, Minneapolis and Omaha in Chippewa county—since the figures in the appraisal sheets of this road show the "actual amount of money disbursed for this realty."[6] The total number of acres in this right of way is 408.54, and the total cost to the railway company was $15,998.10, making the average price per acre $39.18, as opposed to $42.50, the figure determined by the state appraiser from the records of the sales used. Using the same ordinary value as has been used in the table on page 800, we should have a ratio of 3.61 instead of 4.01 as there given. The difference is considerable, but the lower (and probably more accurate) figure is yet far above that finally adopted by the engineer of the board,

---

[6]For this information and for other helpful suggestions, I am indebted to Mr. T. A. Polleys, tax commissioner for this road, who has done much valuable work in collecting data in this and other states.

namely 2.5. In view of the foregoing facts, this ratio seems to be quite low enough.[7]

There is in this state no example of a right of way recently purchased through a city of considerable size. After due consideration and comparison of previous appraisals, the ratios adopted by the engineer of the state board of assessment were 1.33⅓ for right of way 100 feet wide or less, and 1.10 for right of way more than 100 feet wide. The figures adopted in the Michigan appraisal were 200 per cent of the ordinary value for cities with a population of more than 3,000, and 225 per cent of the ordinary value for cities and villages with a population of less than 3,000, plus $8.50 per acre for severance charges.[8]

That the figures used in the Wisconsin appraisal are rather too low than too high, was borne out by the results that came to light in the investigation that was carried out by Mr. Brandt on the Dixon-Peoria branch of the Chicago and Northwestern, about one mile of which lies in the city of Peoria. The market value of this right of way was determined by the same method that had already been used in Wisconsin and which is described on page 808. This value was determined from 254 transfers, representing a value of $535,472, all made between July 1, 1900, and March 31, 1901. The assessed value of this property was found to be 80 per cent of the aggregate sale price. Using this figure as a basis, the ordinary value of the right of way was determined to be $1,120 per acre. The records showed that the railway company had paid $3,096 per

---

[7] It was argued by the representatives of some of the roads that the methods employed to find the ordinary value of the farm lands adjacent to the railroad right of way gave too low a value, and consequently made the ratio of the right of way value to the ordinary value too high. It must not be forgotten, however, that this would have little influence upon the right of way value as deduced from the ordinary value, since after all the right of way value is the fixed quantity in the equation by which the ratio is determined. It matters little whether the ratio be low or high, provided the ordinary value be determined in the same manner throughout the state and *the ratio is reasonable with respect to the ordinary value so determined.*

[8] M. E. Cooley: Instructions relative to right of way, 1901.

acre. The ratio is then 2.76. The width of this right of way varies from 150 to 385 feet.

The determination of this ratio of right of way value to ordinary value has been discussed at length for two reasons: First, because of the far-reaching effect of the use of such a ratio, and second, because the methods used were precisely the methods used in the determination of the right of way for all roads in the state.

METHODS EMPLOYED.

Right of Way Through Farm Lands.

As we have already seen, the state board of assessment required that the appraisal should be based upon actual sales of land situated near the right of way Without special facilities for obtaining data from such sales, the method would be practically impossible. However, in the state of Wisconsin, the register of deeds in each county is required to transmit annually to the secretary of state a report of all sales of real estate made in the county during the year for which the consideration was not merely nominal. These reports contain (1) a brief but accurate description of the property, (2) the date of sale, (3) the consideration, and, in the case of farm lands, the number of acres transferred. The existence of these reports made fairly simple a piece of work which otherwise could hardly have been completed in a reasonable time and at a reasonable expense. By means of them, it was possible to obtain in the office of the secretary of state in a few weeks information which it would have taken the same force as many months to collect had the men been obliged to go to the offices of the registers of deeds in the various counties. The transfers are usually arranged by towns, the boundaries of which in a general way coincide with the boundaries of the government townships.

In the first place, the best maps to be obtained were secured.[9] With the help of these maps, lists of sections lying in strips approximately two miles wide with the railways through the center were made out and arranged so far as possible in the order of their numbers. A clerk then scanned the registers' reports covering that particular region and made a record of each sale that had taken place within the two-mile-wide strip and recorded in his notebook a brief description of the parcel, its acreage, the consideration and the last previous assessment.[10] The rates for a particular section of road were arranged by years, so that from them it was an easy matter to determine the average price for any one year or for the five-year period. This acreage for the five-year period was then recorded as the "average sale price" for the land. The inspectors were then sent into the field to collect data in the way of opinions from men actually familiar with the land lying along the line of the road, and to judge from personal inspection the value of the right of way. Finally, the names of many reliable business men, farmers, etc., living along the line of road were obtained, and to these a printed form was sent which they were asked to return to the office of the board of assessment with their estimate of the acre value of the right of way through a certain section. From these data, the inspector, after weighing all the evidence at hand, put down what was in his opinion the ordinary value per acre of the right of way along the line. Where sharp dif-

---

9 Considerable difficulty was experienced in securing sufficiently accurate maps. The railroad commissioner's map of Wisconsin is excellent, but it is too small. The difficulty was even greater in the case of the small towns. In September 1903, the writer saw in the office of one of the registers a recorded plat for an incorporated village which was a mere rough pencil sketch; and so far as he could learn, no other existed.

10 These assessments were not used in the case of the farm lands except to assist the inspector in discovering whether the consideration was the true one, and for this purpose rarely. For example, when the assessed value far exceeded the consideration, this fact was ordinarily accepted as *prima facie* evidence that the consideration was not the true one. So it usually proved when the full information concerning the transfer was obtained.

ferences in value existed, the road was divided into shorter sections, so that estimates could be made more accurately. These last figures, increased by 150 per cent, are the figures that appear in the appraisal as giving the *cost per acre of the right of way on the supposition that the road were completely eliminated and the company obliged to purchase it anew.*

Right of Way through Villages and Small Cities.

The methods employed to determine the value of the right of way through villages and small cities were in the main the same as those employed to determine the right of way through farm lands. All transfers of land located within one block of the right of way, where the recorded consideration was not merely nominal, and which had taken place during the five-year period, were examined. The acreage of this property was determined by increasing its dimensions by one-half the width of all streets fronting it, and from this acreage the price per acre was obtained by dividing the aggregate of the considerations by the total acreage. The property was then viewed by the inspector, and estimates were obtained from persons familiar with the situation. From these data, the inspector made an estimate of the value of the land adjacent to the right of way, giving to the various elements such weight as in his judgment the circumstances seemed to demand. This estimate, increased by the percentage as agreed upon, was taken to be the acre value of the right of way. No account was taken of the existence of villages with populations of less than 500, since the amount of right of way within their borders is relatively small and is in most cases contiguous to land which, although it may be platted, is really farm land.

Very great difficulty was encountered in this part of the work. It was difficult to obtain the dimensions of the lots accurately. In many cases, the number of transfers of property near the right of way was too small to furnish sufficient data upon which to base safe conclusions. In many other cases, the value of adjacent land varied greatly owing to the distribution of improved property. This difficulty was at least partially overcome by dividing the right of way through the village or city into smaller sections, so that a relatively large number of sales of property of a given class would not determine the acre value for the whole right of way through the corporate limits. The field inspectors were directed to note carefully the physical conditions in such cases.

The most serious difficulty, however, arose from the fact that the recorded consideration includes, of course, the value of the improvements upon the property, and in most cases the value of the improvements far exceeds the value of the naked realty. The only method of solving the problem thus presented that seemed at all feasible was to find from the later assessment rolls the assessed value of the improvements[11] and to separate the consideration into two parts having the same ratio that the assessment upon land bore to that upon the improvements. This was unsatisfactory at best, the effect being, in cases where the consideration was the true one, to increase the value of the land, since there is a strong tendency on the part of assessors to place the greater part of the assessment upon the land.[12] In cases where the recorded consideration differed from the true consideration, the method would lead to serious errors.

The evidence turned in by persons who were asked to estimate values contiguous to a railroad right of way through a small city was of very doubtful value. This is clearly shown by the figures given by three of the most reliable real estate men of the city of Madison for the acre value of the land contiguous to the right of way of the Illinois Central railroad through the city. These estimates were approximately $1,000, $2,000 and $3,000 per acre. As a matter of fact, the value as determined by sales was not far from the middle figure.

With the best efforts of the appraisers, this part of the work remained the most unsatisfactory of all that was undertaken. Fortunately, its relative importance was such that it could not

---

11For a number of years, the city of Milwaukee has required its assessors to assess the land and improvements separately. Since the year 1900, this has been done for all real property in the state.

12It would be difficult to prove this statement, but to one who has examined many such assessments the evidence seems almost conclusive.

seriously affect the total result, though it must be admitted that the chance for error in the individual towns is very considerable.

The total value of all the right of way in the state was finally placed at about $25,500,000. Of this amount, $2,977,941, or less than 12 per cent, is given as the value of right of way through cities and villages with populations of less than 10,000. The average price of right of way through these cities and villages was found to be $421 per acre, which would be $80 to $100 for an ordinary building lot. This value would not seem to be excessive when one considers that the towns were all above 500 population and that care was taken to omit from consideration all towns where the road does not run into the town.

Right of Way through Larger Cities.

For the larger cities, the scarcity of sales near the right of way and the high value of the property involved made it necessary to seek for some method different from the one just described. The method used was devised by Mr. John Marston, Jr., engineer inspector for the state board of assessment, who was placed in charge of the work for the larger cities of the lake counties and the Fox river valley. The method was as follows:

The assessed value of all the land, exclusive of improvements,[13] lying within one block of the right of way was determined for both sides of the road. This was reduced to assessed value per acre for sections not exceeding two blocks in length. The arithmetic mean of the figures on the two sides of the right of way was then taken and the result used as a sort of "assessed value of the right of way." The aggregate of the considera-

[13]With the exception of the city of Milwaukee, the assessed value of the land had to be of date 1900 or later, as prior to that date the values of the land and of the improvements were not separated by the assessors. Some confusion and doubtless considerable inaccuracy arose from the fact that for some cities the assessments for the years 1900, 1901 and 1902 differed sharply, owing to the efforts of the state board of assessment to have all real property of the state assessed at something like its full value.

tions for all sales for the city or for the ward in a single year was obtained. This figure was compared with the aggregate assessments on the same property for the same year. The result of this comparison gave a so-called "ratio of assessed to true value" for the city or for the ward as the case might be.[14] Finally, the assessed value of the right of way was divided by the ratio of assessed to true value, as determined from transfers in the city or in the ward. This result was taken as the true value of the right of way. To obtain the cost of reproduction, the true value was increased by 10 or 33⅓ per cent, according as the width of the right of way did or did not exceed one hundred feet.

It will be seen at once that in using the method just described, all error arising from the imperfect determination of the ratio of the value of the land to the value of improvements from the consideration, which includes both, has been eliminated. The method, which, from a theoretical standpoint, leaves little to be desired, was not without serious shortcomings when the practical application came to be made. By far the most important source of error is to be found in the determination of the ratio of assessed to true value of the real estate of a given city. This difficulty was increased by the fact that during the five-year period which the state board requires to be taken into consideration, the assessments had been very materially increased throughout the state. In several cases, it was found better to base the ratio on the sales of a single year and the corresponding assessments on the same property, even though the number of sales was thereby greatly diminished. For most of the cities, the sales and assessments for the year ending September 1901 were used. The determination of this important ratio will be taken up in a later paragraph.

Another difficulty arose from the fact that in many places the right of way occupies a peculiar location with respect to adjacent property. A conspicuous example of this sort is the case of the Chicago and Northwestern railway along the lake

[14]It must be carefully borne in mind that wherever the term "assessed value" is used it refers to the local assessment.

front north of the passenger station in the city of Milwaukee. For nearly a half-mile, the track runs over made land along the lake shore under a bluff forty to fifty feet high. For a part of this distance, the land on top of the bluff is occupied by Juneau park, and for the remainder, by the most expensive residence property in the city, worth $100 to $200 a front foot. With land on top of the bluff worth $50,000 per acre and upward, and the lake on the other side, it is difficult to say what the right of way lying between is worth.[15]

THE APPRAISAL BY THE RAILROADS THEMSELVES.

At the request of the state board of assessment, most of the larger roads of the state made an inventory of their own property at the same time that the work was going forward under direction of the board. The following roads turned in appraisals for their right of way: Chicago and Northwestern; Chicago, Milwaukee and St. Paul; Chicago, St. Paul, Minneapolis and Omaha; Duluth, South Shore and Atlantic; Eastern Railway of Minnesota; Green Bay and Western; Minneapolis, St. Paul and Sault Ste. Marie; Wisconsin and Michigan, and Wisconsin Central. The methods followed by the various roads were not given in all cases, and for those that were given the differences were not enough to warrant a description for each road. In order, however, to make a comparison of results, it is necessary to describe some of these methods.

Of the various appraisals of right of way made by the railway companies, that employed by the Wisconsin Central for a portion of its appraisal was probably as carefully done as any and may be taken as typical. This appraisal was made by a careful right of way man who has been in the employ of the road for many years and who is familiar with the line throughout its whole length in the state. Careful inquiry was made in person of responsible men familiar with land values

15 The situation for this particular piece of road was aptly put by an Irish appraiser employed by the railway company who, when directed to obtain the right of way value by comparison with "lands similarly situated," reported that "there is no land similarly situated."

in their respective localities, and the average of these opinions and that of the appraiser were taken into consideration in making up a final estimate of value.

In the counties of Waukesha, Fond du Lac, Manitowoc, Waupaca, Portage, Wood and Price, which best represent the most valuable right of way of the company, the most competent men obtainable in each locality were hired and sent out with instructions to make a personal canvass from farm to farm and lot to lot abutting the company's right of way. These agents first asked the owner of adjoining property what price he would be willing to pay for the right of way in its natural state, then what price he would be willing to place upon his own property *exclusive of improvements,* and finally the price at which he would sell a strip of land through his holding for railway purposes. The appraiser was required to give his opinion of the average valuation of the adjacent property for the preceding five years without improvements. In addition to all these items, the assessed valuation of the property for the last preceding assessment was noted on the blank furnished the appraiser. The appraiser's valuation for the five-year period, increased by amounts varying with the different localities, but on the whole less than the percentage determined by the engineer of the state board, was taken as the value of land for right of way purposes.[16]

Methods similar to the above were employed by other roads, though none of them carried out the work with such detail as that employed by the Wisconsin Central company in the counties mentioned above. Several of the roads, notably the Chicago and Northwestern, refused to recognize the principle of an added increment for right of way purposes, and consequently their figures represent what has been called the ordinary value. Others adopted the principle, but allowed the application of it to depend upon the character of the land and the

[16] I am indebted to Mr. George A. Kingsley, tax commissioner for the Wisconsin Central Railway, under whose immediate supervision the valuation for his company was made, for a detailed statement of the methods employed.

local circumstances, so that in the returns as finally made to the state it is impossible to give percentages.

For the appraisal of the value of a right of way through city property, the work done by the officials of the Chicago and Northwestern railway in the city of Milwaukee may be taken as an example. In this work, representative pieces of property were selected in each block lying near the company's right of way, and their market value was carefully estimated by two to four men familiar with land values in the vicinity. The average of these estimates was taken as the market value. The market value so determined was compared with the assessed value. The assessed value of the property adjacent to the right of way was then obtained, and the market value was found, assuming that the ratio of assessed to market value for all the property adjoining the right of way was the same as that for the representative piece of property.[17]

The first results obtained for some of the more important cities by the two methods, differing only in slight details, are interesting. The following table will show how great the differences were.

Table showing comparison of results obtained by state appraiser and the Chicago and Northwestern Railway company for the "ordinary value" of the latter's right of way through the principal cities of Wisconsin.

	Population, 1900.	Ordinary value per acre as given by state appraiser.	Ordinary value per acre as given by C. & N. W. appraiser.
Milwaukee	285,000	$20,266	$16,119
Fond du Lac	15,000	1,282	1,080
Oshkosh	28,000	2,005	2,469
Marinette	16,000	2,940	845
Racine	29,000	3,906	2,883
Kenosha	12,000	17,888	2,858
Manitowoc	12,000	6,097	1,758

As will be seen, the difference in the city of Milwaukee was more than $4,000 per acre, or, in round numbers, about 20 per cent of the state appraiser's figure. For the 170 acres

[17] For this information, which does not appear in the company's reports, I am indebted to Mr. C. D. Cleveland, land commissioner for the Chicago and Northwestern Railway company.

occupied by the railway company, the total difference was more than $700,000. Subsequent conferences between representatives of the state and of the railway company served to diminish this difference somewhat, but by a relatively small amount. This difference was still further increased when the percentages for right of way value were added. The final figure adopted by the state appraisers was $22,775 per acre, making a total of $3,859,009 for the city.

Further comparison will be found in the following table,[18] which gives the total value of the right of way for eight large roads of the state.

Table showing comparison of results reached by the state appraiser and the railroad companies for the value of their rights of way through Wisconsin.

Name of road.	Mileage.	Total value of right of way, state appraiser.	Total value of right of way, railway company.	Per cent of difference in right of way.	Per cent of difference in all other items.
Chicago and Northwestern.	1,759.04	$9,155,831	$6,200,866	32.2—	4.27—
Per mile	....	5,205	3,528	....	....
Chicago, Milwaukee and St. Paul	1,691.26	10,790,047	9,998,842	7.33—	4.19—
Per mile	....	6,380	5,905	....	....
Chicago, St. Paul, Minneapolis and Omaha	736.97	1,309,700	1,212,735	7.40—	.92—
Per mile	....	1,776	1,644	....	....
Duluth, South Shore and Atlantic	106.53	88,675	19,082	78.5	9.73
Per mile	....	832	179	....	....
Eastern Railway of Minnesota	32.46	216,458	218,941	1.15+	8.07+
Per mile	....	6,670	6,740	....	....
Green Bay and Western	252.00	330,816	140,967	57.7—	32.9—
Per mile	....	1,313	559	....	....
Minneapolis, St. Paul and Sault Ste. Marie	330.88	155,331	101,980	34.3—	11.8—
Per mile	....	469	309	....	....
Wisconsin and Michigan	36.48	16,323	10,426	36.1—	0.4
Per mile	....	447	286	....	....
Wisconsin Central	732.03	1,548,037	1,388,359	10.3	8.5
Totals	6,125.77	$25,051,723	$19,274,185	21.7	3.6
Per mile	....	4,080	3,145	....	....

At first glance, this table would seem to show nothing except possibly the utter unreliability of all figures obtained. However, if it be remembered that the officials of the Chicago and

[18] I am indebted to Professor W. D. Taylor, engineer for the state board of assessment, under whose supervision the data for this table were brought into final form, for permission to use his results.

Northwestern road consistently refused to increase their right of way value above the market value, one very large difference is removed at once. The value of the right of way of this road through farm lands is approximately $1,286,285, according to the estimate of the appraisers for the road. If this figure be increased by 150 per cent, the percentage of difference would be changed to 11.2, and the percentage of totals in the right of way columns to 15.4, without materially affecting the percentages for the column for all the items.

The Green Bay and Western road was very low in all its estimates, as is shown in the column for all items. It is also possible that its estimate of the value of its right of way is the estimated ordinary value without any added increment. If this be true, a large part of the difference would disappear in this case also.

The great difference in the case of the Duluth, South Shore and Atlantic is not so easily explained. This road runs for most of its length through land that was formerly covered with a heavy growth of pine, and it is possible that many of the considerations recorded give the value of the land with the timber standing, and it may be with the value of saw mills located upon it added, while the figures given by the road indicate the present value of the land with timber cut off. Assuming the right of way to be 100 feet wide, the road's figures would be about $15.00 per acre, while those given by the state appraiser would be nearly $70.00 per acre. It is quite certain that outside the city of Superior the market value of the right of way for the road would probably not exceed one-fifth of this sum, so that $45 per acre or $550 per mile would be a liberal estimate for the cost of reproducing the right of way outside the city of Superior. If the state's estimate of this right of way is too high, it is just as certain that the road's estimate is much too low, if one assumes that the cost of reproduction is the thing required, for this estimate would bring the market value of the land below $8.00 per acre for the whole line.

Further comment upon the table seems unnecessary. It must be regretted that the figures on both sides cannot be presented so as to compare market values, since in that case there would be a common basis for the comparison.

THE SO-CALLED RATIO OF ASSESSED TO TRUE VALUE OF REAL ESTATE.

The use of the ratio of the locally assessed value to the true value of real property in connection with the determination of the ordinary or market value of right of way in Milwaukee and other cities in the eastern part of the state has already been noted. This ratio has played such an important part in the appraisal, and the use of it for this and other purposes has been so vigorously attacked by the railway officials, that it deserves some notice here. The question as it has come up is not upon the use of the ratio, but on the possibility of determining it accurately from the considerations as recorded in warranty deeds conveying the property sold. In what follows, reference will be made largely to the determination of this ratio for the city of Milwaukee, since it is for this city that its importance is greatest. The *ad valorem* law of 1903, changing the basis of railway taxation in Wisconsin, directed that the state board of assessment should make a formal determination of the "true cash value" of all railway property in the state. The tax commission had already made free use of the reports of sales of real estate in connection with their work in determining the value of real property in the state. The validity of this method of determining the value of the larger part of the general property of the state became at once a fundamentally important question to the railway companies, since, by the law of 1903, their property was to be valued "in like manner as other property of the state." The prime question at issue was the accuracy of the determination of the value of the real property of the state; the determination of the relation of assessed to true value was only incidental, though it was used later in several ways.

Early in the year, the matter was taken up for the railroads by a committee consisting of Messrs. Frank P. Crandon, A. S. Dudley and W. W. Baldwin, tax commissioners for the Chicago and Northwestern, Chicago, Milwaukee and St. Paul and Chicago, Burlington and Quincy roads respectively. This committee employed Mr. Thomas H. Brown, formerly tax commissioner for the city of Milwaukee, to sift the reports of the register of deeds in several counties and to ascertain if possible how far these reports of sales could be made a basis for the determination of the ratio of assessed to true value. Mr. Brown and his assistants spent several months working with the records of sales for the year, going over the data in the offices of the various registers, and rejecting all sales where it appeared from the deed that the consideration as recorded did not express the true consideration, or where for any reason the consideration could not be compared with the assessment of the year in which the deed was given. The results of these investigations have been privately printed in a pamphlet of 190 pages, entitled "An analysis of the reports of land sales made by the registers of deeds to the secretary of state, showing the unreliability of these reports as a basis for determining the true value of real estate in Wisconsin." The committee's conclusions may be given briefly as follows: (1) Owing to the fact that in so many cases the recorded consideration does not represent the actual sale price, no accurate determination of this ratio is possible from the reports of the registers to the secretary of state. (2) By carefully sifting the data and by securing information from the parties to the sales, the committee concludes that Milwaukee real estate was, in 1902, assessed at about 52 per cent of its true value."[19]

Using the average of the five-year period, Mr. Marston obtained a value of 56 per cent, using the registers' reports and making no attempt to sift data except to throw out such sales as were on the face of the record not available.

In the summer of 1904, the state board of assessment commissioned Professor T. S. Adams to undertake an investigation

---

[19] Subsequent investigations by agents of the tax commission have brought to light a very considerable number of omissions and inaccuracies in Mr. Brown's work—enough, it would seem, seriously to affect the value of his conclusions.

covering the counties of Barron, Dane, Ozaukee and Milwaukee, to ascertain whether the reports of the registers of those counties for the years 1898-1902 contain data of sufficient accuracy to justify their use in determining the ratio of assessed to true value. Professor Adams' report has not been published, but through his courtesy and with the permission of the state tax commission the writer is permitted to refer to some results arrived at and to add some comments of his own based upon observations taken during the progress of the work.

Under Professor Adams's direction, every deed referred to in the registers' reports was read, and every restriction, reservation and condition was noted upon a card designed to contain all data relating to the transfer. The existence of mortgages was also carefully noted. After the deeds had been read, the assessments of the property for two or three years were copied upon the same card, and finally men were sent into the field to find the parties to the sale and verify all data found as well as to obtain pertinent data not contained in the record.

The result of this careful sifting is shown in the following table, which gives the figures originally given by the tax commission and the figures found by Professor Adams. The results give in every case the average of the ratios for each year for the five-year period 1898-1903, expressed as a percentage:

Table showing ratios of assessed to "true value" according to methods of tax commission and according to work done by Professor Adams.

County or City.	Ratio of assessed to true value as determined by commission from data furnished by registers of deeds.	Ratio of assessed to true value as determined by Professor Adams, after carefully sifting data given by registers of deeds.
Barron	51.52	48.40
Dane	48.53	46.89
Ozaukee	60.22	59.48
Milwaukee (county), not including city	40.29	43.97
Milwaukee (city)	57.34	51.59

The relatively small differences in the figures go far to confirm the commission in its methods and show that on the whole the result of "sifting" the data increases the valuation of the right of way, since the lower ratio gives the higher valuation.

Some of the reasons that tend to invalidate the data contained in the registers' reports may be noted briefly:

1. The deed may contain some restriction placed upon the property or its maintenance in the future.

2. The consideration may be purposely misstated.

3. The number of cases for which the recorded consideration is merely nominal, that is one dollar and other considerations, may be so large that the remainder do not furnish a sufficient body of data upon which to base safe conclusions. In the city of Milwaukee, the number of "dollar" sales is about 85 per cent of the whole number of conveyances. It is very much smaller in other parts of the state.

4. Improvements may have been placed upon the property or removed from it between the date of sale and the date of the assessment with which it is compared.

5. The deed may be given in fulfillment of a land contract, in which case the assessment is compared with a sale price of much earlier date.

6. The grantee may assume a mortgage outstanding against the property, which mortgage needs to be added to the recorded consideration to obtain the true consideration.

7. The consideration may include personal property of considerable value.

It must be admitted that these considerations would seem to cast grave doubt upon the usefulness of the registers' reports. Nevertheless, after most careful examination of all data, the results obtained by Professor Adams seem to show that for long-settled farming communities and for cities in which real estate movements are not measurably affected by speculation, data obtained from the registers' reports will give results very close to the truth, while even in such a city as Milwaukee, where during the last ten years real estate has been subject to violent fluctuations owing to the existence of a multitude of purely speculative ventures, fairly accurate results may be obtained by sifting the data carefully. With these conclusions, Mr. T. A. Polleys, tax commissioner for the Chicago, St. Paul, Minneapolis and Omaha railway, who has examined the matter carefully in several counties of Wisconsin and in some counties in Minnesota and Nebraska, is in substantial agreement.

It may be noted in passing that in the discussion of this ratio the representatives of the railways had no thought of applying the ratio to the determination of right of way values, but rather to enable them to compare valuations made on their property with valuations made on other property in the state. Curiously enough, it works in diametrically opposite directions when applied to these two purposes. A low valuation upon contiguous real estate would entitle the road to the same low valuation, but when applied to finding the market value of the right of way as described above, would increase that value very greatly as the ratio diminished.

COST OF THE APPRAISAL, AND TIME REQUIRED.

No accurate statement of the cost of any particular part of the appraisal can be made, since many of the men employed worked on several parts of it. The cost, therefore, can only be estimated.

The work was done by twelve men, with salaries per month as follows:

1 chief inspector	$160 00
1 engineer inspector	275 00
1 inspector	160 00
1 inspector	140 00
1 inspector	125 00
7 assistants	80 00

Making a total pay roll of $1,435 per month. In addition, the men were allowed traveling expenses but not hotel bills while away from Madison. Had the work been pushed forward with the whole twelve men, the work could easily have been accomplished in four months, making the total cost, including traveling expenses, something more than \$6,000. The total cost of reproduction of all right of way as estimated by the state is \$25,051,728, as compared with a total of all items of \$201,206,300. It will be noted therefore that the appraisal of the right of way was a relatively large item in the whole expense, which amounted to about \$25,000. The cost of the appraisal of the right of way was thus about one-fourth of the cost of the whole appraisal, while the value of the right of way was found to be about one-eighth of the total physical value of the roads appraised. It must be noted, however, that in the determination of the value of the right of way less assistance was received from the roads themselves than in the determination of other parts of the physical value.

CRITICISMS AND SUGGESTIONS.

In the opinion of the writer, the most serious sources of error in the results obtained for right of way value by the method used by the appraisers lie in the facts that for the limited areas considered the number of the land sales is subject to such great variations, and that it is practically impossible in these sales to find the true consideration for the land stripped of all improvements. The experience of the inspectors proved conclusively that information from local business or professional men otherwise than by personal interview is extremely difficult to obtain and when obtained is of very doubtful value. Moreover, personal interviews with any considerable number of men in each locality require a large amount of time and expense.

It would seem wise, then, to lay more emphasis on local assessments. Under present methods employed in Wisconsin, it would be an easy matter to find the assessed value of all farms within one mile of the right of way through farm lands or within one block of the line through urban property. The ratio of assessed to true value could then be determined by taking into account *all* sales over larger units of area. The unit should not be less than a government township for farm lands or a ward for city property. Where special local conditions render this method useless (and the number of such cases would be relatively small), a small committee comprising perhaps a chief inspector, the local assessor and one or two men familiar with local conditions could make a special determination of the value at small cost. This would be carrying out for the whole state, with slight modifications, the plan adopted by Mr. Marston for the city of Milwaukee.

It ought not to be difficult to arrange for local assessors to turn in to some county or city official their estimate of the right of way as compared with that of adjacent property, and for such official in turn to forward the estimates to the state board of assessment. By the state board, these figures could be treated exactly as the assessments on any other real estate.

It seems likely, however, that under any scheme that may be devised the cost of the appraisal will be relatively high as compared with the value of the right of way as an element in the value of the railroad property. For, after all, the relation of the value of the right of way to the earning capacity of the road, either present or prospective, is ordinarily exceedingly small, and it is precisely the ability of a road to bring in returns that has more to do with its value to investors than any or all other factors. Nevertheless, while it may be true that for purposes of taxation the value of the physical property of a railroad is less important than some other factors, it must be noted that in problems involving an equitable adjustment of rates it is a factor of great importance. It is probably true, also, that for most roads the value of the right of way will constitute in the future a relatively larger part of the physical value. This fact is at once evident when one considers the sharp advance that has taken place in the value of farm lands in the middle West in the last twenty years and the great increase that is taking place in the area covered by our cities.

For reasons similar to the foregoing, it is desirable that the right of way should be appraised certainly as often as other parts of the physical property and probably oftener. In any case, the appraisal should be made often enough so that the appraised value can be adjusted to the fluctuations in the value of contiguous real estate. Under normal conditions, there will be an increase and not a decrease. As an example, the valuation of the farms of Dane county, Wisconsin, increased from $26,373,804 as given in the census of 1890 to $38,869,830 as given by the census of 1900. Again, during the decade ending with 1905, the city of Madison in this same county has extended its corporate limits so that some four miles of right of way has been brought into the city, and during the same period the value of the land contiguous to these four miles of right of way has increased in value from 100 to 1,000 per cent or even more. It would seem only fair, then, that in the decade 1890-1900 the valuation of all right of way through farm lands in Dane county should be increased by nearly fifty per cent, and the valuation of the four miles taken into the city of Madison in the decade 1895-1905 should be increased to keep pace with the value of several hundred acres of land that has been changed from acre property to city lots. These two cases are doubtless extreme, but many such occur. It is altogether probable that valuations taken at ten-year intervals would give sufficiently accurate adjustment for all practical purposes.

In conclusion, I have to thank the members of the Wisconsin tax commission, Messrs. N. S. Gilson, George C. Curtis, Jr., and Nils P. Haugen, not only for their courteous permission to use much of the material contained in this paper, but for valuable suggestions as well.

JACOB WYMPFFLINGER'S "TUTSCHLAND."

E. K. J. H. VOSS.

It is a strange fact, but nevertheless a fact, that the Modern High German literary language is not the natural development and the continuation of the language which the classic writers of the twelfth and thirteenth centuries used, but that it developed out of the language of the *Middle East* of Germany rather than out of that of the *South*. A glance at a Middle High German dictionary will easily prove this.

We know a great deal about the older Germanic dialects, and also about the twelfth and thirteenth centuries, during which German literature reached its first climax. But the transition period from Middle High German to Modern High German, that is the literature of the fourteenth and fifteenth centuries, has been neglected until recently by Germanists and is in a good many respects an unknown quantity to us still. This period alone, however, can throw the necessary light upon the history and development of our Modern High German literary language.

Since the days when this stupendous task became distinctly clear to those interested in the solution of this most wonderful and interesting phenomenon, a great deal of painstaking work has been done. But at times the hope of ever seing this task accomplished and the problem solved must have been a very faint one indeed. Recently, however, a sister institution of this academy, the Royal Academy of Sciences at Berlin, founded by Leibniz in 1700, has taken hold of this problem in a way that guarantees its final solution.

It succeeded in getting the German emperor interested in this work, and when in 1900 the Royal Academy celebrated its bicentennial, his Majesty augmented this illustrious body of scholars by providing for three new members for the especial study of the German language and literature from an historical point of view. In order to create a broad and safe foundation for this work, a special German Commission was founded in the summer of 1903, to which belong, besides the three Germanists of the Academy, Professors Schmidt, Burdach and Roethe, also Professors Diels, Koser and Dilthey.[1]

This commission has mapped out for its work the following program:

First: To publish and edit, mostly for the first time, important German texts of the Middle Ages. So far, five volumes have been published: "Friedrich von Schwaben," edited by Jellinek; "Rudolfs von Ems Willehalm von Orlens," edited by V. Junk; "Die Lehrgedichte der Melker Handschrift," edited by A. Leitzmann; and "Volks- und Gesellschaftslieder des XVten and XVIten Jahrhunderts," edited by Arthur Kopp.

Second: To catalog all literary monuments written or printed in German up to the sixteenth century, wherever found.

Third: To investigate the history of the Modern High German literary language from 1300 up to Goethe's death. For the present, four volumes are in preparation, relating to the origin and development of the written language of the fourteenth and fifteenth centuries.

In addition to this, the Commission is also in charge of an exhaustive study of all German dialects. The compilation of a Rheno-Franconian dialect dictionary is already under way.[2] It is also the aim of this Commission to furnish us with critical

1 To this commission have been added as non-academic members Professors Franck in Bonn and Seuffert in Graz.

2 This work has been entrusted to Professor Franck of Bonn.

editions of the works of the great writers of the second classical period of German literature, like Wieland, Klopstock, Winckelmann, Justus Moeser and Hamann.[3] The Commission reports from time to time in the proceedings of the Royal Academy, and has just issued a special announcement of the work to be done and the manner in which it is to proceed.[4] This report, which was submitted to the Modern Philological Society of Germany at its last meeting in Hamburg, calls for the co-operation of all scholars and learned societies in this national and patriotic work, which, when accomplished, will be a lasting monument to German scholarship. For all this is only preparatory to a *"Thesaurus linguae Germanicae,"* which some day shall take the place of the great German dictionary begun by the brothers Jacob and Wilhelm Grimm. The dream of this Commission is the final establishment of a permanent Germanic Institute, the members of which shall devote all their time and energy to anything related to Germanic life and culture.

Being myself interested in the transition period from Middle to Modern High German, I collected during my last stay in Germany (1902–1903) some material as an illustration of the German language in the different parts of Germany at the beginning of the sixteenth century. From this I offer the following as a contribution to the study of Early Modern High German. It has, of course, not only linguistic value, but will no doubt be welcome to any one interested in the history of those days.

---

3 A critical edition of Wieland's works is being prepared by Bernhard Seuffert. Cf. his "Prolegomena zu einer Wieland Ausgabe." Berlin, Reimer.

4 "Generalbericht ueber die Gruendung und bisherige Taetigkeit der deutschen Kommission." Berlin, 1905.

INTRODUCTORY.

The question whether Strasburg and the Alsace belong by right to France or to Germany is an old one. It was raised long before the Franco-Prussian war, after which the disputed territory became again part of the German empire. In 1501, the famous humanist Jacob Wimpfeling published a treatise in Latin in honor of the city of Strasburg,[5] in which he proved, as he thought, by the hand of history, that Strasburg always had been a German city.

It was not unnatural that this treatise should call forth opposition at a time when the kings of France were stretching out their hands towards the crown of the Holy Roman Empire (of the German nation). Besides, it was not very difficult to reject some of the rather unfounded historical proofs of Wimpfeling, who, e. g., claimed Pipin as a German simply because his name had become proverbial. The opposition remarked that with the same right King Solomon or Croesus might be claimed as a German. The chief attack upon Wimpfeling's "Germania" came from a man about half his age who had even enjoyed his hospitality, but who had set aside everything (so it appeared to Wimpfeling at least) for the sake of notoriety, and who attacked the older man in a most unmerciful manner. I refer to Thomas Murner's "Germania nova," published at Strasburg in 1502 and republished by Charles Schmidt together with the first part of Wimpfeling's "Germania" in 1874.

Wimpfeling of course replied to this,[6] but not in a very

[5] Cf. Goedeke, "Grundriss," vol. 2, p. 409. "Germania Jacobi Wimpffelingii ad Rempublicam Argentinensem," 1501.

[6] "Declaratio Jacobi Wimpfelingii ad mitigandum adversarium," s. l. et a. 4 Bl.

effective nor convincing manner. Finally, friends came to his rescue [7] and saved as much as possible of his reputation as a thorough, conscientious and truth-loving scholar. His patriotism had no doubt carried him a little too far in this matter. But we must also remember that in this same pamphlet he is pleading for a cause which was very dear to his humanistic heart, namely the establishment of a higher school of learning for the glory of Strasburg. Viewed from this standpoint, his enthusiasm is praiseworthy, but at the same time it becomes easier also to understand the opposition of the friars in this matter,[8] who feared that their prospects for the future might be endangered if the education of the Strasburg youth should pass out of their hands.

Wimpfeling announced, at the same time that his "Germania" appeared in Latin, that a German edition would also be printed. No doubt he was thinking of a larger public than the members of the Strasburg Common Council to whom he dedicated his treatise. This German "Germania," however, was not issued during his lifetime. Probably he became disgusted with the whole affair and in his discouragement desisted from furnishing any further material for an attack upon his person. Towards the middle of the seventeenth century, after Opitz had prepared the ground by his "Aristarchus sive de contemptu linguae Teutonicae," at a time when a new interest in the study of the German language was aroused, when Schottel published his "Teutsche Sprachkunst" (1641) and his "Lamentatio Germaniae expirantis" (1640), when Lauremberg stirred up the German conscience in his "Scherzgedichte," when the "Teutsche Haupt und Heldensprache" was eulogized all over Germany, another patriot of Strasburg, Joh. Mich. Moscherosch, whose name is connected by some scholars with the "Unartig teutscher Sprachverderber" that appeared in 1643, brought to light this German edition of Wimpfeling's

[7] "Defensio Germaniae Jacobi Wympfelingii guam frater Thomas Murner impugnavit."

[8] Cf. "Germania von Jacob Wimpfeling." uebersetzt u. erlaeutert von Ernst Martin. Strassburg, 1885.

"Germania":—"Tutschland Jacob Wympfflingers von Slettstadt, zu Ere der Statt Straszburg vnd des Rinstroms, Jetzo nach 147 Jahren zum Truck gegeben durch Hansz Michel Moscherosch, Straszburg, 1648."

It appeared in the same year that the treaties of Muenster and Osnabrueck were signed and a war was terminated which had almost ruined Germany. The student of history will readily see that Moscherosch had probably more than one reason to call attention to this defense of Strasburg and the Alsace in 1648, one hundred and forty-seven years after Wimpfeling wrote it. He explains at length in his introductory remarks what prompted him to publish the essay at this time and calls special attention to the fact that it is an exact reproduction of the original essay by Wimpfeling.

This reprint follows the original at the Royal Library at Berlin (Rh. 4902). Obsolete words have been explained in the footnotes.

Tutschland

Jacob Wympfflingers von Slettstadt

zu Ere

Der Statt Straszburg

vnd

des Rinstroms

Jetzo nach 147 Jahren zum Truck gegeben

durch

Hansz Michel Moscherosch

Getruckt zu Straszburg bey Johann Philipp Mülben vnd
Josias Staͤdeln,

1648.

Des H. Roͤm. Reichs

Freyer Stat Straszburg

Wol-Edelgebornen, Gestrengen, Edelen, Ehrenvesten, Fürsichtigen vnd Hochweisen

Herren Raͤthen den Ein-vnd-Zwantzigen:

Meinen Genaͤdigen Gebieteten Herren

GEnaͤdige Gebietete Herren. Dieweil eines jeden Ehrlichen Manns schuldigkeit dahien gehet, dasz er all seine Sinne vnd Gedanken, all sein Vermoͤgen vnd Absehen zu Ruhm vnd Rettung des Vatterlands verwende; Alsz werde desto weniger Misdeutens zu befahren haben, wann ich gegenwertiges Buͤchlein, so vor 147 Jahren geschrieben worden, bey jetzigen zeiten herfuͤrgesucht, zu Lob vnd Ehre vnseres Reinstroms, durch offentlichen Truck an tag gebe. Zwar gestehe ich gar gern, dasz, dergleichen sachen auszzufuͤhren vnd zu verfechten, meiner geringschaͤtzigen vnd machtlosen beyhuͤlffe nicht von noͤthen geweszt: In erwegung, von hohen orten hiezu einige Gelegenheiten vnd ersprieszliche Mittel her zu hoffen: Vnd wolte GOtt, dasz von jeglichem solches nur alsz wohl geschehen, alsz billig es geschehen sollen, auch jederweilen geschehen koͤnnen, so waͤre man klagens vnd gefahr desto mehr geuͤbriget gewesen. Dann wie von anbeging her je vnd alle weg Leutte gefunden worden, die es mit jhrem Vatterland nicht auffrecht noch redlich gemeynet; also sind hiengegen je vnd alle weg auffrechte redliche Maͤnner herfuͤr getreten, die vber solche Untreu geseufftzet vnd gejammert haben. Vnder disen ist auch der erste Verfasser dieses Werckleins Herr Jacob Wimpfflinger;

Er schreibet treulich vnd einfaͤltich, redet offenhertzich vnd recht von der sache; Vnd siehet man hierausz, beneben dem hauptzweck, wie vor nun vergangenen anderhalbhundert Jahren, die Worte so deutlich vnd klar, so rund vnd satt, die Rede so kurtz vnd kernhafft gesetzt, das Gemuͤth aber so auffrichtig, so Teutsch vnd thaͤtig geweszt; da hiengegen heutigs tags vile des hohen hoͤflichen Redens sich befleissigen, in der That aber so leiden wenig guts vnnd dem Vatterland vortraͤgliches erweisen. Darumb dann ich des Verfassers wort so fleissig in obacht gezogen, dasz auch meines Wissens oder Willens nicht ein buchstabe davon noch dazu gethan worden. Vnd obschon nach allerseits vorgegangenen weltbekandten aͤnderungen der Zeiten, des Stands vnd Wesens, an jetzo etliches haͤtte moͤgen auszgelassen, oder ja, wie ich mich berede, mercklichen verbessert werden; so hab doch, ausz jezt erzehltem, es vil lieber bliben, vnd dem Verfasser, alsz einem Teutschen Mann, ich seine Meynung, seine Art vnd redliches Absehen vngetraͤhet[9] lassen wollen. Man siehet auch ausz dieser vor anderthalbhundert Jahren im Obern Elsasz geweszten Mund-art, wie die Sprachen von jahren zu jahren, alsz die Kleidungen vnd Muͤntzen, der wechselung vnderworffen; so gar, dasz ein vnfern entsessener Landsmann in vilen Worten ohne erlaͤuterung anstehen, vnd sie kuͤmmerlichen wirde errathen moͤgen. Was solte dann wunder seyn, wann vnsere Teutsche Haubtsprache, seithero bey nahe drey Tausendt Achthundert vnd Fuͤnfftzig Jahren, von der Hebraischen [deren sie vor allen andern sprachen an alter vnd gleichheit alleinig zugethan, vnd minder nicht alsz eine Mund-art derselbigen zu achten war] durch beywohnen vnd Handlungen so vieler von Babbel entwichener Voͤlcker vnd Zungen, nunmehr so ferne abgekommen. Wann aber dises gantze Wercklein ohn meine schlechte rechte Vorsorge, wo nicht gar in das Feuer, jedoch sonder allen zweiffel zu anderem vnguͤltigem gebrauch waͤre verwendet worden; wie dann dergleichen vil herrliche vortreffliche Buͤcher vnd Geschrifften allerhand (in dem der vnsinnig-rasend Poͤfel vnd

[9] Unchanged. Cf. Grimm, "Wörterbuch," vol. 2, p. 1361.

Bauern vor hundert Jahren, bey fuͤrgegangenen aͤnderungen der Religion, vnder dem vorwandt der Moͤnch—vnd Meszbuͤcher, vnd vnder dem schein der Guͤlt-, Jahr- vnd Saalbuͤcher,[10] welchen sie die einige vrsach all jhres Leids vnd Jammers zugeschriben hatten, mit vollem grimm gewuͤthet vnd getobet) im Feuer vnd Wasser zu scheittern vnd zu grunde gegangen, zu staub vnd aschen verbrandt worden, davon in ewigkeit einiger buchstabe nicht mehr zu erstatten, vnnd wir deren mit vnwiderbringlichem nachtheil vnd schaden ermanglen muͤssen: so soll ja billich, was ausz solcher gefahr noch vberig vnd errettet gebliben, oder doch nicht gar zertruͤmmert worden, gleichsam es gefunden waͤre, desto hoͤher vnd waͤrther, so gering es auch vor etlichen augen scheinen moͤchte, gehalten werden: Aldieweil noch immerzu etwas anzeigungen Alt-Teutscher Auffrichtigkeit, auch Bericht fuͤrgeloffener dinge vnd haͤndel darausz zu erlernen vnnd zu erforschen an hand kommen.

E. G. hab ich aber dises Wercklein, wie es ist, ausz underthaͤniger schuldigkeit zuschreiben sollen: vnd, dieweil ja Herr Wimpfflinger selbst, obschon Er dises Teutsche nicht zum Truck gebracht, gleichwol eben solchen ruͤhmlichen Willen zuvoran gehabt, demselben zu volge, beid dises getruckte, sodan auch seine Handschrifft vnd *Original* oder erste Abfassung hinderbringen wollen. In gehorsamlicher zuversicht, E. G. sich dieses alles wohl belieben lassen, vnd mich zu bestendiger hoher gewogenheit so fuͤrterhin genaͤdig werden empfohlen haben. Die der Allerhoͤchste in Anstellungen mit heilsamen Rahtschlaͤgen besegnen, in verrichtungen mit Gluͤckseligkeit auszruͤsten, auch bey fridfertiger Regirung vnd gesundem froͤlichem Alter allergenaͤdigst fristen wolle. Straszburg den 23. Christmonats im Jahre 1648.

E. G.

Underthaͤnig gehorsamer Diener

H. M. Moscherosch.

---

[10] Cf. Schmeller-Frommann, "Bayerisches Wörterbuch," vol. 2, p. 251. *Salbuech*, Verzeichnis aller an eine Corporation gemachten Schenkungen und der daraus fliessenden Renten.

Den Groszmaͤchtigen, Edelen,

Meyster vnd Rath,

der loͤblichen Statt Straszburg,

winscht Jacobus Wimpfling von Sletstat,

Sellikeit vnd Merung des gemey-

nen Nutzes.

VIl sint die do vermeynen, O jr Hochberiemten Rathsherren, vwer Stat Straszburg, vnd andere Stett vff disem gestaden des Rins gegen der Sunnen Nidergang gelegen, etwan gewesen sin in handen der Kuͤnige von Franckrich, dadurch werden dann zu zitten bewegt die gemelten Kuͤnige, zu widerfordrung derselben Land, die doch allwegen, von zitten des Keisers *Julij* vnd *Octaviani,* bisz vff diesen tag, dem Roͤmschen, vnd nit dem Frantzoͤsischen Rich verwant gewesen vnd vesteklich angehangen haben: Als dann Ludwig der Delphin, *Caroli* des sibenden Kuͤnigs von Franckrich erstgeborner Sun, do er *Helvetiam,* so man nembt das Elsasz, In dem Jor Christi Tusent, Vierhundert, Viertzig vnd Vier, vberfiel: vnder andern sins Zugs vrsachen ouch diese fuͤrhielt, naͤmlich dasz er erobern vnd zu handen bringen wolt die Gerechtigkeit des Husz von Franckrich, so sich bisz an Rin (als er seit) vszstrecken wer, vnd vsz solcher vrsach vnderstund er vwer Stat Straszburg zu belegeren.

Diese Irrung ist erwachsen vsz vnwissenheit der alten Historien oder geschribenen Geschichten, vnd wurt solchs waͤnen der Frantzosen bevestigt, dasz ouch wir selbs, solchs faͤlschlich wor sin vermeynen, vnd dasz vil vsz den vnsern mer dem Franckrichschen, dann dem Roͤmschen oder Tuͤtschen Rich geneigt sint. Dann von den vnsern werden zu zitten zu den Franckrichschen Kueenigen Bottschaften gesant, die halb Frant-(A) zosen sint, wann dieselben frueentlich von den Frantzosen entpfangen werden, so pflegen sie denselben liebkosen vnd vergueenstigen, In hoffnung ob die Kueenig von Franckrich dise vnsere Land gewynnen, dasz dann sie vnder derselben Oberkeit etwas Eren oder Wueerden erfolgen wirden, welches doch, so lang die Roeemsche Adler hie herschen werden, sie besorgen nit moeegen erlangen.

Aber ich verhoff, zu lieb vwer Statt vnd gemeynen Nutzes (ob Gott will) moeegen anzeig thun, zum ersten mit worglaeeubiger vermutigung, darnoch mit glaubwueerdigen Gezueegen, zum letsten mit den bewertsten Geschichtschribern, dasz vwer Stat vnd die andern Stett des Rhins, den Frantzosen nie vnderworffen gewesen sint.

Darumb woeellen Ir Fueersichtigen vnd Vernunfftwisen Herren Meister vnd Rat, dise myn vngeschickte arbeit, mit geneigtem gemiet entpfahen vnd mich vch lossen bevolhen sin.

Datum vsz dem Kloster des H. Sant Wilhelmen, in vwerer Vorstatt, vff den xiiij. Tag Octobris M. CCCCC. im Ersten.

DAS ERST BUCH.

Dasz die Frantzosen nit sygen Roeemsch Kueenig gewesen.

KUnt sig allen Tueetschen, dasz von der Zitt *Julij* des ersten Keisers, bisz vff die zitt des Allerdurchlichtigsten vnser Kueenigs Maximiliani, kein Frantzosz ye dem Roeemschen Rich vorgewesen sey. Man lesz das Namenbuch der Roeemschen Kueenig, so finden wir in demselben, antweders Latiner oder Kriechen, oder Tueetschen, aber gantz kein Frantzosen, es sig dann, dasz derselb von sym vrsprung, geburt, vnd vaeetterlichem Blut ein Tueetsch gewesen sig.

Was Lands die Roͤmsche Kuͤnig gewesen sigen.

NAmlich haben die Roͤmschen Keiser jren Vrsprung gehaben vsz Italien, vsz Thracia, vsz Arabia, vsz Hungern, Wyndschen Landen, bisz vff *Carolum* den Grossen, der ein Tuͤtscher gewesen ist vnd von demselben, bisz vff vnser zitt, haben regnirt vsz den aller Edelsten Tuͤtschen Geschlechten, von Sachsen, Beiern, Oesterich, Swaben, Habspurg, Lutzelburg, Nassau, vnd sind nit einen (wan ich glichwol von dem Kuͤnig *Clodoveo* anfoh) Frantzosen ye Roͤmsch Kinig gewesen sin, dann allein die so Tuͤtsch geborn, nochmals vszgetrieben vnd abgetilckt haben etlich vnnuͤtz Franckrichsch Kinig, vnd sie von dem Rich vnd Adel des Lands Franckrich, vsz Baͤbstlicher gewaltsamy, in derselben Stul wunderbarlichen erhoͤht worden sint.

Dasz, zwischen Franckrich vnd dem Ryn, Tuͤtsche Land ein mittel sint.

JUlius der Keiser, noch dem er das Land Frankrich bezwungen, hat er die mit namen vnderscheiden, vnd *Galliam* (das so wir jetzt Franckrich nennen) geheissen, von Nidergang bisz zu dem Rin, dann er wolt die Land mit schiffrichen Wassern vnderscheiden: vnd hat nit geachtet, dasz in mittel zwischen dem rechten Franckrich vnd dem Rin gelegen syg die Hohestrasz vnd das gebuͤrg des Wasichen, durch welche dasselb teil Tuͤtsches Landes, so anstosz des Rins ist, von dem Franckrichschen Land hett doch gemoͤcht vnderscheiden werden.

Ein Vermutigung, die Erste.

VS der Hohenstrasz, so *Austrasia* genembt wurt, ist *Pipinus* (Aij) des Grossen *Caroli* Vatter (als *Blondus* als auch *Robertus Ganguinus* schreiben) buͤrtig gewesen. Dasz aber *Pipinus* nit sig ein Frantzos gewesen, vermut ich darusz, dasz von Jugent vff ich ingedenck bin, desselben Namen in yedermans Red, ouch der Kinder gewesen vnd noch sin, dann es wart brocht gar noh in ein ta^e^glichs Sprichwort, wann etlich zanckenden mit einander redten, dasz sie sprochen, du magst das oder das ding nit tun oder zu wegen bringen, wann du glich werst als wisz als Ku^e^nig Pipis. Deszhalb ich nit glouben kan, dasz die vnsern so dick vnd gemeinsamklich einen Namen eins Frantzosen, sunder eins Tu^e^tschen in iren Leffzen geu^e^bt haben.

Die andere Vermutigung.

ABer *Carolus* der Grosz, *Pipin's* Sun, es sig dasz er in dem Schlosz Ingelnheim, oder in eym dorff by Gu^e^lchern, oder den Lu^e^tu^e^chern geboren sig, ist er doch Tu^e^tsch gewesen, dann er auch Bu^e^cher in Tu^e^tscher Zungen gedicht hat, hat auch den zwo^e^lff Moneten vnd den Winden Tu^e^tsche Namen vffgesetzt, welcher ding ich selbst vast alt vnd offenbar anzeigung gesehen hab. Er hat auch sinen Su^e^nen vnd Do^e^chtern nit Welsch sunder Tu^e^tsche Namen geben, als do sint Hymeltrut, Hiltegart, Adelheit: so doch dieselben Namen by vns etwas verstentlichkeit haben, vnd by andern Sprochen fu^e^r vnerkant oder vszlendisch gehalten werden, darusz folgt, dasz nit vsz Welschen Eltern, sunder von Tu^e^tschen solch Namen erfunden sint, vnd den Kindern vffgesetzt worden.

Die dritte Vermutigung.

CArolus der Grosz hat in Tu^e^tschen Landen jensit Rhins nit allein gemeinklich sin wonung gehaben, sunder ouch doselbs Klo^e^ster vnd Kirchen gestifft, Stett vnd Schlo^e^sser gebuwen, welches niemans gloubt, ist auch nit lichtlich zu glouben, durch einen Frantzosen geschehen sin. Dann *Carolus* der Grosz hat im Rinckow vnd zu Frankfort gestifft vnd vffgericht Kirchen, zu Selgenstatt lyt ein siner Do^e^chter begraben, in Franckenlant ein Slosz, die vsz sym Namen Carlesburg, vnd ein Stat, die Carlesstatt, bisz vff disen Tag genembt ist, gebuwen. Es ist ouch vil Kloͤstern in Swaben, vnd im Land zu Francken gelegen, durch den grossen Carle vnd sin Kind guttat geschehen, als von den Tuͤtschen: dann die Frantzosen hetten ir Gut oder Richtum, in die Tuͤtschen, vber Rinlaͤnder, so verr von iren Landen nit vszgedeilt: vnd zum letsten hat der Grosz Carle ein erlich Begrepnisz Im in Tuͤtschen Landen erwoͤlt.

Die vierde Vermutigung.

ES ist nit glouplich dasz die Frantzosen jensitt Rins in Tuͤtschen Landen Stett oder Buͤrg gebuwen, Herschafft vnd Oberkeit ye gehan haben: dann die Swoben, Beyern vnd Francken, die doch stanthafft Luͤt sint, hetten solchs nit gemoͤcht lyden, dasz Luͤt vsz Franckrich vber Rin zu Inen kaͤment vnd vber sie herschten, do sie doch weder *Julius* noch *Augustus* ye hat gemoͤcht bezwingen. Aber die vber Rinschen Francken, so gegen der Sunnen vffgang gelegen, vnder dem Bistum Wurtzburg, haben in Franckrich regiert. Dann noch dem ein Kuͤnig vsz Franckrich vnnuͤtz zu dem Rich erfunden, durch ein Babst abgesetzt, ward *Pipinus* des Grossen Carles Vatter, welcher dann zu zitten ein Fuͤrweser vnd Hofmeister des Kuͤnig von Franckrich was, an desselben Statt gesetzt als das in dem *Decret* 15. 9. 5. *cap. alius* geschriben stat, ouch andere Historien manigfaltlich anzeigen: Domit bewert wuͤrd, wor sin den spruch des wisen Mans *Eccl.* 10 Eim sinnrichen Knecht werden die Fryen dienen. Deszhalben haben angefangen die Tuͤtschen zu herschen vber die Frantzosen, (Aiij) vnd nit die Frantzosen vber die Tuͤtschen, jo die Tuͤtschen, die eygentlich Francken genembt werden moͤgen, dann solch Tuͤtschland ist etwan *Francia* genembt worden, als dan der heilig *Hieronymus* schribt in dem Leben *Hilarionis,* darzu stymbt *Lupoldus* vnd *Eneas:* darumb soltten die Welschen nit Francken, sunder billicher, vsz Francken geboren, genant werden. Dasz aber die Namen der Land dick gewon sint, verwandelt zu werden, ist ein Gezu^{e}g[11] *Aulus Gellius* im xiij. Buch am sechsten Capittel, vnd ouch *Blondus.*

Der erste Gezu^{e}g.

INnocentius der dritt, in dem Capittel *venerabilem, de Electio.* seit, wie das Ro^{e}msch Rich von den Kriechen vff die Tu^{e}tschen verwent syg, in die Person des Grossen Carles, darusz lutter bewert wurt, dasz derselb ein Tu^{e}tscher gewesen sig: dann ist das Rich vff die Tu^{e}tschen verwent, vnd zum ersten in die Person des Grossen Carles, so musz der Grosz Carle ein Tu^{e}tscher gewesen sin.

Der ander Gezu^{e}g.

DEr Keiser spricht, dasz die Agrippiner, das sint die Ko^{e}llner in nider Tu^{e}tschland, sigen des Italianschen Rechtens, als dann die geschribne Recht haben, *in l. 1. ff.*[12] *de Censibus.*

Der dritt Gezu^{e}g.

AMmianus Marcellinus schribt, dasz der Agrippiner Ko^{e}lln sig ein namhafft Stat in Tu^{e}tschen Landen: deszglichen sagt er ouch von Trier, das er nembt ein kostlich Behusung der Fu^{e}rsten. Witter spricht er also: vnd in dem ersten Tu^{e}tschen Land, on andere Stett, sint Mentz, Wurms, Spir vnd Straszburg.

Der vierd Gezu^{e}g.

VRbanus der ander, Babst, in dem *Concilio* zu *Claremont*, erzehlt in siner Red, dasz der Grosz Carle ein Tu^{e}tscher gewesen sig.

11 Zeuge—authority.
12 First book (liber 1.)

Der fu^e^nfft Gezu^e^g.

ENeas Sylvius in siner *Europa* spricht, wiewol *Carolus,* der Frantzosen Rich vberkummen hab, sig er doch ein Tu^e^tscher gewesen, in Tu^e^tschland geboren vnd erzogen, vnd dasz sin Sitz gemeintlich zu Ach gewesen syg, das do ein Tu^e^tsche Stat ist.

Der sechste Gezu^e^g.

MArcus Anthonius Sabellicus in der Geschicht der Venedyer, gehillt[13] ouch vff ein semlich meynung.

Der sibend Gezu^e^g.

COrnelius Tacitus von der gelegenheit Tu^e^tscher Land, setzt vnder die Tu^e^tschen *Tribotes* das sint die Straszburger, *Nemetes* das sint Spirer, *Vangiones* sint Wormser, *Vbios* das sint die Ko^e^llner nun genant werden.

Vnd ist doch derselb *Cornelius* alt, dann er vnder *Vespasiano* von der gelegenheit Tu^e^tschlands geschriben hat: vnd *Franciscus Petrarcha* spricht, das gantz Rhintal sin das a^e^dlicher teil Tu^e^tsch Landes.

Die History Suetonii, in dem Leben Augusti.

NAch dem *Augustus* bezwang, zum teil durch sich selbs, zum teil durch sin geheisz *Cantabriam,* Aquitanien, Hungern, *Dalmaciam,* mit gantzen Windeschen Landen, desglichen Allgow vnd Beiern, auch die Salassern die Inwoner der Alpen gesweigt, vnd den Inbruch der Dacier, durch niderlag dryer jrer Fu^e^rsten, mit eyner grossen menige, vnd die Tu^e^tschen vber das Wasser die Albe getreib, vsz welchem die Swob vnd

[13] To confirm. Cf. "Bayerisches Wörterbuch," vol. 1, p. 1081, sub *hellen.*

Gellerschen, die sich ergaben, hat er gefiert in *Galliam* (die dann also von *Julio* dem Keiser geheissen was) vnd in die naͤchsten Land an dem Rin gesetzt. Solchs seit *Suetonius,* den die Italen grosz halten, den die Frantzosen nit moͤgen verwerffen, den ouch all Voͤlcker achten worhafft sin.

Darumb von den gezitten doch, *Augusti Octaviani,* sint vff disem vnserm Staden des Rhins, vff welchem vwer lobliche Stat gelegen ist, Tuͤtschen gewesen, vnd nit Frantzosen, darumb ouch dis Land, Tuͤtschland, durch Inwonung der Tuͤtschen, vnd nit *Gallia,* oder Franckrichsch Land, genennt werden soll.

Dohar kumbt, dasz die Roͤmer, als sie zum ersten mit vberwindung der Tuͤtschen, so disem vnserm Gestaden allernaͤchst gelegen, nochmols vber den Rhin sich detten, vnd sahen, dasz die vber Rinschen Luͤtt, mit wildekeit des Gemiets, geradigkeit des Libs, mit schoͤner farb, Gestalt, Sitten vnd Gewonheit zu leben, als die, so vff disem vnserm Staden wonten, sich hielten vnd verglichten, do achten sie dieselben, vnd nembten sie *Germanos,* das ist, unser Brieder. Aber wiszlich ist das die Tuͤtschen sint den rechten Frantzosen weder an farb des Hors, noch Angesicht, noch Zung,[14] noch Gemiet, noch Sitten glich, Jo ouch die Tuͤtschen sint gewont mit geradekeit irs Libs, aber die Frantzosen allein durch viele irs Volcks den sigk zu gewynnen, als dann spricht *Vegecius.* Darumb gar billig, dis vwer Statt, vnd das gantz Land Elsasz (das, als Eneas in *Europa* schribt, *Helvetia* geheissen ist) hat ergriffen die Roͤmsche fryheit, vnd beschirmbt ouch sich selbs, mit sperrung zu fallen in die verargwaͤnigte Dienstbarkeit der Frantzosen, in welche etlich halb Frantzoͤsische Bottschafften (nit sag ich Verraͤtter irs Vatterlands) so zu zitten die vngehorsamkeit der Roͤmschen Kron vfffuͤhren sint, ein freud hetten, vch moͤgen hingetrengt werden, als dann etwan Peter von Hagenbach dise Land vnderstand vnd begert zuzufuͤhren in den Gewalt Carle des Hertzogen von Burgundy.

14 Speech, language, tongue.

Entschuldigung der Gilgen[15] *halb in der Myntz.*[16]

MIch will beduncken etlichen Vynd vwer Statt, oder Veiltrager des Vatterlands bereit sin wider vnz zu baͤllen, als ob die Gilg, so vff vwer Myntz zu schlagen gewon ist, ein anzeigung sin soll einer alten Vnderworfflichkeit deren Frantzosen: dem ich also geantwortet, dasz so du widerbyllst der Gilgen halb, ist ein Murmel des Volcks, vnd in dem Piefelvolck (so gar offt betrogen wurt) geuͤbt, Zeig mir aber ein History, Zeig mir einen Gezuͤgen, wuͤrdig des Gloubens vnd der Worheit, dasz die Gilg durch diser vrsach willen syg in der Myntz vnser Stat, als ob sie vff jr trieg ein alte Herschafft oder Oberkeit der Frantzosen, als ich dir mit bewaͤrlichsten Gezuͤgen vnd Historienbeschriber, die vnwidersprechlich sint, angezeigt hab, vnser Statt Straszburg, zu keinen zitten, den Frantzosen vnderworffen gewesen sin.

Ein Kuͤnig von Franckrich hat dryg Gilgen, vnser Statt allein eine, ein Kuͤnig von Franckrich fiert sin Gilgen in den Panern[17] vnd Schilten, vnser Statt die ir in den Pfenningen: Dann sie hat gar vast ein ander Stritt Paner, naͤmlich ein rote Strosz durchgezogen vnd zerdeilende ein wiszschinende Felt, welche (als ich von eim gar alten gehoͤrt hab) beduͤt ein gross vergiessung des Bluts, so vor zitten vsz Totschlag der Menschen in diser Stat, antweders durch des Gloubens, oder des Roͤmschen Richs willen geschehen, vergossen, vnd durch die Strossen diser Stat als ein Bach oder Wasser geflossen sig. Vnd wann ir (als du vermeynst) ein Kuͤnig von (B) Franckrich, zu gedaͤchtnisz einer vormals gehabten Oberkeit, diser Stat die Gilg verlossen hett, warum hat er sie nit mer, in das Paner vmbzufuͤhren, dann vff die Myntz zu slagen angesehen. Es ist ouch das Zeichen der Myntz nit so alt, dasz es sich zu denen zitten vergliche, in welchen du vermeynst, die

15 Lilies.
16 Coins.
17 Banner.

Franckrichschen Kuͤnig geherschet haben vber dise Stat, dann dise Stat hat vormals ander bildnis in der Myntz gebrucht als Engel, Adler Vettich,[18] welcher noch huͤt by tag vil vorhanden sint, by den Liephabern der alten Myntz. Wie, ob ein Roͤmscher Keiser, der diser Stat nun langst Gewalt geben hat zu myntzen, nit ouch gemoͤcht hab zulossen, ein Zeichen zu slagen noch jrem gefallen? als dann ouch die Roͤmsche Keiser, vil Edlen in Tuͤtschen Landen, etlichen eyne, etlichen vil Gilgen fuͤr Jr Ritterlich Woppen vnd schilt verluͤhen haben. Doch, wie den sachen sig, so ist mir genug, angezeigt haben (als ich verhoff) dasz dise Land, von den Zitten des Keisers *Augusti* die Tuͤtschen, vnd nit die Frantzosen inhands gehebt haben: vnd dasz Carlus der Grosz, der allervnuͤberwindtligst Keiser, nit ein Frantzos, sunder ein Tuͤtscher gewesen, wiewol (wie vor geseit ist) er vber die Frantzosen geherschet hat, von welches Durchluͤchtigkeit vnd groszmaͤchtigen Geschichten wir Tuͤtschen vns billig beriemen moͤgen. Dann als das wore Gesleht *Caroli* vrsprung von den Tuͤtschen gehaben, als ist es ouch in Tuͤtschen Landen bliben bisz vff disen tag, in dryen Allerdurchluͤchtigsten Geslehten, Beyern, Saxen, vnd Oesterich Aber by den Frantzosen hat, noch abgang des Kuͤnig Ludwigs, der Kuͤnig Lotharij Sun was, das Gesleht des Grossen *Caroli* nun langst vffgehoͤrt vnd abgangen, vnd ist Franckrich kumen vff einen Houbtman, genant *Hugo Capucius* oder Zschappeler, den das gemeyn Volck, eins Metzigers [19] Sun gewesen sin, sagen.

[18] Wings.
[19] Butcher.

DAS ANDER BUCH.

Von der Einhellikeit.

DJewile nun mit dem allerbilligsten Rehten (domit wir ioch ouch vnsers langen Gewur [20] vnd Besitz geswigen) Jr Vernunfftwisen Herren Meyster vnd Ratt, das Frantzoͤsisch Joch vnd Dienstbarkeit wol moͤgen abschittelen, So bin ich in guter hoffnung, dasz vwer Statt, wider aller andern, wer ioch die sigen, Vyndschafft, Zusatz, vnd Vffruhr, selliklich wol moͤg bestan, insunders so ich acht, dieselbe vwer Stat gerehtiklich vnd fuͤrsihtlich durch vch regiert ze werden: dann ich hoff dasz vnder vwern Rattsfruͤnden, vnder den Edeln, vnder den Funfftzehen Gbuwherren, vnder den Drytzehen Kriegsherren, ouch den andern Meyster vnd Schoͤffen des Volcks vnd Gemeyn, Einhaͤllikeit gehalten werd, Durch welche, kleine ding gruͤnen vnd vffwachsen, so durch vnhaͤllikeit ouch die maͤchtigsten ding zerstroͤwt vnd zerruͤtet werden: Als wan vnder vch nit synt Parthien, nit Anhaͤng, nit Widerwertigkeit, nit heimlich Nyd, welche wo sie vberhangk nemen, ist es geschehen vnd vszgericht, vmb Kuͤnigrich, vmb Stett vnd allen offnen Nutz: Aber ich vberslag in mir selbs dasz vsz lieb des gemeynen Nutzes, jr all Einhaͤllikeit vnd gantze Liebe zusamen tragen vnd gegen einander haben.

Von Lieb des gemeynen Nutzes.

DAnn ein vffsehen vnd Lieb des gemeynen Nutzes,[21] ist ein band, zu behalfftung oder vffenthalt einer Statt, solchs ist vch nott zu haben, so offt vnd dick jr zusamen berieft, vnd in den Ratt kumen, dasz ir, vwer eigne Geschaͤffdt vergessende, allein sorgen die gemeinen haͤndel. (Bij.)

20 Cf. "Bayerisches Wörterbuch," vol. 2, p. 971. Ghewere—justa possessio. Eines Gutes in geruwiger bessesse vnd gewerde sein.

21 Common weal.

Von Fuͤrsichtikeit des Kriegs.

DArusz erwechszt, dasz Profand[22] vnd die Schatzkammer vffwachsen, vnd die beharr-ader des Kriegs (das ist bar gelt) gemert wurt; dann on Gelt vnd Profand moͤgen die Krieg nit beharret werden, als das vermutigt werden mag von vilen, die vsz anreitzung jrer smeichler sich zu kriegen bald vberreden liessen, wo nit Koch, Keller, Seckelmeister vnd Spichermeister mit iren Raͤtten vnd beklagung solchs hinderten vnd darwider werent.

Von vermydung zuvil Stoltzikeit.

DOch soll man sich weder von gemeynen noch eigenen Schaͤtzen vnd Richtum vberheben, dann vsz solchem beriemen, vermaͤrt die Torheit sich selbs, Hochfart streckt jr horn vff; Demut wurt vndergetruckt, Gott wurt erzuͤrnt, Nyd vnd Widerwertikeit der vszlaͤndigen vffbewegt, vnd zum letsten, vaht an [23] ze swancken oder abgon der gemeyn Nutz.

Von Fruͤntschafft der Nochgeburen.

DAnn es ist vast nutz zu heil den Burgern vnd Stetten, Nochburen haben, es sygen gemeyne Voͤlcker, oder Fuͤrsten die wol gynnend [24] sint, dann es ist im Sprichwort, mit Nochburen richt man die Schuͤren vff. Der Fuͤrsten fruͤntschafft ist zu suchen vnd anzenemen, aber doch nit gantz in derselben allein soll die hoffnung der sicherheit vnd des heils gesetzt werden, ouch nit zu vesteklich daruff sich zu laͤnen, von wegen der grossen vile der Smeichler die dann die Durchlichtigsten vnd allersaͤnfftmuͤtigsten Fuͤrsten verfuͤren, vnd sie lichtlich vberreden, die Stett des Richs sigen

---

22 Provisions.
23 Begins.
24 Well meaning.

zu vil Rich, man soͤll sie angriffen vnd bekriegen vnd das ir naͤmen, dasz also durch roub vnd nom [25] die rich werden moͤgen, die das ir mit Fuͤllen, Spiel, Bulschafft, Liederlicheit, Hofiern, Mutwill, Stechen [26] vnd Durnieren, oder sonst vppeklich verton haben. Dise Smeichler vnd sanfftrabende vynd sagen den Fuͤrsten nit, dasz die Stett sigen die hochschinenden Glyder des Richs, das sie sigen die edeln Doͤchter der heiligen Cristenheit, vnd ein vffenthalt des gantzen Vatterlands, ouch ein sunder zuflucht der Fuͤrsten: by welchen Stetten (wo not geschieht) Gelt vnd Profand (ouch etwan zu entlehend) vffbrocht werden moͤgen: Sie sagen den Fuͤrsten nit, dasz in den grossen Stetten des Richs, beider gesleht Menschen funden werden, die vsz reinikeit irs Lebens, vnd heilikeit irs Waͤsens, Got (von dem alle Vberwuͤntnisz kumbt) angenaͤm sint. Gar vil anders achtet der allerfromst vnd sighafftigst Fuͤrst von Beiern, Hertzog Fryderich Pfaltzgrave by Ryn, des yetzigen Hertzog Philipsen Vatter Bruder, dan derselb die fruͤntschafft der Stett gar hoch achtet, als er ouch nit klein fruͤcht vnd bystant von inen hat entpfangen, dann er wust dasz Burger vnd das Volck nit durch des Fuͤrsten willen, sunder den Fuͤrsten durch des Volcks vnd Burger willen erwoͤlt sint, vnd dasz er ouch den Stetten des Richs pflichtig waͤr, hatt er kein zwifel an, so die wile er ein Fuͤrst des Richs was, so die wile vnd er ouch ein Cristlicher Fuͤrst, der zu nutz vnd friden der Cristen sich zu flissen verbunden was: vnd wiewol er kein Stat des Richs verachtet, so seit man doch das er vfft gesprochen hat, er sig mit einer gutten vnd starcken Muren vmbzogen vnd bewart, so lang er von Vffgang, Nierenberg, vom Osterwind vnd Mittemtag Straszburg, von Nidergang Spyr vnd Wurms, von Mitternacht Koͤlln, ihm wol woͤllen hoffen moͤcht: ein vernuͤnfftig vnd redlich Vrtheil, eins allerfuͤrsichtigsten vnd vffrehtigsten fuͤrsten, fuͤrwor, den durch sin fuͤrsihtikeit die smeichler nit moͤchten betriegen, vnd dem, durch siner Gerehtikeit vnd Andacht willen, alle Roͤuber

[25] Capture.
[26] Sport.

haessig waren, von dem sie ouch allenthalben abgetilckt wurden. (Biij.)

Von der Gerehtikeit gegen den Vszlaendigen.

ABer solcher Blut sugenden aeglen[27] strick mag ein Stat nit basz entrynnen, dann so sie Gerehtikeit vnd Billicheit lieb hat, vnd gantz niemans gewalt geschehen leszt, domit die Vffsetzer vnd begierigsten des froembden guts, so etwan ein vrsach zu kriegen von eim Zun zebrechen vnderstan, kein farb noch schin, einer redlichen klag haben moegen, deshalb es ettwan not ist, pacientz, Gedult, nit woellen wissen, gut Wort geben, vnd Senfftmuetikeit zu halten gegen den vszlendigen oder froembden, die etwan gern sehen vnd begertend dasz inen ein smoch oder gewalt geschaeh, domit vsz kleinem widertriesz,[28] oder vsz entpfangenem schaden eins Pfennings, sie mit jrem anhang ein gantze Stat vnd Vatterlanl verwuesten moechten: dardurch dann die herlichen Land vnd grossen Stett, zu widerwoer vnd sich zu beschirmen, vast mercklichen swaeren kosten zu haben getrengt werden, vnd sint doch von den allerverlorensten Lueten keinen gewyn dargegen wartten, es sig dan dasz du achtest einen grossen gewyn sin, eim schaentlichen moerderschen Buben sinen schoebigen [29] Kopff abzehowen.

Von der Behaeblicheit[30] zu der gemeynen Schatzkammer.

ES soll ouch ein yeder Fuerwaeser oder Pflaeger des gemeynen Schatzs ihm nit mynder lossen leit sin, soll ouch nit mynder sich hietten, von der gemeynen Schatzkammer Goldt oder Silber vszgeschittet oder verliederlicht ze werden, dann ob er vsz sym eigenen Seckel zu verderplicheit sins Vaetterlichen Erbs, oder zu mynderung sins eigenen Guts, zu vffenthalt sins

27 Leech.
28 Grievance.
29 Cf. "Bayerisches Wörterbuch," vol. 2, p. 354, sub *schebig*, worthless.
30 Economy.

Lebens, etwas vszgeben genoetigt wuerd. Es soll ouch ein yeglicher gedencken vnd in sym gemiet ihm fuersetzen, als ob in eym yeden Geschaefft einer Statt, do man ettwas anslagen [31] oder ratten sol, sin eigene sach gehandelt wuerd: also dasz er nit mynder vff gemeynen offenen Nutz vnd Ere der Stat, dann als ob sin selbs, siner Kind, vnd alles sins Geslehts sach gehandelt wuerd: jo so vil mer soll eim yeden der gemeyn Nutz anmuetiger vnd begirlicher sin, so vil an solchem gemeynen Nutz, Heil vnd Vffenthalt mer vnd vil Menschen hangt: dann ein yeglichs Gut, so vil es gemeiner ist, so vil ist es Heiliger, so vil ist es auch Goettlicher, dann an dem ist die lutere Lieb, an dem wurt die veste Truw zu dem gemeynen Nutz bewaert, dovon dann allermeyst heil vnd zunemens hangend ist. Solche Dapferkeit, solche Stanthafftikeit, solche Frumkeit, solche Truw, solche Vffrehtikeit zu dem gemeynen Nutz, hat die alten Roemer vffbracht, vnd sie noch jrem Tod vndoetlich vnd durchluechtig gemacht, dann sie gloubten durch ein solchs inen ein gewisse Statt by Gott in dem Hymel berachtet [32] sin; dargegen denen, die zu zerstoerlicheit des gemeynen Nutzs vnablaeszlich betrugnusz geuebt hetten, achten sie den weg zu dem Angesicht Gots verschlossen sin.

Von der Gerehtikeit in der Stat.

ES ist ouch nit genug, dasz ein Stat gereht sig gegen den froembden, jo ist ouch not dasz inwendig den Muren, zwischen den Mittburgern die Gerehtikeit der schnur noch gehalten werd, das nit die gewalttigen den myndern, dasz nit die Richen den Armen, dasz nit die Edelen den gemeynen Man, in einichen weg, nit allein nit vndertrucken, sunder ouch nit zu versmohen oder verachten vnderstandent, vnd dasz kein Stadt den andern zu vertrucken oder zu myndern such.

---

31 Propose.
32 Martin translates: bereitet—prepared; berachtet, berechtet—entitled to.

Von dryer hand Stadt,[33] *so in eyner Stat notturfftig sint.*

DANN noch dem zu gezier des Richs, zu Ere des Fuͤrstenthums, zu fuͤrtraͤfflicheit einer Stat, dryg Staͤdt notturfftig sint, der Geistlich, der Ritterlich, vnd der Burgerlich, so haltten sich alle ding wol, wann ieder in sym Stadt fridlich vnd geruwlich lebt, vnd durch den andern nit wurt durch Vngerehtikeit geletzt. Aber der Hellsch Hunt, der Tuͤfel (durch welchs Hassz willen der dot ingangen ist in den vmbkreisz der Erden) der den Friden vnd Einikeit mit hoͤchstem nyd verfolgt, der hoͤrt nit vff zwischen den Menschen diser dryer Staͤdt zu saͤgen,[34] Vnhaͤllikeit, Vffsatz, heimlich Vyntschafft, mit fuͤrhalten vnd vberreden, dem einen, als ob die andern zwen Staͤdt zu vil guts hetten, in mossen, dasz niemans sich sins wesens ader Stadts beniegen[35] loszt, sunder sucht dem andern ze schaden, also entspringt dann Hassz, also murmeln, also hinderredung, also ein begirlicheit froͤmbdes Gutes taͤglich im Rich, in Fuͤrstenthuͤmen, vnd in den Stetten: die Rittermaͤssigen vnd die Burger murmeln wider die Geistlichen dasz sie muͤssig gangent, dasz sie nit arbeiten mit der Hend vnd naͤmen doch in grosse Guͤllten vnd meinen die Geistlichen besitzen on arbeit grosz Gut, darumb murmeln sie vnd sint inen nydig, vnd will sie beduncken der Geistlich Stadt gantz vnnuͤtz sin. Dargegen etlich Edlen, duraͤchten[36] beyde Staͤdt, den Buͤrgerlichen vnd den Geistlichen mit hassz vnd verachtung, vnd in gegenwart der maͤchtigen, oder vnder jnen selbs hoͤren sie nit vff zu murmelen, wider das Gluͤck, Ruw, vnd Richtum beyder Staͤdt. Diser Hassz, disz murmelen verderbt allen gemeynen nutz der Christenheit, zerstroͤwt Tuͤtsche Land, vertruckt die Priesterschafft, macht vngeruͤwig[37] die Stett, vnd schafft der Tuͤrcken vnd Heiden Macht gemert

[33] Estates, classes.
[34] To sow.
[35] To be satisfied with.
[36] Persecute.
[37] Unsafe, unruly.

zu werden. Solche zweytracht zwischen den Menschen vnd Parthien des gemeynen Waͤsens,[38] ist glich als in eym menschlichen Lib, wann desselben Glyder sich selbs vnder einander zerzerten, nagten, zerryssen. Aber kuntlich soll yederman sin, dasz diese Staͤdt alle in eim gemeynen Regiment zu sin, glich als an eym Lib vil glider, notturfftig sint: Der Geistlich Stadt als die Ougen: der Ritterlich Stadt als das Hertz oder Magen: der Burgerlich Stadt als die Hend: deszhalb der Burgerlich wider den Geistlichen Stadt nit murmelen soll, als ob derselb fry wer von der arbeit der Hende, dann er hat ein ander Ampt, naͤmlich sin heilige Opffer, Gebett, Gesang, Sacramenten, Kunst, Lehr, Ratt, Danckwuͤrckung gegen Gott zu volbringen, vnd geschiklich zu machen zu guten Wercken, durch welche wir zu dem end, zu dem wir geschaffen sint, kumen moͤgen: welches Ampt dieweil der Geistlich nit moͤcht volbringen, wann er ouch mit sinen Henden zu wercken gezwungen wer, So ist not, dasz der Ritterlich vnd Burgerlich Stadt, zu vffenthalten, vnd mit iren Guͤllten zu hilff kum, ouch den Zehenden vnd nottwendige nutzlicheit hantreich. Des Ritterlichen Stadts Ampt ist, die Beschirmung an sich ze nemen, Friden machen vnd Ruw. Der Buͤrgerlich Stadt soll behilfflich sin vnd darbieten die ir handreichung des Gelts. Vnd wann dann also yeglicher ein vffsehen hat vff sein Ampt, vndertruckende das hellsch gifft vnd inblasung des Tuͤfels, so moͤgen alle ding fridlich vnd vffreht in offenem waͤsen geregirt werden. Es mag ouch also der Geistlich Stadt in siner bluͤst[39] beston, wann den so Geistlich werden woͤllen, oder durch Liebe Gotts in eyn Kloster gohn, ir angebuͤrlich teil oder vaͤtterlich Erb nit abgeschlagen wurt: wann der Letst will der Priester oder Burger nit verhindert: wann erbern Frowen vnd Wittwen nit wider iren willen Voͤgt geben werden: wann mit Zoͤllen, Vngaͤlten, Schatzungen vnd vnzimlichen Erforderungen, on verwilligung vnd zulasz eines Bapsts, die Priesterschafft nit beswaͤrt, sunder die geistliche Fryheit

[38] Commonwealth.
[39] Floss, bloom.

gantz vnzerbrochlich gehalten wurt: So die gaben zu den Spittalen der Armen, vnd zu den Gebuwen (C) vnd gezierd der Kirchen von den miltten Kristgloͤubigen dargeben, nit werden in ander gebruch verkert: wann Dottschleg, Eebruch, Diebstal, vnd andere grosse myszhaͤndel mit *dapferer Busz* gestrofft werden, dann Stroff ist ein meisterin vnd vffenthalt[40] des Fridens: Dann was ist nuͤtz, vszwendig streng ze sin, wann man vbel lebt im Husz? dann ob glich wol vil Stett erfochten, vil Voͤlcker gestrofft, vil Rich mit der hant erobert wurden, es wer dann dasz an Gericht vnd Reht zimlich ampt vnd schamhafftikeit bestont, so mag der Huff der eroberten ding, wann er glich wol an den Hymel reicht, kein bestaͤndigen sitz behallten, als spricht der nammhafft vnd aller Historien zusamen leser *Valerius.*

Von Fuͤrsiehtikeit.[41]

NIt mynder ist nochmols Fuͤrsiehtikeit zu heil einer Statt als notturfftig, als do ist die Gerehtikeit, es sig dann dasz der Meister *Plato* falsch geschriben, oder dasz Salomon gelogen hab.

Etliche eins fuͤrsiehtigen Rattsherrn Eigenschafft.

ZV Fuͤrsiehtikeit eins Rattsherren oder Meyster gehoͤrt, dasz er wiss dasz er trag die Person der Statt, vnd dasz er schuldig sig derselben Wuͤrde vnd Ere vffenthaltten, die Gesatz zu handthaben, die Recht vszzeteilen, vnd zu gedencken, dasz dieselben sinem vertruwen bevolhen sygen, Kunst vnd Wiszheit nit zu verahten, Goͤttlich vnd menschliche Gesatz zu ervorschen, nit vff sin eigen Houbt sich zu verlossen, Gebruch der andern Stett zu wissen, in Staͤdtlichen vnd Burgerlichen dingen die Gelertten der Reht zu fragen: Aber in

---

40 Preserver.
41 Wisdom, prudence.

den ha^e^ndeln dar durch Gott erzu^e^rnt, der na^e^hst Mensch beleidigt, die bru^e^derlich Lieb gemyndert, die Conscientz verwundet, vnd die Sele verderben mag, soll er Gelerten der heiligen Geschrifft rattsfragen: Heimliche Ra^e^t soll er ha^e^len, vnd niemer brechen verswigene ding, das ist das allerbest vnd sicherst bandt der verhandelten dingen. Von den Fu^e^rsten soll er ersamlich vnd ma^e^szlich reden: by dem Ro^e^mschen Stull vnd Keiserlicher Majestat soll er allzit getruw Fru^e^nd haben: Gest vnd zukumend Lu^e^t soll er fru^e^ntlich entpfohen: eym yeden (ouch den fro^e^mbden) Reht[42] sprechen, vnd das andertheil ouch ho^e^ren, keinen lihtlich anfallen, oder bald glouben schuldig zesin, ouch nit bald in Gefengnisz oder zu dem Tod zegeben: synen Vyndt nit zu vast vo^e^rchten ouch nit zu vil verahten: den Gelertten vnd den Edeln, die dem gemeynen Nutz, ioch ouch vmb soldt dienen, vorgeben: vnd die Kunst, ouch den Adel, so hoch schetzen, dasz sie sygen ein Ere der Statt vnd des Ratts: dann die Ere wurt dem zugeleit, der sie eim andern erbu^e^t.

Von Ja^e^rlichen Geschiehten.[43]

ES stott ouch eim Fu^e^rsiehtigen Ratt zu, dasz er alles das, so wu^e^rdig ist der Geda^e^htnisz, so in der Statt, in dem Land, im ganzen Rich geschieht, eigentlich in Cronickbiecher, vffzeschriben bevelhe, vnd also durch vffzeichung der geschrifft zu erkantnisz der nochkumenden zu behaltten, domit die Va^e^tter solchs kunt trigen iren Su^e^nen, vnd dasz ander Geschleht solche ding vermerck: solchs will mich beduncken vast dienen vnd nutz sin, zu Ere, zu Fruht, zu anreitzung das gemiet der Jugent, zu vermutigung ku^e^nfftiger zufa^e^ll, zu eym fundament einer kunfftigen Betrahtung, zu behaltnisz der Gerehtikeit, zu verwerffen der Vngerehten gedat, vnd klag der nochvolgenden[44] Welt, zu erzelen eim yeden oder sinen Vorfaren angehengte

[42] Original: Rept (misprint).
[43] Yearbooks, annals, chronicles.
[44] Original: nochvolgengen (misprint).

Guttat oder Dienst, zu beschirmung der Fryheit, zu hanthabung der Privilegien von Ba^{e}bsten vnd Keisern gegeben, zu Kriegen vnd zu Friden des gemeynen Nutzes.

Ein mittliden mit den groben Vngelertten.

ES ist zu verwundern vnd fu^{e}rwor zu erbarmen, dasz ettlich gemeyn Volck also erblendt ist, dasz sie solchs so sie nit ku^{e}nnent, als do sint all a^{e}delich frye Kunst, Historien, Keiserlich Gesatzde so zu Latin geschriben sint, nit mynder dann der Tu^{e}fel die zeichen des heiligen Kru^{e}tzes verdammen, verahten, verfluchen, vnd von der Lehr derselben wenden sie ab, sie myszratten vnd verfu^{e}ren vil Va^{e}tter, dasz sie ir Su^{e}n nit geben zu Kunst der Wiszheit, der geschribenen Rehten, zu gutten Sitten, zu Historien, oder zu der heiligen Geschrifft. Solch hasser vnd verahter aller gutter Ku^{e}nst mo^{e}chten ettwan basz vrteiln vber Geiszfa^{e}ll vnd Swynen hu^{e}t; dann vber die edelsten Bu^{e}cher vnd aller kostbarlichsten Geschrifften. Solche Vynd, sprich ich (o ir Fu^{e}rsichtigen Rattsherrn vergunnend der Eren vweren Kindern) sie haben lieber sich selbs vnd ir eigene Ere, dann das heil vwers gemeynen Nutzs, oder das vffgond vnd zuna^{e}men vwer Statt.

Die Nutzbarkeit
der Latinischen sproch.

WEr es nit wa^{e}ger,[45] wer es nit erlicher, wer es nit loblicher dasz vwer Su^{e}n, die doch gut scharf vernunfft haben, noch die wile sie iung, on bartt, vnd vnder iren Joren weren, wu^{e}rden zu den Latinischen Bu^{e}chern gethon, in welchen sie die alleredelste sproch lertten, domit sie die fro^{e}mbden Bottschafften, Bischo^{e}f, Cardina^{e}l, vnd wo nott wurd sin, den Babst selbs ansprechen vnd mit im reden mo^{e}chten ouch die Priester,

45 Better.

so sie miteinander redten, die Evangelisch Historien, vnd anders so in gottlichen aͤmptern gelesen wurt, verston, vnd eym Priester antwurtten, vnd, noch gewonheit aller Walhen, mit demselbigen vor dem Alttar ire Conscientz reinigen moͤchten. Ich sprich die Latinischen Buͤcher, in welchen Wiszheit, Gerehtikeit, Lieb zu Gottsdiensten, Fuͤrsiehtikeit, ein sellig Regiment eins gemeynen Nutzs, die redlichen Keiserliche Gesatzde, Historien vnd Geschihte der altten, gut Sitten, die schinbaren Tugenden, die vrsachen der Natuͤrlichen ding, die maͤssigung vnd Gebuͤrlicheit der scharffschnidenden geschribenen Rehten, die Ritterlichen kunst vnd bereitschafft zu kriegen vsz sugen moͤchten: vnd dasz, so sie zu Mann wuͤrden, die Bottschafften vnd Gesanten in der versamelung des Richs verston moͤchten: oder dasz sie doch in iren eigenen haͤndeln die Latinischen Redner verston vnd begriffen, ouch worlich wissen moͤchten, ob die Latinischen Grabgeschrifften, so Jnen oder den Jren gemacht wuͤrden, gebresten hetten, dasz nit, fuͤr ein Vesten oder Strengen,[46] ein Wolgeborner vff ein Grabstein gehowen wuͤrd: Ouch dasz sie kunten die vmbgeschrifft der Myntzen lesen: vnd inen nit verborgen wer, warumm die Kloͤster Sant Johanns vnd Sant Niclaus in *vndis,* das ist zwischen den Wassern, genembt weren vnd nit vnschicklich dieselben, zu den Hunden, in duͤtscher Sprach nanten, dann also sint, vsz vnwissenheit der Latinischen Sproch, vil namen der Stett verkert vnd vbel verstanden worden: als dann die betrogen werden, die die letsten end in Hispanien gesehen haben, so das Latin nembt *Finis terrae,* vnd wann sie har wider kummen, beriemen sie sich, sie sigen zu dem Finstern Sternen[47] gewesen, vnd verstont nit, dasz *Finis terrae* heiszt, zu end der Welt: als ist ouch in den Alpen ein Flecken, genant *Inter lacus,* das ist zwischen den Seen, nembt man hinder Lappus[47]: als ist die Kirch Sant Peters zwischen Molszheim vnd Sultz genant *Domus* Petri, aber die Ungelertten nennen

---

[46] Refers to the way of addressing people according to their position in life.

[47] Folk etymologies.

das Donpfiertren,[47a] So doch verr[48] von der Latinischen Sproch, mit welcher sie zum ersten genant sint, entfrembt worden.

Von einer Vaehtschul,[49] darinn die Kind, noch dem sie die ersten Ruchwerck der Buchstablichen Geschrifft ergriffen, gelert wuerden, anzesehen.

ICh sprich, wer nit waeger vnd besser, vwer Suen, die zu vnzitten vsz den Kintlichen Schulen genomen werden, so sie noch kum die ersten Buchstaben lesen kuennent, dasz dieselben ioch ein fuenffjaerig zit, oder doch dry Jor lang, in ettlich Schulen gesendet vnd gegeben wurden den fryen Kuensten? Welches ouch in vwer Statt on allen kosten des gemeynen Nutzs, wann allein ein Husz dazu gefryet wer, vffgericht werden moecht: disz wer besser, dasz sie also in irem Vatterland, by iren Fruenden, mit kleinem kosten, mit kurtzer doch nutzlicher anwisung, geschickt werden moechten nochmols zu den hohen Schulen, oder villiht gen Rom, zu eym geistlichen Stadt, zu eim ampt eins Notarien oder Schribers, zu froembder wandelung der Kouffmanschatz noch, zu dienst eins Cardinals, jo zum letsten, Ratt ze geben in dem Ratt: fuerwor besser wer es, dann dasz vsz zuvil nochlossung, (ich gethar[50] nit sagen Versumnisz) irer Eltter vnd Verwanten sie gelossen werden, Vogeln, Prassen, Muessiggon Spielen, Hor pflantzen, mit boeser beider gesleht Gesellschaft zerstoert, ver fiert vnd verderpt werden. Vnd domit man nit gedenck, dasz disz diene zu schaden vnd abbruch der andern Schulen in den Kirchen vnd Kloestern, will ichs also gemeynt haben: dann in dise nuwe Vaehtschul soltten nit on vnderscheidt alle Kind vffgenomen werden, sunder allein die Jhenen, die ettlich Jor ander Schulen vorhin gesucht hetten, vnd die in dieselben

47a Folk etymology.
48 Far.
49 Higher school of learning.
50 Dare.

fu^e^rter nit gon wu^e^rden, sunder verlossen werden, mu^e^ssig vnd in mutwill hie vmb zegen, vnd verderbt zu werden, oder die zu andern fro^e^mbder Stett schulen mit grossem kosten der Fru^e^nd geschickt, oder zu vil fru^e^g zu den Hohenschulen geleit werden, in welchen, die wile sie noch nit gantz Latinisch vnd *Grammatici* sint, deshalb nit haben ein vest grund vnd fundament, vohen[51] sie an zu ho^e^ren die hohe Kunst *Aristotelis,* oder die Keiserlichen Reht, vnd bliben also alle ir zitt des Lebens vngeschickt, dasz sie niemer by den Gelertten vnerschrocken reden ku^e^nnen, durch vnwissenheit der rehten Latinischen Buchstaben, vnd durch mangel des woren grunds der Latinischen Zungen.

Also mag vsz solchem ansehen eine nuwe Va^e^htschule gar kein schaden den Schu^e^len des Mynsters oder ander Stifften erwachsen, dann myns Gemu^e^ts nit ist, einichem Menschen zu schaden, oder yemans beleidigen wo^e^llen, vnd gar vil mynder die Schulmeister, myn sunder guten Fru^e^nd vnd wolta^e^ter. Es ist ouch nit zu besorgen, dasz vsz einer solchen Va^e^htschul die zall der Pfaffen vester gemert werd: dann in diser Schul wurd man allein leren die Geschrifften der Wolredenheit, die Sittlichen bu^e^cher, vnd die Historien oder Geschihten, welche nit allein eim Geistlichen, sunder gar vil mer zu eim Bu^e^rgerlichen, zu eim Ritterlichen, zu eim Rattsherschen stadt nutz ze sin geachtet werden mo^e^gen: vnd wie wer ihm, wann glichwol vsz diser heilbaren vffsatzung oder ansehung, mer dann bisz har, vwer Statt Kind zu der Geistlichkeit geschickt gemacht wurden? fu^e^rwor es ging dardurch einr Statt weder an Eren noch an nutz etwas ab, wann die Pfru^e^nden, so von Keisern, von Bischo^e^fen, so von Edeln vnd von Burgern in diser Statt etwan gestifft vnd begabt sint, vwer Kind vnd Kindskind nochmols vberka^e^men, nit mynders dann dasz vsz andern Stetten vnd Landen, io fro^e^mbden Zungen geboren, wir biszhar gesehn haben, sich darzu flissen vnd schicken, vnd darusz leben, vnd iren Fru^e^nden vnd Verwanten ouch diensten

[51] Begin.

darmit woltun vnd nutz sin. Vnd domit nit zu besorgen wer dasz die Jungen so in diser nuwen Vaͤhtschul durch vsserwelte Meyster zu leren gesetzt, des Gesaͤngs gantz vngeuͤbt bliben wurden, moͤhten sie an eym Fuͤroben das Gesang des mornigen Tags vbersingen, vnd lihtlich vff einen Sontag oder andere Fuͤrtag zu eym gebruch vnd vͤbung des Gesangs zu vberkumen, in der naͤhsten Kirchen by solchem Husz zu dem Fronampt[52] zu singen die Meyster mit den Schulern zusamen kumen.

Ein Ebenbild der Fuͤrsten

vnd ander Stett.

ICh bitt vch, aller Erentvesten Rattsherrn vnd Magistraten, volgen noch *Phillippo* dem Kuͤnig von Macedonien, volgen noch vil mer den Allervnuͤberwindtlichsten Keisern, volgen noch den edeln Fuͤrsten, Grafen, Herren, Rittern vnd Knechten, deren ich vil erkant hab, jo ouch vil erlicher Stett duͤtscher Land Fuͤrsiehte Burger, die ir Kinder zu der heilsamen Ler der Geschrifft zugeeignet haben, volgen mer denselben noch, vnd verahten die dorechten anschleg der nydeschen Menschen, vnd geben ouch vwer Suͤn zu lernung vnd vnderwisung der guten Kuͤnsten, dasz sie die edelen Geschrifften lernen, zu gezierd jrer Selen, zu vffwachsung der Tugenden, zu vwerm Trost, zu heil vwerer Stat vnd des gemeynen Nutzes, vnd zu lob vnd ere vwers gantzen geslehts, zu erfarend die Erkantnisz ir selbs, vnd der vndoͤtlichkeit[53] der Selen, zu bevestigung des Gloubens, zu bestaͤtigung des Gotsdienst, zu ewigem Leben mit vch lihtlicher zu erfolgen.

---

52 Mass.
53 Immortality.

Von schaden des Muͤssiggonds vnd Vngelerykeit.

WAs werden doch vwer Suͤn tun, so sie aller Geschrifft vnwissend sint, vorusz so sie nit der Ritterschafft nochgondt oder die kein Kouffmanschatz, oder ander gewerb hant tieren? Ich sprich, was werden oder kunnent sie anders tun alle zitt jrs Lebens, dann anhangen dem Muͤssiggon, dem Spiel, dem Schloff, dem Zeren vnd Fuͤllen, als weren sie geboren allein korn zu essen, schamhaffte Doͤhter vnd erbere Frowen anzevehten vnd zu beflecken, dann welche suͤnd ist zu deren dasz muͤssiggon nit anreitzt? Nit sollen waͤnen vwer Suͤn, das sie von Gott in dise Welt gesetzt sygen, dasz sie allein dem Jagen, allein dem Vogeln anhangen, vnd dasz sie sigen Knechtsknecht, das ist, der Falcken vnd Habich diener, so sie dieselben Vogel mit vermuͤdigung der Arm, vnd vorht zu beschissen der kleider, tragend sint: nit volgen vwere Suͤn den schnoͤden vnd allerburischten Luͤten, die sie von Ler der Geschrifft vnzittlich abzuziehen vnderston: welche heimliche Vynd sint jrer Eren, welche fuͤrwor sint Widersaͤcher einer gantzen Stat, vnd ein gifft des Vatterlands, nyder der Tugenden, fruͤnd der lastern, gruͤnder des muͤssiggonds, anreitzer der geylikeit,[54] stupfer der vnluterkeit, vnlydlicheit der Jugent anzuͤnder, verlierer der Selen, schiffbrecher des Heils, verderber der Knaben, vnd des Gemeynen nutzes zerstoͤrer, die fuͤrwor nit wissen, was Fruht, was Lust, was Ergetzlicheit, was Eren vsz erkantnisz der Latinischen Geschrifft vnd Buchstaben entspring. Ich bitt verziehen mir, aller Fuͤrsiehtigsten Herrn die Raͤt, vnd ir aller Erbersten Burger, dann ich winsch, ich beger, vnd hab liep (als ich von mynen jungen Joren allzit liep gehept han) den nutz vwer Kind, vnd das heil vwers Gemeynen nutzes, ouch das vffwachsen vwer Statt, gar vil mer dann dise groben vngelertten verkoͤrer. Dann ich

[54] Voluptuousness.

sorg, dasz nit villiht vwer allersynnrichsten Suͤn, wann sie die Geschrifft nit leren, villiht nochmols sie vnder oder zwischen den Gelerten vnd vernuͤnfftigen, in iren eigenen oder vwer gemeynen Stat haͤndeln, als die stummen by sitzend werden vnd on fruht anfohen zu beklagen den verlust jrer zitt, vnd die schamlich vnwissenheit, vnd villiht nochmols jrer Eltern oder Frund boͤz vnd hinlaͤssig versumnisz scheltten werden: dann solches klagen, solches beweynen hab ich von Durchluͤhtiger, Wolgeborner vnd Edeln Luͤt kind gehoͤrt, vnd me dann einist mit inen ein mittliden gehaben. (D.)

Von dem Gotsdienst.

ZVm letsten (welches doch dz aller billichst ist) soll ein Wiser Ratt, der do hofft den Gemeynen nutz saͤlliklich zu regieren, sorg vnd vffsehen haben vor allen dingen vff den Gottsdienst, vnd die behalttung der Goͤttlichen Gebott nit versumen, dann Gott wil nit veraht sin von den menschen, vnd wider die Goͤttlichen Gesatz vnmilttlich handeln blibt nit vngestrofft, alle ding noch dem Gottsdienst zu setzen, hat die Statt Rom allzit gehaltten, vnd hatten die Roͤmer keinen Zwifel sie wurden Regierer aller zittlichen ding, wann sie dem Goͤttlichen gewalt wol vnd vesteklich dienten: deshalb sollen wir naͤmen ein bispil von den Heiden vnd Appgoͤtteryern, vnd vns flissen dem woren Gott sin Ere ze geben: so doch die selben als sie noch nit mit dem woren Glouben erluͤhtet waren, iren falschen Goͤttern zum flissigsten solch Ere erbotten haben: Vnd ist kein zwifel, der Barmhertzig Gott werd zu merung, zunemung vnd bewarung vwers Gemeynen nutzes so lang wachen, als lang ir von der geflissensten Ere sins Gottsdienst vnd behaltung siner Gebott vwer ougen nit werden abkoͤren. Aber dem Gottsdienst gehoͤrt zu, das oberst Opffer, das ist, Mesz zu hoͤren, Psalmen vnd Lobgesang gesungen werden, Gott danckwuͤrkung zu sagen nit vnderwegen zu lossen vmb sin Goͤtliche guttat vnd sigk so er vns verluͤht: als ir alle Jor von vberwintnisz des Burgunders, ouch wider den Ertbydem[55] vff Sant Luxtag loblich haltten.

Von eim Cantzelprediger.

ZV dem Gottsdienst gehoͤrt ouch Predig zu suchen, vnd ein Prediger, der die Worheit seit, gedulteklichen liden vnd beschirmen, vnd vorvsz einen Weltlichen Gelertten der Goͤttlichen Geschrifft der mit zymlichem soldt versehen sig, domit er stanthafftlich vnd vnerschrocklich, was die Worheit ist, oͤfflich reden geduͤrr,[56] ist waͤger, dann ob sie vsz dem Opfer oder dem Bettel vffenthalten[57] werden soltten. Vnd solt in sunders dise Statt zu Hochgelertten der H. Geschrifft geneigt sin, als sie vor zitten gehebt hatt, durch die Straszburg erluͤhtet vnd vast namhafft worden ist, als do gewesen sint *Thomas* vnd *Vlricus* welcher namen vnd Vatterland in allen Schulen wittberiemmt sint, durch ir hohen Ler willen der naturlichen Kunst vnd ouch heiligen Geschrifft, deszglich ouch durch ir scharpfe vnd nutzlich schriben, so sie vsz iren adelichsten Vernunfften, zu ewigwaͤrendem Lob irs Vatterlands, den Nochkummen verlossen haben. Aber gelert vnd erbers wesens *Theologos* der Goͤttlichen Geschrifft Lerer, ouch fridsamklich der Geistlichen Reht gelertten moͤht vwer Statt on allen kosten lihtlich zu ewigen zitten haben, wann inhalt der schoͤnen lieplich vnd heiligen brief, so Johannes Keisersperg, der wisest vwer Prediger, zu dem Durchluͤhtigen Senfftmuͤtigstem vwerm Bischof vsz Cristlicher Lieb nun langest diser sachen halb zugeschickt, in ein fruhtbarlich Werck yemer vollzogen werden moͤht.

---

[55] Earthquake.
[56] Dare.
[57] To support.

Was durch Lieb willen des Gotsdiensts zu straffen sig.

OVch gehoͤrt zu dem Gotsdienst, das murmeln, das vff vnd ab spatzieren, dz Geschwaͤtz, das Schrygen oder huͤlen der Bild[58] by den Orgeln in dem allerheiligsten Tempel. Insunders diewile der Gotsdienst gehaltten wurt nit zu lyden, noch der Heiligen Tag gebannenden Obent vnd abstinentz der heiligen Vasten; in den offnen Huͤsern, von den starcken vnd muͤssig gonden, zu ergernisz yederman oͤfflich zu brechen, die taͤglichen fuͤllerigen vff den Stuben, mit eym verbottenen Gesatzde, als die Roͤmer gethon haben, abzestellen, Loszwerffen, Aberglouben, Gotslaͤsterung, vnd verbottene Spiel die gar kum on Gotslaͤsttern geschehen moͤgen: menschliche Gesatzde, Gebruch vnd Gewonheiten dem naturlichen oder Goͤtlichen Reht widerwertig, in keinen weg zu tulden: offene Eebrecher zu grossen Eren nit bruchen: die altten vnd krancken Burger (durch vertribung der starcken Bettler) mit dem Almusen vffenthalten. Ouch sunst zu merung vnd zunaͤmen des Gotsdiensts so dient nit vbel darzu, wann ir rehtlich vnd aller billichst zurichtent vnd begerten vsz einem sicheren vnd vesten Baͤbstlichen Gewalt, mit vwers Hochwuͤrdigen vnd Durchluͤchtigen Bischofs, ouch der wolgebornen Herren des Capitels der hohen Stifft, desglich der andern Wuͤrdigen Stifften vnwandelbarer verwilligung, dasz ein yeder mit einer in vwer Stat Dumhern-Pfrunden (noch gestalt der Person) nun hinfuͤr me, sich beniegen liesz, als dann zu Basel, zu Spir, zu Wurtzburg, zu Babenberg vnd in ettlichen andern Stetten in Tuͤtschen Landen, in welchen Bischoͤfflich Stuͤl sint, erberlich vnd heyliklich gehaltten wurt: dann also moͤchten vil vwer Kind vnd Kindskind gar lihtlich versorgt werden, vnd der Goͤttlich Dienst wuͤrd gemeret, dem Letsten willen der Stifftern der

[58] ? Martin renders this passage: "Das Schreien oder Heulen *aus* dem Bilde unter der Orgel."

Pfrunden gescha^{e}h genug, den Selen der Abgestorbenen mo^{e}ht fruhtbarlicher geholffen werden, vnd vwer lieben Kind vnd Kindskind dientten Gott, vnd wurden mit vch gefu^{e}rdert zu Hymel, welche sunst mit vile der Pfrunden beswa^{e}rt, denen sie nit mo^{e}gen genug thun, so sie wider billickkeit, wider inbildung rehter vernunfft, wider briederliche Lieb, wider das gru^{e}szlich verbietten Babst Johans des xxij, besitzend, verdiffet in die Hell, mit ewigen Pinen gekru^{e}tzigt werden. Wer wer doch so fra^{e}vel,[59] wer wer ein so grosser des gerechten Gots, des Bischo^{e}fflichen vnd vwers gewalts verahter, der ein so heilig vffsetzung der Go^{e}ttlichen Ere, heiles der abgescheidenen Selen, vnd so zu merung der Fu^{e}rsehung viler Menschen von dem Heiligen Stul zu Rom bevestiget, ouch durch eins Bischofs vnd Capittels, vnd vwer Groszma^{e}htikeit mit ewiger vnd starker hanthabung bewart, yemer vnderstu^{e}nd zu brechen oder darwider kummen? Ich hab hertzlich vnd on alle vorht vnd schamen vwer allerwachenste Fu^{e}rsiehtigkeit, Wisen, Lieben Herrn, ermant von denen dingen, die zu merung des Gotsdiensts geho^{e}ren, vnd hab mich verlossen vnd vertru^{e}wt vff vwer angeborne, vnd von vwer Groszva^{e}ttern in vch gegossene Tugend vnd Erberkeit: dann vwer Vorfaren haben vsz lieb des Gotsdiensts Kirchen, Tempel, Spittal, Klo^{e}ster, Pfru^{e}nden vffgericht, den Gotsdienst im Mynster, vorusz in vnser Frowen Cappel, morgens vnd obends vffgesetzt, die zal der Diener Gots gemert, die heiligen Stet mit kostbarlichen Kleinoten geziert, die Pfarrkirchen (die doch alter sint dann die Klo^{e}ster Bettelsorden haben sie liep gehabt, die Juden vertriben, die heilige Ro^{e}msche Kirch vnd Ba^{e}bstlichen Stu^{e}l haben sie als wore Cristen allzit geeret, vnd ir Botten vnd Gesanten gu^{e}tlich empfangen vnd fru^{e}ntlich gehalten, vnd domit sie dem Nochvolger Santi Petri vnd dem Statthalter Christi entfor[60] geben, haben sie zu eyner beschirmung des Ba^{e}bstlichen Stuls, eynen Meyster der Ka^{e}tzer, genant Friderich

---

59 Wicked.

60 Cf. Bayerisches Wörterbuch, vol. 1, p. 847; *enpfor geben*, to honor, give reverence. Martin translates: "aus Rücksicht auf."

Tunawer, welcher von der Vergabung des Keisers *Constantini* vbel reden was, mit dem Fuͤr, vnd ettwan vil, beider gesleht, sin nachfolger, ein teil zu dem tod, ettlich zu verswoͤrung des Lands verurteilt vnd verdampt, in dem Jor m. cccclviii.

Deshalb nit vnbillich die Roͤmsch Kirch vnd der heilig Vatter der Bapst, vwerm Gemeynen nutz geneigt, guͤnstig, vnd was ir billicher ding begaͤren, oder harnoch yemer begeren werden, wurt er vch on widersprechen, zu ewigen zitten bestendig verluͤhen vnd zulossen.

Von den guten Burgern.

DEn guten Burgen gehoͤrt zu, zu vil ligenden oder ander Guͤter nit zu begeren, den wucher fliehen, den Gemeynen nutz lieb haben, sin mittburger nit verahten, die Oberkeit zu eren, Vffrur zu wenden, Kirchen vnd Geistlicheit zu eren, die Ere Gottes zu meren, den armen Luͤten senfftmuͤtig sin, billichs vnd glichs Rehten mit andern Burgern zu leben, nit zu vil zu verwuͤrfflich oder vndertrucklich sich haltten, ouch nit zu vil harfuͤr brechen in eym Gemeynen nutz, woͤllen das so fridlich vnd ersamklich ist, iren Gemaheln vnzertrent anzehangen, mit einer Frowen sich beniegen ze lossen, von synem Gebluͤt kein Frow ze nemen, vnd nit allein durch Schoͤn oder Richtum, sunder mer durch Ere vnd Tugend willen ein Huszfrow zu erwoͤlen, vnd nit in zu vil Jungen Joren zu der Ee zegriffen oder sich vermyschen, vnd mer zu kaltter dan zu warmer zitt mit siner Huszfrowen vnderstan ze kynden: ein gut waͤsen irer Eefrowen tulden, das boͤz vndertrucken: Gut waͤsen oder eigenschafft heisz ich, Scham, Milttikeit vnd Barmhertzikeit; Boesz eigenschafft der Frowen sint, dasz sie gemeynlich on mosz oder vngezempt ir lidlicheit nochvolgen, dz sie sint klappereht vnd zaͤnkesch vnd vnstanthafftig, deshalb sollen sie von den Mannen regiert vnd gehaltten werden zu der maͤssikeit, zu Stillswigung vnd zu Stanthafftikeit. Zu der Maͤssikeit gehoͤrt Kuͤscheit, Schamheit, abbruch an Essen, vnd nichterkeit des Wins, dann es zymbt sich dasz sie kuͤsch sygen, nit allein dasz sie iren Eemannen truw halten, sunder ouch dasz von inen nit Kind vsz Eebruch entpfangen zu froͤmbdem vaͤtterlichem Erb kummen, welchs doch der groͤszten suͤnd vnd laster eine ist, vnd das ouch by den Bichtvaͤttern zwifelhafftig ist: Ich setz ouch darzu Schamheit, dann es it nit genug Kuͤscheit durch welche die Frowen nit froͤmbder Mann sich gebruchen sollen, sunder sollen sie ouch Ersam vnd Schamhafft sin, dasz sie von allen zeichen vnd wortten, die etwas Vnerberkeit oder Ergernisz vff jnen tragen, mit dem hoͤhsten flisz gesehen werden sich ze hietten. Dann es ist nit genug dasz kein froͤmbder Sun in des Mans Erbgut kumm, sunder gehoͤrt ouch zu der heiligen Ee, dasz der Vatter von synem Kind ettwas wissenheit, oder ioch ein gut zuversicht hab dasz er sin syg. Zu solcher Kuͤscheit, Schammheit, Verswigenheit, Abbruch vnd Nichterkeit, sollen die myttelmaͤssigen Burger durch sich selbs, aber die hoͤhern an Adel, Waͤsen oder Gut, sollen ir Eewiber durch frum erbere Frowen, die eins guten Lymuts sint, ermanen lossen. Es stat ouch eym Eeman zu maͤszlich vnd bescheidlich zu gebruchen eeliche werck, vnd vffmercken haben, der zitt, der stat, der ersamen mosz, vnd vermoͤglicheit oder gesuntheit des Libs. Es soll ouch ein yeder Eeman sin Eefrow noch syner vermoͤglichkeit vnd noch gestalt sins Stands mit bekleidung vnd Libs narungen ersamklich haltten, vnd gegen ir siesse fruͤntlich vnd tugentlicher wise mit senffter Red vnd manung sich erzeigen; Aber zu denen die do hochfertig vnd Naͤrren sint, ist eins herttoren anfarens nott: zu demuͤtigen vnd vernuͤnfften sint senffte vnd fruͤntliche wort genugsam. Die Mann sollen ir Frowen liep haben als ir mitgesellen, nit als ir Dienstmaͤgde, von yferen[61] sollen sie sich huͤten, doch sollen sie ouch lugen[62] dasz sie nit durch die Vinger sehen, vnd die hanthab eim andern zu bietten gesehen werden.

---

[61] Jealousy.
[62] See to it, take care.

Von Anwisung der Kind.

DJe Elttern sollen lugen dasz die Kind von irer Jugent in dem Glouben, in guten Sitten, in fryen Kuͤnsten vnderwisen werden, dasz sie nit ewiklich hungerig vnd durfftig bliben, als dann Sant Augustinus von dem selligen Leben spricht, deren gemuͤt ze sin, die in keinen Kunsten gelert sint, vnd nitzet von dem Brunnen guter Ler geschoͤppffd haben. Die Kind sollen ermant werden, dasz sie nit in ir Red, Gesicht oder Gehoͤrd suͤnden: ir vnvollkummenheit der zungen,[63] ettlicher Buchstaben halb, sollen sie vsz kunst vnd vernunfft vnderston zu meystern, glich als *Demosthenes* gethon hat. Sie sollen in Spisz vnd Dranck nit vberdretten; in arbeit, lidlicheit des gemuͤts vnd des Libs sollen sie sich uͤben, dasz in Kriegschen vnd Burgerlichen geschaͤfften ir geschicklicheit erfunden werd: Gott sollen sie eren, Gott sollen sie voͤrhten: dann was mag yemans vnder den Menschen heilig geahtet werden, dem die Gottheit verahtlich ist: den Goͤttlichen Namen sollen sie nit verfluchen, vnd sollen nit lihtlich gelossen werden by Gott sweren, by ir Seelen, by ir Truwen, by dem Eid, dann dardurch gewonen sie Meyeidt[64] zu tun, gefuͤrt vsz empsikeit des swerens, in verahtung der Truwen vnd des Eids, als die Walhen duͤnt by irem Glouben vnd Truwen zu sweren in allen dingen. Die Eltern sollent ir Kind leren, dasz sie, Vatter vnd Mutter, Priesterschafft vnd die Alten eren, vor inen vffstanden, niemans uͤbel reden, niemans verspotten, nieman verahten; ouch niemans mit schelttwortten oder Trowwortten[65] beleidigen: Gotslaͤsterung, Diebstal, Luͤgen, Rouben hassen: niemans zu suͤnden hilff geben, boͤsz Gesellschafft fliehen, fruͤntlicheit vnd Redsam sin leren: verherttigung irs eignen Willens vnd fuͤrnaͤmen sich abtuͤgend: vil geswaͤtzd vnd muͤssiggon fliehen, dasz sie huszlich, demuͤtig vnd senfft sigen:

63 Impediments of speech.
64 False oath.
65 Threat.

Hochfart verahten, vnd schampern bildung[66] sich entziehen: ersam Gesellschafft suchen, dappfferkeit der Sitten, vnd maͤssikeit der Red liep haben: Jr hoffnung in die Richtum gar nit setzen, dasz sie sich bald zu Tugenden vnd guter Gewonheit bereitten: Vnkusch vnd Hor pflantzen[67] vermyden, gewonen die betriepten beweglicheiten des Gemuͤts zu stillen: Ir Leben sollen sie vsz andern bessern: die so sie stroffen geduItekIich vffmercken: Fuͤr ir Spiel die Historien; fuͤr ir Prassen, ersam Ergetzlicheit; fuͤr ir muͤssiggon sollen sie fuͤr sich naͤmen die Lere der Geschrifft, dasz sie also by den Froͤmbden, by den Fuͤrsten, in den Versamlungen des Richs, vor froͤmbden Rednern, inen selbs lob, iren Fruͤnden ergetzlicheit, vnd dem Gemeynen nutz zu Straszburg Ere vnd Vffung[68] zu ewigen zitten zu geberen.

Von ziehung der Doͤhter.

DIe Elttern sollen ouch sich flissen jre Doͤhter von vmbsweiffen, vnd daraffter louffen, von vil swaͤtzen, von muͤssiggon verhietten: wiewol sie Rich oder Edel sint, sollen sie sie doch zum werck der hent gewaͤnen, domit sie die Geylheit vnd boͤse Anvechtung vberwinden moͤgen: man soll sie heissen bispel naͤmen von den Doͤhtern *Octaviani Augusti* vnd des grossen Carles, deren der ein der allermaͤchtigst by den Latinischen, der ander der groͤszest by den Tuͤtschen Keisern gewesen ist, welche ir Doͤhter zu den Froͤwlichen wercken gethon haben: dann inen beiden was vnverborgen die vnstaͤtikeit des Gluͤcks, vnd der Laster zufaͤll, denen Muͤssikeit anreitzung gibt, vnd die vile, ouch groͤsse derselben. Io vil mer sollen sie nochfolgen der allerheiligsten Jungfrowen vnd Mutter Gottes, welche der heilig Jeronimus bezuͤgt mit webendem werck in dem Tempel vmbgangen sin. Sig ouch ein Exem-

66 Coarse, indecent.
67 Martin renders "horpflantzen" by Eitelkeit, vanity.
68 Middle High German ûfenunge—respect. Vffung not to be found in Sanders, Schmeller.

pel, die durchluͤhtigste Hertzogin vsz dem Blut von Beyern Margarita, ein allerschamhafftigste huszfrow Pfaltzgrav Philipsen, zc. welche von den uͤbungen Froͤwlicher wuͤrckungen, so mit Zettlen,[69] Weben, Wollen, Syden, Neygen, Sydensticken, vnd derglichen kuntlich ist, so lang sie gelebt hatt, nie abgestanden sin, mit allem irem Frowenzymmer, so dardurch muͤssikeit vnd anreitzung des fleisches vberwinderin gewesen sint. Nit sollen sich schamen oder verdrosz hoben die Burgers vnd Rittersdoͤhter, dasz sie solchs tuͤgen, so die Mutter Gotts, so die Keiserynen, so der Keiser vnd Fuͤrsten Frowen vnd Doͤhter sie verstont flisseklich gethon haben.

Es ist witter ein ampt der Elttern die ire Kind reht vnd Cristlich liep haben, die ouch verhoffen mit inen ewiklich in dem kuͤnfftigen Leben sich zu froͤwen, dasz sie ir Kind in den zarten Joren, so sie noch menschlicher bloͤdikeit kein wissen, ouch die bruͤnstikeit des fleisches vnd anreitzung der Welt noch nit versucht haben, weder mit senfften worten, noch mit trowen anzebewegen, oder zwingen, in ein herter Leben, oder zu einem engern weg des Lebens, dann Christus vnser Gesatzdgeber vns vffgestezt oder gebotten hatt. Dann diewile Vatter vnd Mutter vsz menschlicher bloͤdikeit die Gebott Gottes, die doch liht sint, kum volkummentlich erfuͤllt haben, so ist es von vaͤtterlicher Miltekeit froͤmbde zu ahten, ir Kind, so noch zart sind, vorusz wider iren willen vnd gefallen, mit groͤssern Geluͤbden, Raͤten, Geistlicheiten vnd Vffsatzungen zu verknippfen, vnd nuͤtzt anders gedenken, weder wie sie von iren Kinden entledigt werden, vnd dasz sie fuͤrbasz kein, oder gar wenig sorg haben muͤssen fuͤr ir Kind zu ziehen: vnd hant wenig acht noch sorg, ob sie in den guten Geschrifften, ob sie im fundament der Ler *grammatica,* ob sie in guten Sitten, ob sie in Tugenden, ob sie in Gottes vorht, ob sie in behaltung der Gebott Gottes, on boͤsz Exempel taͤglich zunaͤmen vnd wachsen: Dann ein beschorner Kopf vnd Kutten machen niemans sellig, der nit ouch die Gebott des Herren halttend ist.

---

[69] Cf. Schmeller, Bayerisches Wörterbuch, vol. 2, p. 1160. Probably refers to the "Zetteln," i. e. spreading out of the flax.

Deszhalb gar vnwiszlich (als ich schetz) werden die vnschuldigen Doͤhterle etwan ingestossen, an die ort, die kum dryg schritt vom Frowenhusz[70] stont: die Eltteren die solchs duͤnt, moͤgen geaht werden, inen lieber sin, dasz sie haben Doͤhter die Huͤrlin sygen, dann das sie der andern Kind miterben weren: vnd so sie des irdeschen vnd zittlichen Guts halben schad zu empfohen besorgen, oder ir Kind nit gern nider zu der Ee versorgen, fallen sie selbs vnd die Selen irer Kind in groͤsseren schaden, vnd in einen ewigen flecken des gantzen Geslehts.

Der Edelen vnd Buͤrgers Suͤn, warin sie vnderwisen werden sollen.

ABer die Suͤn, welche noch weich vnd zart, vnd deshalb zu der Rittery, zu Kouffmanschatz, zu eim Gemeynen nutz regieren noch nit genugsam geschickt sint, wer das nutzlichst, sie werden vnderwisen Latinisch sproch ze reden, dasz sie verston moͤhten die Historien *Valerii* vnd *Salustii:* ein gut Regiment eins Huses oder Stat, vsz *Egidio:* gut Sitten vsz *Vergerio:* oder die vffgewachsnen Jugent reht ze leben vsz *Seneca:* die andern Tugenden vsz *Tullio:* Kriegskunst vsz *Vegetio:* ein Zug ordnen vsz *Frontone:* Buwerck vsz *Victruvio:* Burenwerck vnd Ackergang vsz *Varrone, Palladio* vnd *Petro* von *Bononia:* welche alle, vnd gar vil groͤssere, moͤhten in einer sundern Vaͤhtschul, wie wir vorgeseit haben, so darzu in diser Stat angesehen wuͤrd, mit wenig kosten, mit lihter arbeitt, in kurtzer zitt domit ouch die Kind in diser vwer Stat bliben, vnd by iren Elttern oder Fruͤnden wontten, gelert werden, mit eym geringen vnd nutzbarlichen weg vnd anwisung, so man den Meystern fuͤrgeben wuͤrd, welchen ouch sie mit allem flisz behalten, vnd von dem nit abwichen geduͤrsten, solten sie by iren eiden versprechen. Vnd solche Latinisch Vaͤht-

[70] House of prostitution.

meister[71] solten erberlich Gelert sin, in der Kunst des Wolredens, der Historien, vnd der Sittlichen kunst, ouch an irem Leben vnd Sitten bewaͤrt, Senfftmuͤtig, Dappfer, nit geneygt zu slagen: als dann dise edele Stat nit zwiflen soll, sie zu allen zitten wol finden wurt: diewile doch so vil Hoherschulen in Tuͤtschen Landen sint, in welchen geschickte Mann wol funden werden moͤgen: das wer besser, erlicher, nutzlicher, loblicher, vwern Suͤnen, iren Fruͤnden, vnd einer Statt, dann dasz sie noch nit, oder gar kum, irs Alters fuͤnfzehn Jor habend, verlossen werden in Muͤssikeit ze leben, alle lihtferikeit in Kleidung, in Worten, mit dem *Hor,*[72] vnd in allem wesen an sich ze nemen, zu ligen in den Scherhuͤsern (nit getar ich sagen in den Vogelkeffigen vnd pferchel der Huren) oder in den offnen Winhuͤsern, by dem Spiel vnd Fuͤllen, vnd in Lib, an Sel, an Gut, an Ere vndergon vnd verderben, als die vieh, die des buchs vnd fleischs kneht sint: In welchen gar kum einige fusztritt der Tugenden erschint: domit also ein guter vnd vnerfarner Juͤngling, der zu keiner guten Ler angewisen wurt, vnd nit by den loblichen Buchstaben der Geschrifft vffgezogen wurt, lebt als ein Vieh, stirbt als ein Vieh, der weder im selbs nutz, noch sym Gesleht erlich, noch vwerm Gemeynen nutz fruhtbar gewesen ist: von welchem, so er gestirbt, nuͤtzt worlich gesprochen oder geschriben werden mag, dann dasz er ein guter Zergesell vnd Prasser (Eij.) gewesen ist, er hatt gespilt, getruncken, vnd ist ein grosser Buler gewesen.

71 Schoolmasters.
72 Cf. note 67.

Durch zwey ding wurt Straszburg sellig, deren eins Doctor Johannes Keisersperg, vwer allerwisester vnd redlichster Prediger, dick an siner Predig bestymbt.

WAnn vwere Su^{e}n (denen doch die Natur vernunfft geben hatt) in den Joren, so sie noch zu Kouffmanschatz, zu Ritterschaft, zu der Ee alters halb noch nit geschickt sint, zu Ler der Geschrifft gethon vnd geben wu^{e}rden: vnd die ta^{e}glich zerung vff den offnen Stuben gemyndert wu^{e}rden, domit nit die frummen Burger, vnd insunders die Handwercksslu^{e}t, ir vnwiderbringlich zitt, vnd das Gelt in Spielbretten verlieren: vnd so vil zerung vnd kostens ein yeder fu^{e}r sin person vff einen Tag da^{e}ten, so vil sie fu^{e}r sich selbst, fu^{e}r narung ir Huszfrowen vnd Kind in zweyen tagen zu husz genug haben mo^{e}hten; dann so hofft ich, dasz vwer Gemeiner nutz fu^{e}r alle andere Stett Tu^{e}tscher land sellig wu^{e}rd: jo ein gezierd Tu^{e}tsches landes, vnd ein kron des Richs wurd es billig geheissen, deren keins ander Stat oder Gemeine, wer die were, lihtlich sich gedu^{e}rst vnderston zu verglichen.

Die Vbertra^{e}ffung der Statt Straszburg.

DAnn fu^{e}rwor was zu Burgerlicher Sellikeit geho^{e}rt, in den dingen wurt vwer Statt gesehen gro^{e}szlich vbertreffend, vnd fu^{e}r alle andere Stet vberfliessen, mit Kirchen, Kappeln, Heiltumen, Spittaln, Klo^{e}stern, mit eyner durchschinbarsten Thumkirchen, mit herrlichen Stifften, Liberien der Bu^{e}cher, Mannen in allen Ku^{e}nsten hochgelert, mit Schulen der Bru^{e}der des Bettelordens, Buwmeistern, vertribung der Juden, koͤstlichen Gebuͤwen, schoͤnen Gassen vnd Planen,[73] mit Zynnen, Graben, Tuͤrn, Zwingolf, Bollwerken, Schuͤtten,[74] Allmenden,[75] Vorstetten, Wartten, Stritgewoͤren, Woffen, Rossen, Geschuͤtzde, Buͤchern, Huten,[76] Adel, Ritterschaft, Vszbund[77] der Handwerckkunst, Geschicklicheit der Vernunfft, mit anfang vnd vrsprung der Truckery (wie wol dieselb zu Mentz volkummen worden) mit gesuntheit vnd guͤte des Luffts, mit zuwegen senffter wind, mit wunderbarer vile der Wasser, mit gemeiner Fryheit zu Jagen vnd Vogelen, mit ge nuͬhtsamkeit der Erd, mit lebenden Vischen, Weiden, Matten, Gerten, Ouwen, *Vischetzen,*[78] Wigern,[79] zam Vieh, Wilttprett, Gefuͤgels, Korn, Win, Fruͤht, Richtum, Pfennigturn, Kouffmanschatz, Zoͤllen, Vngelten,[80] Gewerffen,[81] eim vszbuͤndigen schoͤnen Vischmerckt, Bergen, Schloͤssern, Land vnd Luͤt, Stett vnd Doͤrffer, zc.

In welchen weg Gott vnd sine Mutter

dise Stat beschirmen werden.

SOlcher ding aller, wann dise vwer Stat nit zu vnzimlicher wollust, sunder zu ersamer irer hanthabung sich gebruchend ist, vnd GOtt, (von dem sie diese ding alle entpfangen hat) danck saget, mit andacht vnd behaltung des Gottsdiensts vnd siner Gebotten, so wurt GOtt vber vwren Gemeynen nutz ein wachender Huͤter, vnd vch genaͤdig sin, vnd sin allermilteste Mutter, vnser Frow, wurt vch ihren Sun lihtlicher versuͤnt machen: dann diese Mutter bittet nit fuͤr die, so dem

73 Squares.
74 Moat.
75 Grimm, Wörterbuch, vol. 1, p. 237.
76 Guard?
77 Model.
78 Vischetz—Fischwaid, Fischfang, piscatio.
79 Lat. vivarium, Weiher.
80 Bayerisches Wörterbuch, vol. 1, p. 907: vectigal pro vino, etc., revenues.
81 Ibid., vol. 2, p. 995; das Gewerf-Unterhandlung, Vertrag=valuable treaties, privileges.

willen irs Suns widerwertig sint, vnd sin Gebot verahten. Darumb, vff dasz ir den Sun vnd die Mutter, die vwer sunder beschirmerin ist, entpfinden vch erho^{e}rt zu haben, so wo^{e}llen vwere Su^{e}n zu der Ler vnd zu den Tugenden tun, von den to^{e}dlichen Wollu^{e}sten, die mit dem zergenglichen Lib vergon werden, vnd von dem Fu^{e}llen wo^{e}llen vch selbs vnd vwere Kind entziehen: haben liep Erberkeit, Huezha^{e}blicheit[82] vnd Senfftmu^{e}tikeit, die Go^{e}tlichen gesatzde vnderston zu vollziehen, so wurt die Mutter des Herren das Volck vnd vwer Stat vnder iren Armen vnd irem Fu^{e}rbitten beschirmen, als ir dann solchs in vwern grossen Briefsigel mit diesem Vers ingegraben haben:

Jungfrow bitt din Kint dasz es das Volk behiet vnd die Statt, Amen.

ALler Erentvehsten Herren, Meister vnd Ra^{e}t, dise ding hab ich vwer dapfersten Fu^{e}rsiehtikeitten vbergobt oder zugeeignet, mit vwerm allerbillichsten vrteil, ouch verho^{e}rung vnd flissigsten bewa^{e}rung der wolgelerten vwern mitbru^{e}dern vnd Su^{e}nen, Herrn Jacob Merschwin, ouch Sebastiani Brant, zu stroffen vnderworffen: vnd soll das vwer Wiszheit nit in solchem gemu^{e}t vermercken, als ob ich vch, Allerfu^{e}rsiehtiste Herren, zu leren vnderstand, (welchs doch wer myn allergro^{e}ste Dorheit) sunder dasz ir vermercken vnd erkennen myn ga^{e}ntzlich vertruwen, vnd inbru^{e}nstig begird vnd geneigten Willen gegen vwer Stat Gemeynen nutz: deshalb verhofft, verlossend mich vff vwere gu^{e}tikeit, ir wu^{e}rden nit fu^{e}r u^{e}bel nemen, dasz ich vwerm getruwen Burger Johanni Prysz, dise vwer Stat Lob vnd Fryheit zu erlu^{e}hten, vszzespreiten, vnd durch sinen Druck[83] vszlossen gon, nit hab gewo^{e}lt versagen. Dasz ich aber von eim guten Regiment, von Einha^{e}llikeit, von Gerehtikeit, von Fu^{e}rsiehtikeit, vnd andern Tugenden geschriben hab, ist worlich durch mich nit in meinung geschehen, dasz ich vwern Aller-

[82] Ibid., vol. 1, p. 1032; haushäbig, wirtschaftlich, economical, frugal.
[83] This refers of course only to the Latin edition of his Germania.

fu^e^rsiehtigsten Ratt oder Regiment deshalb mangel haben gloub; sunder hab ich, in eyner gemeyn erzalt, in willen dise ding allen Stetten vnd Gemeinen nottu^e^rfftig sin ze erzeigen: Desglichen ouch vwern Kinden vnd Kindskinden, die villiht disz in iren zartten Joren lesen werden, domit sie befinden, noch dem sie vffgewachsen vnd zu Mann worden sint, inen keinen schaden darusz erwachsen sin.

E N D E

Caspar Hedio,

Doctor im Mu^e^nster zu Straszburg

im vierten theil seiner vszerlesnen Chronick. am 722. blat.

JAcob Wimpfling ward geboren zu Schletstatt 1449. Er ist wie Erasmus schribt von Jugent vff wol erzogen worden in guten Ku^e^nsten: Erstlich zu Schletstatt vnder Ludwig Drigenberg dem Schulmeister, Nochmahls zu Fryburg vnd Heydelberg hat er in H. Geschrifft vnd in Geistlichen Rechten gestudiert, auch andere *Disciplin* nit ohnwissend gewesen. Zu Spir was er ein zitlang in dem Thumstift Prediger: Nochmals zu Heydelberg hat er in H. Geschrifft gelesen, fu^e^rnemlich in dem H. Lerer *Hieronymo.* Mit Bu^e^chlein, die er in den Truck lassen vszgehn, hat er die Jugend vnderwisen, vnd die Priesterschafft zu der Gottselikeyt vnd Ku^e^scheyt ermant. Es hat in ouch nit beschwert vsz liebe zur Gottselikeyt, dasz er etlicher Jungen (von denen grosse hoffnung was) *Pedagog* vnd Schulmeyster worden, deren fu^e^rnemster ist Jacob Sturm vnder den Edeln, der mit Leer, Gottsellikeyt, Fromkeyt, Weiszheit, vnd Verstand war Edel: des truen vnd guten Ra^e^dten nit allein die herlich Stat Straszburg, sonder gantz Tuͤtschland vil schuldig ist. Ouch hat der gut Mann Wimphling nit moͤgen dem neid etlicher onruͤwigen entgehn, von wegen dasz er etwan fry geredt hat. Gen Rom ward er citirt (eyn Mann vnvermoͤglich Alters halb, vnd dasz er gebrochen was) durch anschickung der Augustiner Muͤnch, dorumb dasz er geschriben hett in sinen Buͤchern, *Augustinus* were kein Muͤnch gewesen, oder vff das wenigst keyn solcher Muͤnch, wie yetzund die Augustiner Muͤnch sind, den sie vff Taflen vnd Buͤcher molen, mit eynem langen Bart in eyner schwarzen Kutten, vnd mit einem lederin Guͤrtel:: dorausz im wurde vil ein groͤsser onrug entstanden sein, wo nit Pabst Julius, vff freundlich vnd trulich vnderhandlung des Hochgelehrten Conradi Peutingers zu Augspurg, vnd Jacobi Spiegel Keysers Maxmiliani *Secretari,* der des Wimpflings Schwester Sun was, das fewr by zit geloͤscht haͤt, mit frolockung aller frommer Maͤnner. Vber andere Widerwertikeiten in denen dises Manns Tugend sich geuͤbt, hat in hoch bekuͤmmert dise klaͤgliche trennung der Kirchen zu disen zitten, vnd in gar onlustig gemacht zu leben. Hat sich in seinem Alter zu Schletstatt by siner Schwester Magdalena gehalten, ist by achtzig Jahr alt worden, vnd offt dise Wort gebetten: Du milter Jesus bisz gnaͤdig mir armen Suͤnder, der ich des Gemeynen nutzens, Einikeit der Cristen, der H. Geschrifft, vnd dasz die Jugend recht vferzogen, ein Liephaber bin.

Ist gestorben den 16. Wintermonats 1528.

AN ORDINANCE OF THE CITY OF NUREMBERG, ADOPTED IN THE YEAR 1562.

E. K. J. H. VOSS.

The following is offered here, aside from its linguistic value, as a contribution to the study of city government and sanitary conditions in one of the foremost German cities in the latter half of the sixteenth century, at a time when Europe was swept once more by that terrible scourge, the Black Death.

The original is in the library at Wolfenbuettel. For the translation I am indebted to Miss Haffner, the present holder of the F. W. Allis Graduate Scholarship in German philology.

Of the city ordinances of Nuremberg up to the year 1478 we have an excellent collection in the Bibliothek des Literarischen Vereins in Stuttgart, volume 63. (Nürnberger Polizeiordnungen aus dem 13. bis 15. Jahrhundert, hrg. von Joseph Baader, Stuttgart, 1861.)

Ains Erbern Raths

der

Stadt Nuermberg

Vernewete Gesetz vnd Ordnung,

In gegenwertigen sterbsleufften

Disz M. D. L. XII.

Jars auffgericht.

NAch dem der Allmechtige Gott, durch das vielfeltig suͤndtlich vbertreten, So ye lenger ye mer, mit schendtlichen, hoch streflichen Gottslestern, Fluchen, Fuͤllerey, vnzucht, vnbillichen beschwerungen, wider die liebe des nechsten, vnd andern mer, vor Got hochstrefflichen lasztern, von den Menschen, jungen vnd alten, schier teglich, on alle scham vnd zucht geuͤbt wirdt, Abermals znm hoͤchsten verursacht, vnd bewegt worden, seinen billichen Zorn, vber uns auszugiessen, vnd solch suͤndtlich leben, mit seiner Ruten, der Pestilentzischen seuch, auch wie zubesorgen, mit Krieg vnd teurung zustraffen vnd heim zusuchen, So wil ein Erber Rathe, ausz Vetterlichem gutem gemuͤt, alle jre Burger, Jnwoner vnd zugewandten, allhie gantz getrewlich erinnert vnd vermanet haben, von solchen jren suͤnden abzustehen, vnd sich mit demuͤtigem hertzen, Auch andechtigem gepet zu Got keren, vngezweyffelter hoffnung, sein Allmechtigkeyt werde sich alsdann zu Barmhertzigkeyt bewegen, vnd solchen fuͤrgefasten zorn, vnangesehen wie hoch er darzu verursacht worden, wider gnedigklich fallen lassen.

Daneben aber, dieweyl dannocht bey Regirung diser beschwerlichen kranckheyt, auch nit vnzeytlich, das Natuͤrliche mittel gesucht, dardurch solchem vnlust, zuvor im anfang, sovil menschlich vnd moͤglich, begegnet, oder doch zum wenigsten ein teyl desselben abgeschnitten, vnd fuͤrkummen werden moͤcht, So hat ein Erbar Rathe derselben mittel etlich fuͤr nuͤtz vnd notwendig bedacht, auch in nachvolgende Ordnung bringen lassen, Welche allen Burgern vnd hausz genossen, allhie durch jre Haubtleuͤt, in deren Haubtmanschafften sie gesessen, vberantwort werden sollen, Damit sich niemandt eynichs vnwissens zu entschuldigen haben koͤnde.

Vnd erstlich, Als dise kranckheyt, ohne zweiffel ausz verhengknusz Gottes, nit wenig durch vergifftung des luffts, Auch dieselbig vergifftung nit den geringsten teyl, ausz vbelm boͤ-

sem geschmack erwechst, So lest ein Erbar Rathe, alle jre Burger vnd Jnwoner gantz getrewlich warnen vnd ermanen, Das sie den Harm vnd ander vnsauberkeyt, so vil jmmer muͤglich, auff die gemeinen Gassen vnd strassen nit schuͤtten, Sunder solchs alles in das Wasser der Pegnitz oder Vischbachs tragen, oder sunst dermassen damit handeln lassen, damits einem yeden selbs, vnd auch andern leuten, zu wenigsten beschwerden gelange, sunderlich aber darinn betrachten woͤllen, das der geschmack des Harms von krancken oder vergifften personen, zu disem gebrechen, vor andern dingen, nit wenig fuͤrderung gibt.

Znm Andern, So ist eins Erbern Raths ernstlicher beuelch vnd maynung, Das eynicher Barbirer, Bader oder Wundtarzt alhie hinfuͤro, vnd so lang dise sterbleufft weren, gar keyn gepluͤt, so von den menschen gelassen wirdet, weder bey tag oder nacht, in die heimlich gemach noch auff die gemeynen Gassen nider schuͤtten, lauffen noch kummen lassen, Sunder solch gepluͤt sol, alles on mittel, vnd nyendert anderst wohin, dann allein in die Pegnitz oder Vischbach zutragen vnd zuschuͤtten geschafft werden, bey peen von einer yeden vberfaren fart, Zwey pfunt Newer heller, vnnachleszlich zubezalen.

Zum Dritten, Dieweyl auch von den Mysten so alhie in den Gassen hin vnnd wider, etwas lang ligen bleyben, vil boͤz und vbels geschmacks entspringt, der sunderlich diser zeyt also zugedulden, nit allein beschwerlich, Sunder auch geferlich vnd nachteylig, So setzt ein Erber Rathe, im selben dise masz Das eynicher Myst lenger nit, dann zwen tag also auff der Gassen ligen bleiben, Sunder in solcher zeyt hinweck vnd hinausz gefuͤrt, Jn sunderkeyt aber gar kein Mist mitten inn die Gassen, nider geschuͤtt oder gelegt werden, Jm fall aber das solchs durch yemant, wer der were, nit beschehen, vnd also verlast wuͤrde, das derselbig Myst, alsdann zu sampt verwuͤrckung der gestezten peen, einem Pfundt Noui, einem yeden preysz vnd frey sein soll, den seines gefallens weck zufuͤren.

Zum Vierdten, Auch sol man die Schwein vberal hie in der Statt, in disen sterbsleufften, fuͤrderlich vnd jnnerhalb zehen tagen, nach verkuendigung dieser Ordnung, bey eins Erbaren Raths straffe, aus der Stat thun, Dieweil derselbig Myst vnd gestanck sehr schedlich, vnnd dieser kranckheyt fuerderlich ist.

Zum Fuenfften, Nach dem durch ein Ordenlich gut Regiment, vnd vorgeende fuersehung nottuerfftiger Preseruatif vnd Ertzney, gar vil Menschen, wo sie sich dero gebrauchen, vor diser kranckheyt errettet, vnd behalten werden moechten, So hat ein Erber Rathe, allen jren verwandten zu gut, inn allen Appotecken alhie, vil guter Ertzney vnd Fuersehung, inn disen leuefften nutzbar vnd erspriesslich, Desgleychen zu rechtfertigung vnd reinigung des Luffts inn den Heusslichen wonungen, etlich gut Pulver vnd Berauchung zumachen verordnet, die einem yeden, so deren nottuerfftig, Auch so yemandt mit diser kranckheyt behafftet wuerd, fuer ein Remedium vnd Artzney, vmb zymlichen werd sollen mitgeteylt werden, Welches alles, ein yeder daselbst zu seiner notturfft suchen mag, damit auch ein yedes welchs die kranckheyt begreyffen wuerde, keyns wegs lang verziehen sol.

Zum Sechsten, Als auch bey einer solchen grossen menig Volcks allhie, in disen sterbleufften, die vergifften vnd krancken Personen, nit allemal vor den gesunden erkendt, vnd also zu stundt abgesuendert werden moegen, darumb dann auch ein vergiffter, vnd mit diser kranckheyt beladner Mensch, etwo vil gesundte auch vergifften mag, vnd also darauss volgt, das die grosse Versamblungen der Menschen zu solcher Zeyt etwas ferlich vnd sorgklich, So lest ein Erber Rathe, hiemit menigklich guter vnd getrewer Meynung warnen, Welcher sich mit diser kranckheyt angriffen befindt, oder damit beladen gewest, vnd widerumb zu gesundtheyt kummen, das dann derselbig sich auffs wenigst ein Monat lang aller Kirchen, des Rathauss, der Beder, auch anderer gemeinschafften vnd versamlungen der Menschen enthalten, vnd andere vor nachteyl vnd beschwerung verhueten soll.

Zum Sibenden, Damit auch solch vergifftung anderer personen etlicher massen fuerkummen werden moeg, So hat ein

Erber Rathe das new gebawt Lasaret bey Sant Sebastian vor der Stat gelegen, mit aller nottu^e^rfftigen fu^e^rsehung zum besten zurichten, daru^e^ber auch Verwalter vnd andere personen, so vil von no^e^ten, verordnen lassen, den krancken personen, so hienein kummen, oder gebracht werden, alle Geystliche vnd Leybliche handtreychung, on eynichen jren kosten, nachteyl oder schaden, mitzutheyln, Vnd ist hierauff eins Raths gantz Vetterliche vnd wolmeynende ermanung, das ein yeder Haussvatter sich selbs erinnern, auch wol erwegen vnd bedencken sol, auss was Christlichen guten vrsachen vnnd bewegungen, dise des Lazarets verordnung erstlich fu^e^rgenummen, zu was nutz vnd gutem sie auch bishero bey gemeyner Burgerschafft gereycht, vnd darumb, ob yemandt in seim Hauss mit diser kranckheyt begriffen wirdt, solche krancke personen fu^e^rderlich in das bemelt Lazaret verschaffen wo^e^ll, damit er vnd ander sein Haussgesindt, davon nit auch vergifftet, vnd solchen krancken personen dannocht auch nottu^e^rfftiger wartung widerfaren mo^e^ge, wie dann ein Erber Rathe, inn solchem dermassen verordnung vnd fu^e^rsehung gethan, das jrs versehens niemandt an gepu^e^rlicher hilff, guttem Rate, vnd anderer notturfft, so vil zu seel vnd leyb dienstlich, vnd mer dann einem, bey disen leufften, villeicht inn einem Hausz widerfaren mag, eynicher mangel erscheynen, darfu^e^r es ein yeder gewiszlich halten, vnd daran kein zweyffel tragen soll.

Zum Achten, Hat ein Erber Rathe, nit fu^e^r ein geringe fu^e^rsehung bewo^e^gen, die Kleyder, Pethgewandt, vnd anders, das zu diser vergifften vnd krancken Person gebrauch gedient, ohn Mittel von stat zu thun, in bedacht, das zuuor durch solche kleidung vnd andere gebreuchliche ding der krancken, die Gesunden gar leychtlich vergifftet werden, vnd darumb fu^e^r der fu^e^rnemlichsten mittel vnd Remedien eines verordnet, ernstlich gebietend vnd beuelhendt, das zu zeyten diser sterbleufft, vnd bis sich dieselben zu besserung richten, kein Pethgewand, Kleydung, oder anders, darauff krancke personen gelegen seyen, das sie auch gebraucht oder beru^e^rt haben, auff dem Sewmarckt oder andern orten, keyns wegs, heymlich oder offentlich, verkaufft, sunder als bald von dannen an andere ende vnd ort gethan, vnd in ander gesundter person gebreuch, nit mer bewendet werden. Desgleichen, das auch das Leynen *dinglach*[1] der krancken person, allhie inn der Stat an keinem ort gewaschen oder geseubert, Sunder solch waschen vor der Stadt, vnd nyendert anderstwo, dann beym auszflus der Pegnitz beschehen, mit demselben aber des Vischbachs aller ding inn vnd ausserhalb der Stadt, gantz vnd gar verschont, vnnd dergleychen *ainglach* nichts darinn gewaschen werden soll, bey peen zehen gulden Reinisch vnnachleszlich zu bezalen, oder aber wer es nit vermo^e cht, mit dem Leyb zuuerpu^e ssen, Darnach wiss sich ein yetlicher zurichten, sich vnd die seinen vor ferligkeyt vnd schaden zu bewaren, auch vor solcher straff zuuerhu^e ten.

Zum Neundten, Auff das auch solch yetztgemelt vergifften der gesunden personen, desto statlicher verhu^e tet werden mo^e g, So ist eins Erbern Raths getrewe ermanung, das ein yeder Haussvatter allen seinen haussgenossen vnd zugewandten statlich ansagen vnd befelhen soll zu den krancken personen in jre Heuser, noch das Lazareth nit zugeen, desgleychen auch nicht dabey zu sein, wann die Todten vergraben werden, Vnd sunderlich, so acht auch ein Erber Rathe, das in disen sterbsleu^e fften, so vil Leut mit den Leychen pflegen zugehen, gar nicht nu^e tz oder gut, Sunder besser sein, das solchs auffs engst eingezogen, Desgleychen auch das sich die Handtwercker diser zeit des Leychtragens enthalten, vnd solchs, biss sichs etwo wider zu besserung schicken wirdet, bey den darzu verordneten personen vnd Tragern bleyben lassen solten, durch welchs alles als dann allenthalben vil ferligkeyt verhu^e tet werden mag.

Vber solchs alles, So hat auch ein Erber Rathe mit dem hinausstragen der krancken vnd verstorbenen Desgleychen auch mit bestellung etlicher Mann vnd Weybs person, die zu der krancken wartung, allhie in der Statt zugebrauchen dienst

---

[1]Dinglach vgl. dinglich, Bayerisches Wörterbuch, vol. 1, p. 521. Weisszeug. Grimm, Wb. II, 1175.

lich, auch sunst ander mer nuͤtzliche gute ordnung vnd fuͤrsehung bedacht. Derhalb sich ein yeder, dem solcher gestalt etwas von noͤten, der krancken Treger halb, im Spital, vnnd von wegen der wartung vnd Leichentreger bey den Kirchnern beder Pfarren, auch den vier geordenten dienern, so das Wochenlich Allmusen, vmbzutragen pflegen, nottuͤrfftigs guts bescheyds erholen mag, Guter zuuersicht, vermittelst Goͤttlicher hilff (dem fuͤrnemlich hierinn vertrawt, vnd in sein Goͤttliche barmhertzigkeyt verhofft werden sol) disen vnlust etlicher massen damit zuringern.

Decretum in Senatu den
26. Januarij. 1562.

A LAW AND ORDINANCE OF THE HONORABLE COUNCIL OF NUREMBERG, RENEWED IN THE PRESENT TIME OF PESTILENCE, IN THE YEAR MDLXII.

Inasmuch as God Almighty, provoked in the highest degree by manifold sinful and ever-increasing transgressions of His law, shameful and enormous acts of sacrilege, blasphemies, debaucheries, prostitutions, unjust offenses against the rights of fellow citizens and other crimes of surpassing wickedness, practiced almost daily by young and old without shame or restraint, has been moved to allow His righteous wrath to descend upon us, to punish this sinful manner of life with the rod of pestilence, and to visit war and famine upon the city, the Honorable Council in a spirit of fatherly solicitude earnestly admonishes and enjoins all burghers, inhabitants and dependents to desist from such wickedness, and to turn with a devout heart and humble prayer to God, in the confident hope that His Omnipotence will be moved to pity, and, unmindful of His great provocation, will mercifully stay His intended wrath.

As, however, in addition, natural and timely means should be sought for the control of this grievous disease, in order that the affliction may be at once, to a degree at least, allayed and anticipated, so far as human resources can accomplish it, the Honorable Council has deemed the measures which it has caused to be set forth in the following ordinance advisable and necessary. This order shall be made known to all burghers and tenants in the city through the heads of the districts in which they dwell, in order that no one may plead ignorance as an excuse.

In the first place, since the pestilence, although doubtless a visitation of God, is caused in great measure by pollution of the air, and this pollution in no small degree by foul and offensive odors; the Honorable Council earnestly warns and admonishes each burgher and inhabitant, not to throw urine and other refuse, as far as this is possible, upon the public streets and highways, but to carry all such refuse to the Pegnitz[2] or the Vischbach, or to dispose of it in such a way that it may cause least annoyance to himself and to others, and to be especially mindful of the fact that the urine of diseased or infected persons is, before all other causes, promotive of this disease.

In the second place, it is the earnest command and admonition of the Honorable Council, that from now on, as long as this time of mortality lasts, no barber, cupper or surgeon of this city shall throw, pour or cause to be thrown any blood drawn from human beings into the private closet or upon the public streets, either by day or by night, but shall cause all such blood at once to be carried to, and emptied into the waters of the Pegnitz or the Vischbach on pain of the irremissible payment of two pounds of "Neuer Heller."[3]

In the third place, since from the manure which is allowed to remain for a considerable time in various places on the streets, foul and offensive odors arise, which at this time are not only

---

[2] The Pegnitz flows through Nuremberg and divides at several points into two distinct arms. The Vischbach is a tributary of the Pegnitz.

[3] Two hundred forty heller made one pound.

annoying, but also dangerous and injurious, the Honorable Council decrees that no manure be allowed to remain longer than two days upon the streets, but that it shall be carried away within this time, and especially that no manure be thrown or deposited in the middle of the public streets. In case that any person, whoever he may be, does not obey this regulation, the manure together with the forfeited penalty, one pound "Novi," shall be the reward of any person who shall be pleased to carry it away.

In the fourth place, all swine, wherever they may be within the city, shall during this time of pestilence, from now on, and within the ten days following the proclamation of this ordinance, be removed from the city on pain of punishment by the Honorable Council, for the reason that the manure and offensive odor of these animals is highly injurious and promotive of this disease.

In the fifth place, since through strict regulations and the necessary preservatives and medicines many people, if they use these, may be saved from this disease and preserved, the Honorable Council has ordered for the benefit of the citizens under its protection that there be provided in all dispensaries much good medicine and preventives, useful and salutary in these times; and furthermore to purify and rectify the air in the houses some good powders and fumigants, which will be sold at a moderate charge to all in need; also for any one who may be afflicted with the disease a sufficient remedy and medicine, all of which things any one may seek there as he needs them, and that likewise everything that might overcome the disease would not long be lacking.

In the sixth place, since with so great a number of people, in these times of pestilence, the infected and diseased cannot always be distinguished and at once separated from the healthy, and therefore an infected and diseased person may infect many that are healthy, and as from this follows that great congregations of people at this time are dangerous and unsafe, the Honorable Council, in the best and most sincere intention, warns herewith that any one who feels himself attacked with this disease, or has been infected with it and has recovered, should avoid for at least a month all churches, the City Hall, the baths, and other congregations and meetings of the people, and protect others from affliction and injury.

In the seventh place, in order that such infection of other persons may be in some degree prevented, the Honorable Council with the greatest forethought has equipped in the best manner possible the newly built hospital situated near St. Sebastian before the city. In addition, the Honorable Council has given the necessary orders to the superintendent and other persons connected with the hospital to supply to the sick, who come thither or are brought, all spiritual and physical assistance without charge, disadvantage or injury to them, and it is furthermore the fatherly and well-meaning admonition of the Council that every head of a family should bear in mind, weigh and consider upon what good Christian grounds and motives this hospital ordinance was in the first place established and what benefit and advantage it has thus far given to the citizens, and therefore when any one in his house be attacked with this disease, that he should take such a sick person to the aforesaid hospital, so that he and his family and servants might not likewise be infected, and that such sick person may receive moreover the necessary care, since the Honorable Council has made an order and provision of such a kind through its fault no one would lack due help, good advice and other necessities as much as is good for soul and body, and more than one might obtain in these times in a private house. Of this everybody shoud be sure, and have no doubt of the wisdom of the Council.

In the eighth place, the Honorable Council has deemed it not an unimportant provision to remove at once from the city the garments, bed clothing and other clothing which has been used by the infected and sick persons, in consideration that such clothing and other things used by the sick might easily infect the healthy, and therefore has decreed and urgently ordered as the best means and remedy in these times of pestilence, and until conditions improve, no bed clothing, garments or other things upon which the sick have lain, or which they have used and touched, shall by any means be sold secretly or publicly on the Sewmarket or other places, but shall be put away and destroyed at once, and shall not be given to other healthy persons for use. In the same way, the linen bedclothing of the sick persons shall not be washed and cleaned in the city in any place, but such washing shall be done outside of the city, and nowhere else but in the outflowing current of the Pegnitz. But the Vischbach within and without the city shall not at all be used for this, and such linen shall not be washed in it, on pain of the irremissible payment of ten gulden "Rhenish," and any one who should not be able to pay this fine shall suffer bodily punishment. Let every one keep this especially in mind, to preserve himself and his from danger, and thus protect himself from such punishment.

In the ninth place, in order to avoid such infection of healthy persons all the more effectively, the Honorable Council admonishes earnestly that every head of a family shall emphatically inform and order his family and tenants not to go to sick people in their houses or in the hospital, and likewise not to be present when the dead are buried, and especially is it the opinion of the Honorable Council that it is in these times of mortality an entirely bad and useless custom that so many people accompany the corpse, and that it were better to hold the funeral in the most simple manner; also that the artisans should refrain from carrying the bodies of the dead,[4] but that this should be done, until conditions improve, by the persons and carriers appointed by the city for that purpose, through all of which much danger might then be avoided everywhere.

In addition to this, the Honorable Council, aside from the provisions made for the carrying away of the sick and the

[4] This was the special privilege of certain guilds and no doubt they were loath to give it up on account of the remuneration connected with it. Poor Schiller, by the way, was escorted to the grave in this manner, by the shoemakers' guild of Weimar in 1805.

dead and the appointment of certain men and women who are especially fitted for the nursing of the sick to be employed here in the city, has considered a great many other useful regulations and provisions. On that account, everyone who has in this respect need of a man for carrying the sick, or of the service of the hospital, or of some one to nurse the sick or to carry away the dead, may get the needed good information from the sextons of both parishes, also from the four appointed officials whose duty it is to distribute the weekly alms, in the confident hope of mitigating therewith in some measure this terrible affliction with the help of God, in whom above all we shall trust and in whose divine mercy we place our hope.

Decreed in the Senate on this 26th day of January 1562.

THE ACADEMY: ITS PAST AND FUTURE.

J. J. DAVIS.

(Address of the Retiring President, Delivered February 8, 1906.)

The constitution of the Academy prescribes that the retiring president shall give an address; and this though he have no message to deliver, no art of speech with which to please. And yet, perfunctory though it be, it should be an easy task to address the Wisconsin Academy of Sciences, Arts and Letters. For, if one chooses to be cold and formal and precise, even technical, science will justify him. Or, if he chooses to unfold the wings of fancy or deck his arrow with more feathers than are needed to direct its flight, surely art and letters will justify him there. But do not fear; it is not my purpose to attempt either of these courses, but rather to cast a brief backward glance and peer for a moment into the dark-enveloped future.

The Academy might be said to have had its inception in a letter written by Hon. John W. Hoyt and addressed to various residents of Wisconsin who he thought might be interested in the formation of such an organization. The replies were of such a character as to lead him to circulate a call for a meeting which was signed by many of the men who were making the history of Wisconsin at that time. The meeting was held in this city in February 1870, and the organization of the Wisconsin Academy of Sciences, Arts and Letters was effected. The first meeting for the reading of papers was held the following July. The first paper published was "On the classification of the sciences," by Rev. A. O. Wright of Waterloo, whose name appears frequently in the earlier Transactions as a contributor to the geology of Wisconsin. The second paper was "On the importance of more attention to the preservation and culture of the forest trees of Wisconsin," by P. Engelmann of Milwaukee. During the discussion of this paper, Mr. J. G. Knapp of Madison stated that with the methods of lumbering then in vogue the white pine forests of Michigan and Wisconsin would be destroyed in twenty-five years. And they were. The third paper was "On the Coniferae of the Rocky Mountain region and their adaptation to the soil and climate of Wisconsin," also by P. Engelmann of Milwaukee. As I read these papers, I fell to wondering what would be the added wealth of Wisconsin had their admonitions been heeded, and her magnificent coniferous forests were now in existence yielding their yearly crops. And then I thought of the wide prairies stretching away to the South and West that were partitioned with fences made of pine boards and dotted with houses and barns and granaries, with villages and towns, built of pine lumber from the North, made cheap by destructive methods of lumbering. It was not the only time that Wisconsin got the short end of the bargain.

But before attempting any review, however brief, of the work accomplished by the Academy, it would seem desirable to have some conception of its aims and objects. Let me then state, as clearly and succinctly as I may, the ideas, as I apprehend them, that were operative in the minds of those who founded this Academy and those who have carried on its work. Wisconsin is one of the major states of the Union, extending as it does from the Great Lakes to the Great River, from the pine forests to the prairies, dotted and lined with lakes and rivers that discharge their waters into two of the great drainage channels of the North American continent, that of the St. Lawrence and that of the Mississippi; a state of much geological interest, of mineral richness, covered with a varied and fertile soil, with an abundant vegetation, teeming with many and diverse forms of animal life, bearing upon its surface much evidence of prehistoric human habitation, and the present abiding place and home of a composite and self-governing people. Now, it seems that the geology and the mineralogy, the botany, the zoology, the anthropology, etc., of Wisconsin should be investigated, elucidated and made known. This seems to be a duty: a duty to the state, a duty to the nation, a duty to science. But it cannot be done by legislative enactment nor altogether by official commission, much as it may be aided by official investigation, encouragement, assistance and direction; but it must rather be done, in large part, by the volunteer efforts of loyal sons and daughters of Wisconsin working each in his or her more or less restricted field. I take it to be one of the functions of the Academy to find, encourage and assist those who have the willingness and the ability to aid in this work as well as to bind together the workers in the various fields. And, withal, Wisconsin should do its full share in the general upbuilding of science and in the investigation of those phenomena that do not vary locally but are the same the world around or the universe through.

But knowing is not all; there is something beyond, something higher—that wide sense of relationships, that fine sense of harmonies that we may call feeling. At its best, this is based upon knowing. The shepherd, gazing upon the starry heavens, feels, but the astronomer, looking upon the same objects, feels, I take it, more widely, more deeply, more truly. He who knows but does not feel may be a bad citizen; he who feels but does not know may be fully as dangerous; he who both knows and feels is the ideal citizen. The promotion, then, of knowing and feeling, of knowledge and culture, of the sciences, the arts and letters, is the work of the Academy—a work worthy of its best endeavors and worthy as well of the earnest co-operation of the state, as such, and of its individuals.

The papers presented to the Academy are submitted to a publication committee, and those deemed worthy are printed in its Transactions; the test of worthiness being whether they are actual, original contributions to knowledge. I have looked over the Transactions and have attempted some classification of these contributions. I do not vouch for the absolute accuracy of the figures that I have obtained. It is doubtful if they are accurate; it is probable that they are not; but they are at least approximately correct, which is sufficient for my purpose. In classifying these contributions, probably no two persons would get exactly the same results, and I am quite sure that I should not get the same results in successive attempts. I avoided this difficulty very easily, however, by going over them but once. Remembering the respect and interest with which man views his kind, I first divided the papers into those relating to man and those relating to the remainder of the universe. In the first or humanistic class there are 130 papers, in the second or naturalistic class, 155, or about 45 per cent and 55 per cent respectively. The humanistic class is quite heterogeneous, for in it are included such diverse subjects as literature, art, social and political science, engineering and anthropology. Social and political science with 56 papers is the largest division in this class or in either class. Man is so far a social being that the inter-relations of individuals in the society and the state occupy much of his attention. The next largest division of this class is letters, with 39 papers. I must confess that I placed some papers in this division because I did not know where else to place them. I am glad that the writers will never know what disposition I made of their contributions in this classification. Next comes anthropology, with 25 papers. The papers in this division have characteristics of both the humanistic and naturalistic classes and unite them. In this respect, engineering, with eight papers, is a cognate division. The remaining division of the humanistic class is art, with two papers. In the naturalistic class, zoology is the largest division by a bare plurality of one, its close competitor being geology. In the earlier Transactions geology easily led, but of late years zoology has been creeping up, until now it has 49 papers to 48 in geology. In making these counts, I was struck by the irregular or remittent growth in the number of papers in a given division Sometimes they would increase rapidly, and then for a time remain almost stationary while another division would take a spurt. On examination, these periods of growth would usually be found to be due to the activity of one or two members. I realized more than before the impress which a single active and zealous worker can make on the Transactions of a body like this. The next division in the naturalistic class is botany, with 23 papers. Then follow chemistry with 17, physics with nine, mathematics with six and astronomy with three.

Let me recapitulate the relative proportions of all these divisions, using percentages in whole numbers.

	Per cent.
Mathematics	2
Astronomy	1
Physics	3
Chemistry	6
Geology	17
Zoology	17
Botany	8
Anthropology	9
Engineering	3
Social and Political Science	20
Letters	13
Art	0.7

In the earlier years of my membership in the Academy, I was distressed by the lack of relationship between the papers; the absence of cohesion among them; of working plan or system. I now view with more equanimity the doing by each of the work which he finds at his hand. The fare may indeed be somewhat like that at the picnic when there is an over-abundance of cake and a scant supply of sandwiches, a superfluity of pickles and a shortage of pie, but each article will at least be of the best quality that the contributor can furnish. I feel, however, no less keenly now than then the need of a systematic, scientific study of our state, but look for the accomplishment of that work to the Wisconsin Geological and Natural History Survey, which I believe will be of much aid and honor to the state and which should and doubtless will receive the continuous assistance and support of the Academy. It is not my purpose to attempt any critical review of the work which the Academy has done. It would tax the powers of a much deeper and better-rounded man than I am to appraise at their true value all these papers, but I do know that they contain much of value to be found nowhere else. The desire to make some mention of those who have contributed most largely to the value of the Transactions is a strong one, but many of them are still living, some of them are here tonight, and I refrain.

So much for the past. Let us have done with it and face the future. What science has done for us is an oft-told tale. How it has increased the productiveness of the earth; how it has added to our necessities, our comforts, our luxuries; how it has abridged time and space; how it has made the physical world smaller and the world of mind larger, I will not rehearse. Suffice it here to say that in field or office or shop, on train or ship, in health or sickness, in peace or war, scientific knowledge is becoming the condition of success, of progress, and in the world-family the influence of a nation is proportionate to the scientific knowledge possessed by its people. We sometimes hear of man's mastery of nature, of his dominance over nature. I confess that I do not quite like the terms. A boy is said to have mastered the multiplication table when he has learned the products of the various numbers by each other, but no amount of such mastery can charge by one jot the product of any two numbers. By no degree of mastery can he make the product of 4 by 5 either more or less than 20. Neither can man dominate nature. It would be nearer the truth to say that he learns how to be dominated by nature. And such knowledge influences his almost every act. No address is quite complete without a quotation, and so I offer this from Emerson: "Nature is vast and strong, but as soon as man knows himself as its interpreter, knows that nature and he are from one source and that he when humble and obedient is nearer to the source, then all things fly into place."

But I am straying from my subject. The question is: How can the Academy, how can Wisconsin keep pace? The scientific activity of the day is great, and much work is required to keep abreast of it. To whom shall we look to do this work?

We think first of the teachers of science in our educational institutions as being best fitted by capacity, education and facilities for research, and we think of them first also because in the past they have done most of the best work. But teaching, if well done, exhausts time and energy, and time and energy are what are needed for research. We might say that the competent researcher should be spared the exhaustion of teaching and be allowed to give all his time to research. But that would be a short-sighted policy, for it is necessary that a certain number, at least, of the students should be taught research, and research can be taught successfully only by one who is himself doing research. A compromise policy seems necessary: The research-doer and teacher to be spared elementary and didactic teaching and to take only those students who are ready, and perhaps I ought to add, willing, to do research. I believe some of our higher educational institutions are now following this policy, and I think the Academy should encourage its spread. And then there are the younger teachers, equipped with education, enthusiasm, energy and stamina; with how much of hope the Academy looks upon them!

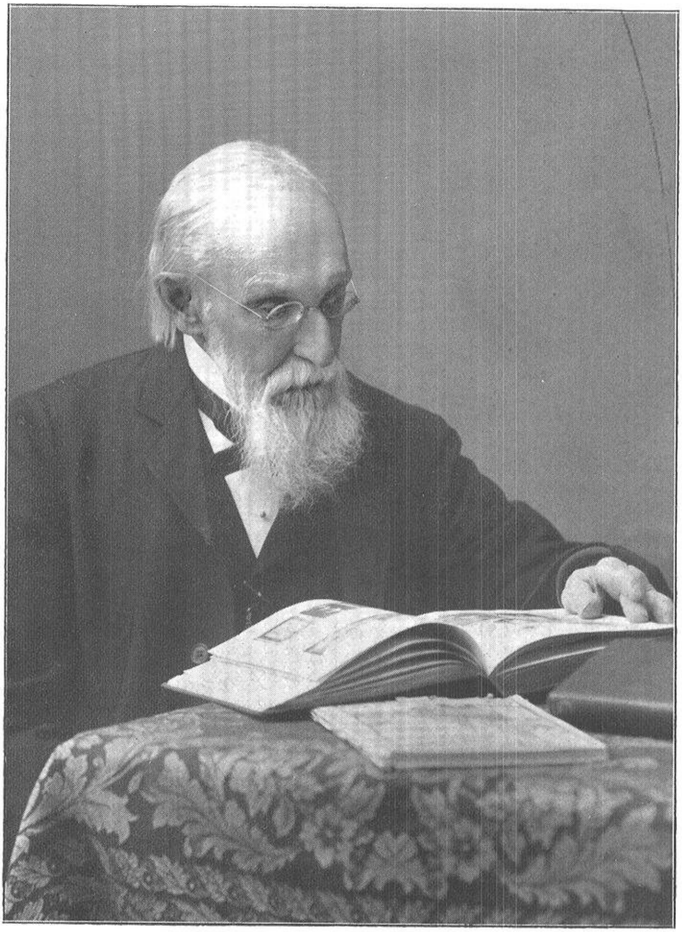
Another class toward whom we may, I think, look hopefully are the advanced and graduate students. Under the policy just referred to, the capable and eager student, under the tutelage of the wise researcher, may produce results of much value. Some of these students will become teachers and producers; some, I am sorry to say, will become teachers and non-producers. Many will pass into business and professions where their opportunities for scientific work will be curtailed but not lost. To each, if he but will, is given opportunity to add in some measure to scientific knowledge, and the collected results of numerous minor observations are often greater than any one person, whatever his labors or ability, could obtain. So also observations through a series of years will bring results obtainable in no other way. The old Scotch saying that "mony a mickle makes a muckle" holds as well in science as elsewhere. No well-informed and right-minded person considers his education completed while his powers remain. Well taught indeed is he who leaves the college knowing how to educate himself. Scientific observation and experiment have an educational value that should commend them to those who have learned that lesson and who can thus aid science while they improve their powers. The influence of the study of nature upon character I believe to be considerable. Contact with nature tends to preserve the primal qualities that characterize those of whom it was said "of such are the kingdom of Heaven," as well as to preserve something of the physical freshness and buoyancy of youth.

Research as a profession, aside from teaching, is as yet but little known in Wisconsin; but it will doubtless increase, and no matter toward what economic ends it may be directed, it will add new facts, open new fields, and contribute to the advancement of science. We have all known, now and then, men and women who had special aptitudes in certain departments of science, but who were unable to use them for the advancement of science because of lack of education. We may well believe that with the more general spread of education a larger number of those so gifted will be able to use their gifts in the furtherance of science. The material development of our state has been such as to bring, here and there, large fortunes, and we see from time to time young men and young women coming upon the field of life for whom the necessities and luxuries are provided for the present and the future. The attempts of many of the members of this class to adapt themselves to their condition have been pitiful. To many such, the work in which the Academy is engaged offers the opportunity for a useful and happy life. Most of them have been sent to college. May we not look to our institutions of higher education to give to some of these an enthusiasm, a purpose, that will carry them across the calm and languorous seas of ease, not detained by the fair isles of luxury or driven from their course by the storms of excitement, on and on to islands and archipelagoes and perchance continents as yet uncharted on the map of human knowledge? Theodore Roosevelt is reported to have said that he who does not need to devote his time and energies to the support of his family should give them to the state. But not necessarily, I take it, to statecraft. He who devotes them successfully to the furtherance of science, or of art, or of letters, gives them to all states. There is much need here in Wisconsin of investigation in physical and biological science. And then there is social and political science. Human society is not the only society, nor is it the oldest. From the older animal societies we learn that social progress has come through differentiation of function, and that this has been followed by differentiation of structure. The development of our society, of our state and nation, with its attendant complexities and differentiations, without sacrifice of those ideals of equality of opportunity and liberty of action that are so dear to every American, calls for the fullest exercise of the scientific spirit and the scientific method.

The contributions to letters that are found in the Transactions of the Academy are mostly in the domain of history, which in its methods of research and exposition is allied to science, and in philosophy—that mental gymnasium where the intellect strives and strains, and that strengthens a strong mind but may cripple a weak one. That division of letters that in its qualities of imagination and depiction is allied to art finds little representation. I will not presume to attempt to forecast letters in the Academy. Were I to do so, I would parallel to a considerable extent what I have been saying of science.

As to art, we can only say that Wisconsin is young; that it is in the vegetative stage, laying up stores of nutriment and energy that later will bring forth the flower. Might we carry the comparison further, and say that as the blossom so often comes but with the decline of vegetative activity, so art reaches its fullest development but when the vigor of a civilization is waning, and that it epitomizes the characteristics of that civilization and carries them on to succeeding civilizations?—The foundations of the Academy are laid wide and deep, and to whoever builds worthily upon them comes encouragement, sympathy, aid. The call is for workers in the sciences, in the arts, in letters, that through their labors may come a greater humanity.

And some dream dreams; dream of a time when man, having pierced the heavens with their massive spheres and titanic forces, having wrested its secrets from the infinitesimal, having searched long and diligently and patiently the dead and the quick, having thought deeply and felt much, will come to a knowledge of the Purpose and will touch the strands, yea, with knowing fingers will feed the loom wherein the future is ever being woven from the past.



JAMES DAVIE BUTLER

MEMORIAL ADDRESSES.

JAMES DAVIE BUTLER.

By the death of James Davie Butler, at his home in Madison, on the twentieth of November 1905, the Academy lost one of its earliest, and in some regards one of its most notable members. Born in Rutland, Vermont, on the fifteenth of March 1815, a scion of one of the oldest of New England families,[1] he passed hence at the ripe age of ninety years and eight months, to the last displaying a vigorous interest in the things for which this institution stands.

Prepared for college both at Rutland and at Wesleyan seminary, in Wilbraham, Massachusetts, he was graduated in 1836 from Middlebury (Vermont) college, as the salutatorian of his class; his oration being on "The Poetical Merit of the Iliad."[2] Young Butler—it is difficult for those of the present generation to imagine our patriarchal friend as a youth—then studied for a year at Yale Theological seminary, tutored for five terms at Middlebury, and in 1840 completed his theological studies at Andover, where his commencement oration was on "Chrysostom as a Preacher."[3] After two years as an Abbott resident—an early sort of fellowship at Andover—Butler

---

[1] See Butler's "Butleriana, genealogica et biographica; or Genealogical Notes concerning Mary Butler and her Descendants," etc. (Albany, N. Y., 1888.) Mary Butler was living in Boston in 1635. The author's autobiography is on pp. 56–61.

[2] Published in the *American Quarterly Register*, February 1837, pp. 235–237.

[3] Published as "Life of John Chrysostom" in *Bibliotheca Sacra*, vol. 1, pp. 669–702.

accompanied Prof. Edwards A. Park of that institution upon a prolonged European tour, then somewhat of a novel undertaking for Americans, involving many hardships as well as a considerable expenditure of time.

The travelers left New York during the last week of June 1842, in a sailing packet for Hamburg, where they arrived early in August after an ocean voyage of forty-seven days. Together they made a leisurely survey of Germany; but then separated, "in order to be forced to speak German altogether." Butler continued his journey through Austria, Italy, Switzerland and France—being for several months in residence as a student at the University of Jena—and then went to England and Scotland, reaching America towards the close of 1843. While abroad, he corresponded for the New York *Observer*, and after returning delivered in or near New England several hundred popular lectures upon his extended travels.

He was soon engaged as supply in Congregational pulpits, first at West Newbury, Massachusetts, and next at Burlington, Vermont; but after six months in each parish became a professor and acting president at Norwich (Vermont) university. Holding this chair for but two years, during which he frequently supplied pulpits, he returned definitely to the ministry (October 1847), being successively pastor of Congregational parishes in the Vermont town of Wells River and the Massachusetts town of South Danvers (now Peabody); and then taking a sudden move westward to assume charge (November 18, 1852) of the First Congregational church in Cincinnati. In January 1855 we find him professor of Greek in Wabash college, at Crawfordsville, Indiana; and at the close of the college year in 1858 accepting a call to the then starveling University of Wisconsin, as professor of ancient languages and literature. It was not long before the people of Madison—in those days a rustic town of six thousand souls—began to recognize the abilities of the stranger, then in his forty-fourth year, as is evident from an item in the *Wisconsin State Journal* for the second of December: "Prof. Butler, who has recently become connected with the State University, is an eloquent and brilliant lecturer, possessing a sharp wit, and a graphic power of description." For nearly forty-seven years thereafter his voice was probably more often heard in this community, on platform and in pulpit, than that of any other of its citizens. In 1862, his alma mater conferred upon him the honorary degree of LL. D., and thereafter our friend was universally known by his well-deserved title.

In the reorganization of the University in 1867, incident to the coming of President Chadbourne,[4] Dr. Butler withdrew from its service, never returning to the professorial career. Freedom from teaching cares was at once taken advantage of by a trip to Europe, this time through Denmark, Russia, Turkey, Greece, Palestine, Egypt, Sicily, Spain, Holland and Belgium, besides countries in which he had formerly toured. Following his home-coming, in the autumn of 1868, after an absence of fifteen months, our now well-seasoned traveler spent the winter in a lecture tour, crossed the American continent by the newly-opened railroad to the Pacific (May 1869), visited numerous western military posts, and penetrated into the then almost inaccessible Yosemite—where, when lost on Mount Broderick, he was rescued by John Muir, the celebrated naturalist, who had been his pupil at Madison. This adventure concluded, he took passage in a sailing sloop to the Hawaiian islands.

For somewhat over four years thereafter, he was in the employ of the land department of the Burlington & Missouri River Railroad company, then pushing westward from Burlington far in advance of settlement. His services consisted in editing various booklets designed to encourage immigration, publications appearing in many forms and in numerous languages and circulating by the millions. While engaged in gathering material for this purpose, our peripatetic friend journeyed extensively through the trans-Missouri country, with which he became so familiar that in later days he was enabled to review Coues' reprint of Biddle's "Lewis and Clark" from the point of view of a geographical expert.

[4] See Thwaites, "History of the University of Wisconsin" (Madison, 1900), p. 90.

In 1878 and 1884, he was again in Europe, in each protracted journey being accompanied by one of his two daughters. In 1883, he entered Portland by the first Northern Pacific train. During this period and thereafter, Dr. Butler was almost annually upon some interesting and usually prolonged tour—to Mexico, Cuba, Canada and other outlying American lands, and in the course of his several trips intimately visited each of the United States. In his seventy-sixth year, the indefatigable savant, the *Wanderlust* still strongly possessing him, rounded out his long career of studious travel by journeying alone around the globe. Leaving home in July 1890, he visited Japan, China and India, in each of which he tarried long, and through the portal of the Suez Canal revisited his beloved Europe, this time venturing as far as North Cape. He reached Madison in September 1891, after a variety of quite unusual experiences, which furnished him with a large fund of anecdote and lecture material through the fourteen happy years that still lay before him.

On the twenty-first of April 1845, while teaching at Norwich, Professor Butler married Anna, daughter of Joshua Bates, for many years president of his alma mater, Middlebury college. Their family life was ideal. Mrs. Butler, a woman of great strength and originality of character, died at Madison in 1892, leaving four children, who survive their father: James D., Henry S., and Miss Anna Butler of Superior, and Mrs. Benjamin W. Snow of Madison.

Following the career of a scholar, Professor Butler practically took no part in public affairs; but he was an active member of several learned societies, before whose meetings he frequently appeared and to whose publications he regularly contributed. The American Antiquarian society early claimed him (1854) as an associate; he belonged also to the New England Historic Genealogical society, and was a corresponding member of the Massachusetts Historical society; from 1867 until 1900, he served as a curator of the Wisconsin Historical society, and during the last decade of that term as one of its vice-presidents; he was one of the oldest members of this Academy, also one of the founders of the Madison Literary club, and for both prepared a long line of notable papers.

As a lecturer, he entertained and instructed two generations of men. His range covered a singularly wide variety of subjects in literature, art, history, antiquities, numismatics, classical study, philology, travel, pedagogics, religion and philosophy. Among his favorite travel topics were: "The Architecture of St. Peters," "The Ceremonies of Holy Week," "Naples and its Neighborhood," "Visits to Pompeii," "Alpine Rambles," "Provincial German Life" and "European Peculiarities."

The most notable and often-repeated of his early published addresses were: "Commonplace Books: Why and How Kept," "Incentives to Mental Culture among Teachers" and "How Dead Languages make Live Men." His many addresses at historical celebrations—as at the Rutland (Vermont) centennial in 1870, and at the Marietta (Ohio) centenary in 1888, on which latter occasion he was Wisconsin's representative—were vigorous and suggestive. His two addresses before the Vermont Historical society, in 1846 ("Deficiencies in our History") and 1848 ("The Battle of Bennington") were the first publications of that body. Space is lacking to cite all of his papers, for his interests were many and his pen busy; but it is proper to mention especially his monographic study on "The Portraits of Columbus" (1882), claimed to be the first English treatise on that subject, his "Prehistoric Wisconsin" (1876), and his "Once Used Words in Shakespeare" (1886), as specimen chips from his kaleidoscopic workshop.[5]

During his long career of literary activity, Dr. Butler was the author of but one book—the genealogy of his family, already cited[6]. His most important publications usually

[5] For a more detailed record, see the accompanying bibliography. The library of the Wisconsin Historical society possesses two volumes, backed *Butleriana*, into which have been bound practically a complete collection, arranged by himself, of Dr. Butler's published writings, illustrated by several family portraits and photographs of his home library.

[6] See ante, p. 897, note 1.

took the form of individual pamphlets, and of separates from the transactions of learned societies. He also issued scores of leaflets bearing upon special occasions; many of these were poems of much merit—for although without pretense in this art, he was nevertheless a facile and clever versifier. He wrote much for *Lippincott's Magazine, Bibliotheca Sacra,* the *Magazine of American History* and the *American Historical Review.* To the London *Notes and Queries,* an antiquarian journal quite after his own heart, he in some years contributed more frequently than any other correspondent. From the founding of the New York *Nation* (1865) until shortly before his death he was a constant and much valued contributor, and for that journal reviewed many important books, especially in the fields of western history and of world travel; his articles appearing in its columns numbered over two hundred. Dr. Butler's somewhat peculiar form of literary expression has been aptly characterized in an appreciative editorial in the *Nation:* "His saturation with the language of Scripture, of Shakespeare and of the Greek authors oozed up in his writings, giving a characteristic quaintness to his style; sometimes, no doubt, too redundantly."[7]

His contributions were frequently seen, either originally or reproduced, in the columns of the Madison press. This fact, added to a well-grounded reputation for general scholarship, as well as for the possession of a surprisingly varied fund of unusual knowledge—a reputation that grew with his advancing years—resulted in Dr. Butler's name being probably more often mentioned by all classes of our people than that of any other of our local celebrities.

Although retiring from the pulpit over a half-century before his death, he was until a few years ago in frequent demand throughout the Northwest as a supply preacher, almost annually served as chaplain at university commencements and other public occasions in Madison, and was a legislative chaplain up to his ninetieth birthday. Upon the afternoon of that anniversary, the members of the state senate of Wisconsin honored

[7] *Nation,* November 30, 1905, pp. 438, 439.

him with a tribute of roses and formally called upon him at his home, where, amid a concourse of friends and with a vigor apparently good for several years to come, he was holding his customary birthday reception.

Small and wiry of frame, Dr. Butler was gifted with unusual vitality, having sprung from a healthful and long-lived ancestry. This inherited tendency he still further cultivated by rigid and persistent physical training, and throughout the course of his travels won much repute as a pedestrian and swimmer. His manner was genial and democratic; he had a quaint and often merry wit, tempered by shrewd wisdom; his conversation, essays and lectures sparkled with apt quotations from Shakespeare, Milton, Dante and the classic philosophers—for he had a marvelous memory, which he was fond of exercising—and his rich equipment of curious information never failed to interest his companions.

A man of such charming disposition, with an unending fund of material for cultivated conversation, could not fail to attract friends. His extensive travels and his varied tastes threw him into intimate association with men and women of many nationalities. It was one of his keenest pleasures to conduct with them a protracted and animated correspondence; and so ubiquitous were his movements, that during at least a half-century of his life each of his friends, whether in America or abroad, might well expect Dr. Butler to knock at their doors and be welcomed any day in the year.

It was, however, in the library of the Wisconsin Historical society that his presence was most actively felt. Morning after morning, through each long winter season—it was chiefly in the summer that he was a bird of passage—he might be seen nestled in some alcove, beside a table piled high with books, cheerfully oblivious to the world about him. Such was his practice up to the last summer of his life, when through increasing feebleness his visits gradually grew less frequent, and we saw his light gently fade from our midst, as a candle sinking low into its socket.

No library assistant so gifted with prophecy as to foretell what line of authorities he might on his arrival be seeking.

One morning, possibly a vexed text in Shakespeare absorbed his interest; another, a stray scrap of American history; a genealogical puzzle, next day, or mayhap a bit of English folk-lore, or the significance of a Cornish place-name; perhaps a curious Yorkshire custom in the days of Queen Bess; the genesis of a Hebrew proverb; a new theory as to the central chamber of the Great Pyramid; an archaeological "find" just reported by cable from Delphi; an inquiry into the composition of Raphael's pigments; the higher criticism of the Bible; the latest census bulletins on race amalgamation in America; or a new-found portrait of Columbus. Yesterday, he was perhaps reviewing for the *Nation* a globe-trotter's log-book; today, he has been criticising for that journal a new edition of Lewis and Clark's tour across the continent, and revealing the fact that he is familiar with almost every river bend upon their route; tomorrow, he may be discussing in its columns the antiquity of chained libraries, the origin of slang, or the meaning of a debated line in Dante or Horace. Perhaps a stranger wandered into the library with an old coin whose history he would have unraveled; our savant would turn with alacrity from his researches far afield and good-naturedly spend an hour with the inquirer, giving him what he sought, for make-weight throwing in a quaintly-phased homily on the science of numismatics, that broadened the visitor's mental horizon. And herein we have two of the chiefest characteristics of our revered friend: breadth of scholastic taste, and winsome courtesy.

Dr. Butler's literary output was not so large as might be expected from one persistently leading a scholar's life, and who for probably forty years seemed quite undisturbed by a concern for material cares; and that output was rather suggestive than creative, seldom rising above the level of the review article, the club paper, or the minor monograph. This was disappointing to his friends, who continually were expecting more important and lasting products from his ever busy workshop. But he seemed deliberately to have set out in life determined not to be a specialist; to wear for himself no ruts in which to live and move; to maintain only a philosopher's interest in the best that travel, art, literature, the humanities, bring to man; to reap and serenely to enjoy the fruits, so far as one mind may, of universal knowledge. Looking only to his personal happiness, probably he chose his course wisely; but in our strenuous American life, this serenity is at least unusual—in the environment of an older civilization, doubtless it would have awakened no surprise. Certain it is, that in our university town the mere presence of this gentle scholar—eager always to drink of the fount of learning, an "intellectual" of the purest type—has for well nigh a half-century been in many ways a joyous inspiration to us all.

He reminded one of a bee flitting from flower to flower of differing species, resting here and there, briefly or at length as fancy dictated, but from each blossom gathering some measure of honey for his store. As for his uniform kindliness of temper, his fair, frank estimate of men and things, they charmed every one. To our "grand old man" age brought no narrowness of view, no tendency to cynicism, no crabbedness of soul; to the last he was mellow, open-hearted, joyfully responsive to the best impulses of his day. He lived and died a Christian, his every fibre imbued with an unquestioning childlike faith. He has left to us a fragrant memory that will long endure.

REUBEN GOLD THWAITES.

List of Writings by James Davie Butler, LL.D.

[This does not include articles in newspapers, of which he wrote hundreds—over two hundred for *The Nation* alone. In the preparation of this list, the writer has had the cooperation of Mr. Isaac S. Bradley of the Wisconsin Historical library.]

Homer. Poetical merit of the Iliad. [Commencement oration at Middlebury college, 1836].
American Quarterly Register, vol. 9, pp. 235-237. 1837.

Life of John Chrysostom.
Bibliotheca Sacra, vol. 1, pp. 669-702. 1844.

Deficiencies in our history. An address delivered before the Vermont Historical and Antiquarian society, at Montpelier, October 16, 1846. Montpelier, 1846. 36 p. O.

The Butler family.
New England Historical and Genealogical Register, vol. 1, pp. 167-170. 1847.

Sermon at Norwich, Vermont, February 22, 1848, during the obsequies of Truman B. Ransom, colonel of the ninth regiment. Hanover, [1848]. 20 p. O.

Discourses at Norwich, Vermont, during the obsequies of Truman B. Ransom, colonel of the New-England regiment, February twenty-second, 1848. I. A sermon by Rev. James Davie Butler. II. A eulogy, by General Frederick W. Hopkins. Hanover and Windsor, 1848. 32 p. O.
Same, reprinted by Norwich University Alumni association, 1905. 31 p. O.

An address delivered in the representatives' hall, in Montpelier, October 20, 1848 [on the battle of Bennington]. Published by order of the legislature. Burlington, 1849. 40 p. O.

Addresses on the battle of Bennington, and the life and services of Col. Seth Warner; delivered before the legislature of Vermont, in Montpelier, October 20, 1848, by James Davie Butler and George Frederick Houghton. Published by order of the legislature. Burlington, 1849. 99 p. O.
Dr. Butler's address covers pp. 5-40.

A descriptive guide to the Connecticut and Passumpsic Rivers railroad, and White mountains, with notices of the region adjoining. Also, route from the White mountains to Lake Champlain and Saratoga springs. Newbury, Vt., [1849]. 12 p. Fe.

Remarks at the dinner of the semi-centennial celebration of Middlebury college, Vermont, August 1850. 8 p. O.

From *Proceedings semi-centennial celebration of Middlebury college*, 1850, pp. 125-131.

Farewell discourse delivered before the Second Congregational church and society in Danvers, Mass., July 18, 1852. Salem, 1852. 23 p. O.

Incentives to mental culture among teachers. Boston, 1853. 33 p. D.

The characteristics of a college. Extracts from the address of Prof. J. D. Butler, of Wabash college, before the State Teachers' association.

In *Indiana School Journal*, Indianapolis, vol. 3, pp. 41-45. 1858.

Armsmear: the home, the arm, and the armory of Samuel Colt. A memorial. New York, 1866. 399 p. Q.

Chapters on the Colt revolver, the armory, and the submarine battery, mostly contributed by Dr. Butler.

Scenes in the life of Christ, and the Catholic hierarchy of the United States. Chicago, [1866]. 12 p. O.

Descriptive of three engravings. *Same*, in German, Chicago, 1866. 16 p. T.

Ibrahim of Stamboul.

Riverside Magazine, vol. 2, pp. 332-334. 1868.

Syrian Sabbath-schools. My visit to Hasbeyeh.

In *The Sunday School Scholar*, Chicago, May 1870, pp. 65-67. O.

Addresses at the centennial celebration of the settlement of Rutland, Vt., October 5, 1870.

Centennial celebration of the settlement of Rutland, Vt., Rutland, 1870, pp. 46-69, 89-93.

Greater Britain. [A review of Dilke's Greater Britain.]

In *Lakeside Reviewer*, March 1872, pp. 248-250.

Nebraska. Its characteristics and prospects. n. p. 1873. 40 p. O.

The naming of America. Madison, 1874. 19 p. O.

From *Transactions Wisconsin Academy of Sciences, Arts and Letters*, vol. 2, pp. 203-219. 1873-74.

Poematia. Blood drops, birthday lines, and other verses of society. Madison, 1874. 18 p. O.

Catalogue of coins and medals, ancient and modern, from the collection of James L. Hill. Madison, 1874. 18 p. O.

How dead languages make live men. A defense of classical studies. A paper read before the National Educational association, at Detroit, August, 1874. Worcester, Mass., 1874. 20 p. O.

Reprinted from *Proceedings National Educational Association*, 1874, pp. 187-204.

General Stark's horse lost at Bennington. Remarks at a meeting of the New England Historic Genealogical society, June 7, 1876.

New England Hist. and Gen. Register, vol. 30, pp. 366-367. 1876.

Historical sketch of the State Historical society of Wisconsin.

In *Historical Sketch of Education in Wisconsin*, 1876, pp. 113-117.

Pre-historic Wisconsin. Annual address before the Wisconsin State Historical society in the assembly chamber, February 18, 1876. 22 p. O.

From *Wisconsin Historical Collections*, vol. 7, pp. 80-101. 1876.

Westphalia medal, 1648. Report on a Holland medal found in Buffalo county, Wisconsin.

Ibid, vol. 7, pp. 102-110. 1876.

Copper tools found in the state of Wisconsin.

Transactions Wisconsin Academy of Sciences, Arts and Letters, vol. 3, pp. 99-104. 1875-76.

Governmental patronage of knowledge.

Bibliotheca Sacra, vol. 34, pp. 88-138. 1877.

A September scamper. Nebraska after three years absence. n. p. [1877.] 32 p. D.

The copper age in Wisconsin.

Proceedings American Antiquarian Society, April 25, 1877, pp. 57-63.

The uses of refuse; let the tramps be marching on.

Transactions Wisconsin State Agricultural Society, vol. 16, pp. 369-372. 1877-78.

American pre-revolutionary bibliography. Andover, 1879. 33 p. O.

From *Bibliotheca Sacra*, vol. 36, pp. 72-104. 1879.

Early historic relics of the Northwest.

Wisconsin Historical Collections, vol. 8, pp. 195-206. 1879, vol. 9, pp. 97-129.

Cheap fuel for the prairies. The Mennonite grass burner; or, The prairie pioneer's pet. [1879.] 8 p. O.

The hapax legomena in Shakespeare. 14 p. O.

From *Transactions Wisconsin Academy of Sciences, Arts and Letters*, vol. 5, pp 161-174. 1877-81. Also in *Lippincott's Magazine*, vol. 26, pp. 742-747. 1880.

First French foot-prints beyond the lakes; or, What brought the French so early into the Northwest. 56 p. O.

From *Transactions Wisconsin Academy of Sciences, Arts and Letters*, vol. 5, pp. 85-145. 1877-81.

Aboriginal use of copper in war and peace.

American Antiquarian, vol. 3, pp. 33-35. 1880-81.

Shakespeare among the Indians, early in the history of the West.

Ibid., pp. 101-104.

French foot-prints in northwestern Wisconsin.

Ibid., pp. 244-246.

Letter to the inhabitants of Rutland county, Vt. Read at the centennial celebration, March 4, 1881.

Rutland County Historical Society Publications, vol. 1, pp. 61-68. 1882.

Address at the Barron county [Wis.] fair.

Transactions Wisconsin State Agricultural Society, vol. 20, pp. 421-434. 1881-82.

Mediaeval German schools.

Bibliotheca Sacra, vol. 39, pp. 401-417. 1882.

Address on the life and character of Hon. C. C. Washburn, LL. D.

Memorial addresses on the life and character of Hon. C. C. Washburn, before the State Historical Society, 1882, pp. 32-36.

Portraits of Columbus. A monograph. Madison, 1883. 23 p. O.

From *Wisconsin Historical Collections*, vol. 9, pp. 76-96. 1882.

Portraits of Columbus.

Lippincott's Magazine, vol. 31, pp. 264-270. 1883. O.

The school life of Walafried Strabo. Translated by Prof. J. D. Butler.

Bibliotheca Sacra, vol. 40, pp. 152-172. 1883.

Commonplace books; why and how kept. 1887. 48 p. O.

Also in *Bibliotheca Sacra*, vol. 41, pp. 478-505. 1884.

The once-used words in Shakespeare. Read before the New York Shakespeare society, April 22, 1886. New York, 1886. 31 p. D.

Portraits of Columbus in Havana.

American Antiquarian, vol. 9, pp. 354-356. 1887.

Our revolutionary thunder.

Magazine of American History, vol. 18, pp. 203-205. 1887.

Alexander Mitchell, the financier. Address delivered before the State Historical society of Wisconsin, January 5, 1888. 24 p. O.

From *Proceedings of thirty-fifth annual meeting of the society*, 1888; also, in abridged form, in *Wisconsin Historical Collections*, vol. 11, pp. 435-450. 1888.

Butleriana, genealogica et biographica; or, Genealogical notes concerning Mary Butler and her descendants, as well as the Bates, Harris, Sigourney, and other families, with which they have intermarried. Albany, 1888. 162 p. O.

French fortifications near the mouth of the Wisconsin.
Wisconsin Historical Collections, vol. 10, pp. 54-63. 1888.

Tay-cho-pe-rah; the four lake country. First white foot-prints there.
Ibid., pp. 64-89.

The French two-barred cross.
American Antiquarian, vol. 10, pp. 44-45. 1888.

Wisconsin at the Marietta centennial. Address at Marietta, Ohio, July 16, 1888. 14 p. O.
From *Report of Commissioners of National Centennial Celebration*, 1888.

In the beginning. [Address at the annual banquet of the Wisconsin Alumni association, 1889.] 4 p. O.

An early decade of Wisconsin university. 8 p. O.
From *The Badger*, 1890. Madison, 1889. pp. 81-89.

A day at Delphi.
In *Report Archaeological Institute of America, Wisconsin society*, Madison, 1890, pp. 10-14.

William Francis Allen. Portrait. 1890. 3 p. O.
From *Transactions Wisconsin Academy of Sciences, Arts and Letters*, vol. 8, pp. 439-441. 1888-91.

Daniel Steele Durrie. Memorial sketch.
Proceedings Wisconsin Historical Society, 1892, pp. 73-81.

Light on Etruscan darkness.
American Antiquarian, vol. 14, pp. 106-107. 1892.

The Gill lineage.
From *New England Hist. and Gen. Register*, vol. 46, pp. 212-215. 1892. 3 p. O.

Address at the third annual banquet of the trustees of the Missouri Botanical garden [on the memory of Henry Shaw]. 7 p. O.
From *Fourth Annual Report of Missouri Botanical Garden*, pp. 37-43. 1893.

Pre-historic pottery—middle Mississippi valley.
Proceedings Wisconsin Historical Society, 1893, pp. 70-73.

Early shipping on Lake Superior. 12 p. O.
From *Proceedings Wisconsin Historical Society*, 1894, pp. 85-96.

The new found journal of Charles Floyd, a sergeant under captains Lewis and Clark. Worcester, Mass., 1894. 30 p. O.
From *Proceedings American Antiquarian Society*, April 25, 1894.

Phases of witticism.
Transactions Wisconsin Academy of Sciences, Arts and Letters, vol. 10, pp. 41-60. 1894-95.

British convicts shipped to American colonies. 1896. 33 p. O.
From *American Historical Review*, vol. 2, pp. 12-33. 1896.

George P. Delaplaine and Simeon Mills. Memorial sketches.
Transactions Wisconsin Academy of Sciences, Arts and Letters, vol. 11, pp. 523-526. 1896-97.

Codfish: its place in American history.
Id., vol. 11, pp. 261-273. 1896-97.

Dante, his quotations and his originality: the greatest imitator and the greatest original.
Id., vol. 11, pp. 149-164. 1896-97.

Father Samuel Mazzuchelli.
Wisconsin Historical Collections, vol. 14, pp. 155-161. 1898.

Household words; their etymology.
Transactions Wisconsin Academy of Sciences, Arts and Letters, vol. 13, pp. 366-383. 1900-01.

Memorial prayer at the Madison obsequies [of President McKinley], September 19, 1901.

Personal names: their significance and historical origin.
Transactions Wisconsin Academy of Sciences, Arts and Letters, vol. 13, pp. 475-485. 1902.

Brewster autograph in Wisconsin. Worcester, Mass., 1902. 6 p. O.
From *Proceedings American Antiquarian Society*, vol. 15, pp. 103-106. 1902.

The vocabulary of Shakespeare.
Transactions Wisconsin Academy of Sciences, Arts and Letters, vol. 14, pp. 40-55. 1903.

Our club's characteristics. [Read before the Madison Literary club at its 25th anniversary, 1903.] 7 p. D.

Response to the birthday greeting of the Wisconsin senate, March 15, 1905. 12 p. D.

DAVID BOWER FRANKENBURGER

No member of the faculty ever had a larger acquaintance among the student body than had Professor Frankenburger, and no member of the faculty was ever better liked. And no member of the faculty was ever more overworked, or ever voluntarily assumed the tasks that he did.

The lot of the instructional force in public speaking is far easier in these degenerate days than it was when forensic oratory flourished with a vigor that was almost violence; when the joint debater was a bigger hero than the football man now; when even each sophomore semi-public of the four literary societies in turn could draw audiences of eight hundred—more than the joint debates do now; when twice in each of the three terms in a year the best senior and junior orator, the best sophomore essayist and the best freshman declaimer appeared before the assembled University. Assembly hall (that is what the miscalled Library hall was called for years after its erection and ought to be called now, unless some man is to be commemorated in its title) was ever resounding to glowing periods of practicing debaters and orators, and Professor Frankenburger was there working with them, throwing himself into the thought of their production, amplifying it, interpreting it, supplying the appropriate gesture. Then our semi-publics alone made a force of thirty-two men to be given rehearsals, and each got at least two. Sixty-four rehearsals there, anyway, and the debaters usually got three or four. And before these rehearsals, the written matter had been gone over with the writer himself, and gone over again when the corrections had been incorporated. Night after night, along toward eleven or twelve, the owls of the student body would see a light in Assembly hall, hear a cavernous voice reverberating through its emptiness. A rehearsal, and Professor Frankenburger there to hear it.

In the morning, he heard his full complement of classes; in the afternoon, he heard essays read, which he took home and

DAVID BOWER FRANKENBURGER

corrected. Dreary things, those essays. Then there was the college paper to supervise, and the annual. This meant seeing the editors and talking with them constantly, over and above the task of correction. As the most courtly man on the faculty —I believe his colleagues will all concede this—he was in constant requisition as master of ceremonies. All social functions of the University, as such, were under his supervision. He presided at the debates, arranged the commencement exercises and supervised them. And we must not forget the correcting of some twenty commencement day orations, and the drilling of the speakers, and the correcting of the class-day literary productions and the drilling of the performers. And on top of all this, literary people in town were always asking the professor to correct and criticise their manuscripts, and he was always doing it.

We students used to wonder how he could do it all. We used to say it was a shame that one man should work so hard, should give the best in him so willingly and unselfishly. It was something we often talked about. And as we ceased to be students and talked as men, and as other people gradually realized what a burden he was carrying uncomplainingly, cheerfully—with never other than a smile and a gracious word, never out of temper after a late night with a stuffy oration in dim Assembly hall, always the same courtly gentleman of the old school—some of the burden was lifted from him. He was given assistants, a number of them. Yet he still remained one of the hardest-working men on the faculty, and his old students will believe that his last years of illness were the result of his unceasing and unselfish labor. He still gave to various literary activities in the city the same aid and encouragement he ever did. Even in his vacations, the city was demanding something of him. It was too much.

I have called him the most courtly member of the faculty. And yet he was a farmer lad. There was that other courtly man with the manners of a born aristocrat—a born aristocrat, mind you, not a money-made, self-made aristocrat—President Adams, a Vermont farmer boy who sawed wood, husked corn and wore shabby clothes in his student days at Michigan. These two farmer boys were the most courtly members of our faculty, men with the grand air, with distinguished manners, high-bred, bred on the farm. They used to say that a New England farmer's daughter could march from the farm to a *salon* and no one would ever suspect she had been anywhere else. Some of our American farmer boys also stand as types of elegance, have the *savoir faire,* an innate and perfect adaptability which they got somewhere, from some strain in their composition.

Perhaps in Professor Frankenburger it was the blood of that politest of nations, the French, or that other politest of nations, the Irish—for despite his good German name, he had French, Irish, Scotch and English in his make-up—a good mixture of strong and vigorous races. The first American Frankenburger came to this country as a youth in 1760, and was a soldier in the Revolutionary war. The name is plainly German and indicates that this first ancestor was of that ancient German stock, erroneously known as Pennsylvania Dutch. Dutch it is not. There is more French in it than Dutch, for a very considerable French element was incorporated in it from two diverse sources, Protestant refugees from France itself and Catholic Acadians after that unfortunate people were dispersed through the colonies by the English.

After the Revolution, the ancestor settled near the boundary of the three states of Virginia, Maryland and Pennsylvania, residing now in one state, now in another. In the natural mingling of blood that makes the name of any family that has been here three generations no indication of the predominant strain, the original German blood was mingled with the blood of other nationalities.

Professor Frankenburger's immediate family came to Wisconsin in 1855, settling on a farm in Green county, which was largely settled by Pennsylvanians. For nine years the boy worked on the farm, attending the district school in winter. He prepared for college at Milton academy, and at the age of twenty-one entered the University of Wisconsin, graduating in

AMOS ARNOLD KNOWLTON

1869. His graduation from the law school in 1871 was followed by seven years' successful practice of his profession in Milwaukee.

In 1879, he accepted the chair of rhetoric and oratory under the impression that in a professor's chair he would find leisure for a literary career. While in college, and in the ten years succeeding graduation, he had often courted the muses. In the decade between 1870 and 1880 he was often called upon to enliven with verse the gatherings of the alumni. Among his best poems are "My Old Home," "The Bells of Bethlehem," "Our Welcome Home."

WARDON A. CURTIS.

AMOS ARNOLD KNOWLTON.

Among the members of the Academy who passed away during the last year was Amos Arnold Knowlton, who died at his home in Madison, April 14, 1906.

He had been very ill for the last half-dozen years. Obliged to give up his university teachings in 1900 on account of a severe attack of nervous prostration, he had been unable since that time to do any regular work, and in spite of every effort to regain his health, neither rest nor medical care nor change of climate had availed to improve his condition or even to alleviate his sufferings. He spent several seasons with his brother, John Roper, of Chico, California, but for nearly two years had been at his home in Madison, gradually succumbing to the influence of the disease and the sufferings which were slowly undermining his health. During all these years, in spite of bodily suffering and depression of spirits—even to the last, during the few moments when it was still possible for him to receive the occasional visits of a friend—he retained unchanged the same lovable qualities of character that had endeared him to so many in earlier days. He still greeted all his friends with the same genial smile and kindly words and with the same cheery ring in his voice, even when he was so feeble that he was able to speak only with painful effort. His friends will always remember him as one of the most kindly and genial of men, as one whose fine personality, impulsive, generous and sympathetic in the highest degree, was so winning and lovable that no one could know him, however briefly, without liking him, or know him intimately without feeling a deep and abiding affection for him.

Although the engrossing nature of his work had left him but little time and opportunity to share very actively in the work of the Academy, and although he consequently had but limited acquaintance among those members who were not likewise his colleagues, all those who had known him personally felt very deeply the loss of the courageous and cheery spirit whom death had taken from them.

The ideals of Professor Knowlton were above all those of the teacher. As in the case of all those who have a special vocation for teaching, his interest lay not simply in the work of his students, but in the students themselves. He was intensely human and sympathetic. For him literature and life were intimately and inseparably bound up together. He was not satisfied to give mere knowledge to his students; he gave himself also, and in the most liberal measure. The subtle penetration of all his work, of all that he said and did, with his own personality, his ready sympathy, his playful wit and his large and human outlook, so free from all narrowness, pedantry and exclusiveness, gave to his teaching a stamp of validity and a power to impress itself on the fresh young minds around him, that was eminently and permanently educative. He made unremitting efforts to come into personal relations with every one whom he taught, and almost invariably a new student was for him a new friend. He took the most lively interest in all their concerns, and was ever ready to give them his ripest thought and his best counsel, to help and guide as well as to instruct them. He was therefore a universal favorite, esteemed and beloved by a multitude of youthful spirits, and in this disinterested return he found alike the great incentive and the satisfying recompense of all his unwearying efforts as a teacher.

HERMAN FREDERICK LUEDERS

He was born in Boston in 1859. An orphan at the age of five years, he was adopted by the Knowlton family of Tamworth, New Hampshire. Here he spent his boyhood on the farm. He graduated from Phillips Exeter academy in 1882, and from Bowdoin college in 1886, in which year he married. He taught in a preparatory school at Providence, Rhode Island, until 1888, after which he studied two years at the University of Leipsic. He was connected as instructor and as assistant professor with the English department of the University of Wisconsin from 1890 till 1900.

WILLIAM F. GIESE.

HERMAN FREDERICK LUEDERS.

Herman Frederick Lueders was born in Sauk City, Wisconsin, September 24, 1861. His childhood was passed quietly at home helping his father in the gardening business. He did not go to school, but with a natural thirst for knowledge applied himself diligently to his tasks at every opportunity. With the exception of a little assistance given him by his father and an elder brother, he received no instruction up to the time he entered the university.

While he was still a child, he set his heart upon a university education, but circumstances conspired against him, and the possibility of realizing it seemed more remote as he grew into manhood. When the prospect was darkest, the encouraging influence of a friend came to the rescue. By strictest economy and self-denial, and by saving all the money he earned on the neighboring farms during harvest and threshing time, he accumulated sufficient means to enter the University of Wisconsin at Madison in the autumn of 1884. Here he found that the actual expenses far exceeded the figures given him, and not willing to contract a large debt, he determined by extra effort to shorten his course if possible. He succeeded—his health paying dearly for it—and finished a four years' course in three, taking the degree of B. S. with honors in 1887.

In the same year, he secured a position as teacher of German at the high school in West Bend, remaining there one year. He was then offered the position of teacher of science and German at the Ryan high school, Appleton, which he accepted and held for three years. During this time, he was twice offered the principalship of the school, but not feeling that his ambitions lay in that direction, he declined. In 1892, he entered Harvard university to take a post-graduate course and do special work in botany, his chosen specialty. In the spring of the following year, he was taken seriously ill and was compelled to return to his home in Sauk City. Although he recovered during the summer, he did not resume his work at Harvard, for the circumstances at home in which his family lived made it necessary for him to be near them. In 1894, with his health only partially restored, he accepted the position of principal of the high school at Sauk City, continuing for two years, when broken health again compelled him to resign and seek other employment.

He had always regarded the farmers' life as ideal, partly for its independence and self-sufficiency and partly for the leisure it afforded in which to pursue other lines of work. It was then the realization of a fond ambition when he purchased a small tract of land near his father's, established bachelor's quarters thereon, and began the scientific development of his agricultural venture. It was successful from every standpoint, and among other pleasures and advantages it gave him the opportunity to pursue his literary aspirations, in which direction he had great ability.

In August 1899, he was married to Miss Edith Silverfriend, a former fellow teacher of Appleton. Conditions were now all favorable for his happiness and welfare, and the influence of his life expanded in many new directions. But again the shadow of ill-health—his Nemesis—enveloped him. The effects of early privation, self-sacrifice and overwork had still to be reckoned with. They could not be overcome. On July 2, 1904, after much suffering, he succumbed, the immediate cause being tuberculosis.

His love for botany was no doubt inherited, as his father was keenly interested in the science and was a successful gardener. When Herman was still a child, he invested a part of his savings in a copy of Gray's "Manual," and during the open season, he spent every leisure hour in roaming over the hills and through the marshes in the neighborhood of his home, and on Sunday he would make long excursions up and down the river in search of new specimens. His collection finally numbered 4,000 native species.

It was while doing special work at Harvard that his attention was directed to the study of caoutchouc. Some men of wealth who were interested in the rubber industry and who hoped to profit by some new discoveries pertaining to the structure of, and impurities in, commercial rubber, arranged with the university to pursue these investigations and founded a fellowship for this purpose. It was offered to Mr. Lueders and he accepted. It was decided that, inasmuch as only dried specimens were available for study in the laboratory, this research should be carried on in the tropics, in the home of the rubber plant. The botanical gardens at Buitenzorg, Java, were selected as the most favorable location, and Mr. Lueders began his preparations for the journey. It was a fearful blow to him to be taken very ill at this time and to be compelled to give up this interesting project. The opportunity was held open to him for a year, but as his physical condition did not materially improve, he was finally forced to abandon the idea.

Among his published contributions to science were the following:

Concerning the structure of caoutchouc: *American Journal of Science,* vol. 46. August 1893.

The vegetation of the town Prairie du Sac. *Transactions of the Wisconsin Academy of Sciences, Arts, and Letters,* vol. 10, p. 510. 1895.

Floral structure of some Gramineae: *Transactions of the Wisconsin Academy of Sciences, Arts, and Letters,* vol. 11, p. 109. 1896.

He was a devoted student of literature and political economy and lectured on these subjects quite frequently during the last years of his life.

His chief claims to distinction were his lofty character and his uncompromising devotion to principle. The patience and stoicism with which he bore pain and misfortune were remarkable, and the cheerful spirit with which he sacrificed his time, his labor and his health for his pupils, his family and others, will never be forgotten by those who knew him, for similar manifestations of unselfishness are seldom seen. Taken as he was in his prime, the world lost at once a profound thinker, a true teacher and one whose place was in the foremost ranks of God's nobility.

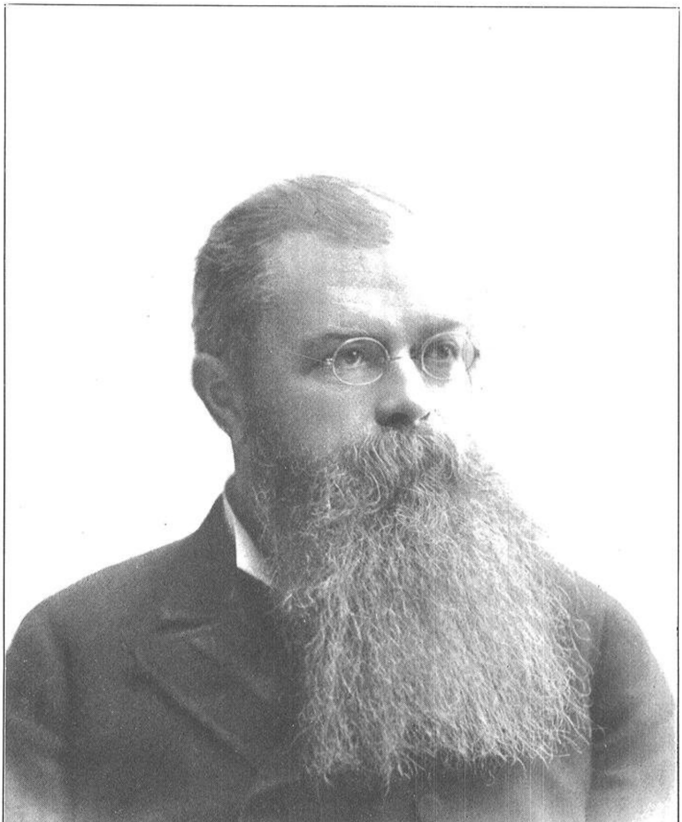
EDITH LUEDERS.

JOHN LENDRUM MITCHELL.

A name which had stood in the list of life members of the Wisconsin Academy of Sciences, Arts, and Letters for more than thirty years was removed from that place by the death of John Lendrum Mitchell, which occurred at Meadowmere, his country residence near Milwaukee, on the 29th of June 1904, in the sixty-second year of his age.

He was the son of Alexander Mitchell, a commanding figure in the material development of the Northwest, who was one of the incorporators of this Academy. His mother was Martha (Reed) Mitchell. He was born in Milwaukee, October 19, 1842. Of Scotch lineage on the one side and Yankee lineage on the other, he possessed characteristics reflecting both, though he never exerted himself in the direction of money-making. For that he had not the incentive which comes from need.

His early education was obtained in the public schools of Milwaukee. Thence he was sent to the military school at



John Lendrum Mitchell.

Hampton, Connecticut, and afterward spent six years in England, Germany and Switzerland, devoting part of this time to study at Dresden, Munich and Geneva. The outbreak of the Civil war brought him home at the age of nineteen. He assisted in raising Company I, Twenty-fourth Wisconsin Volunteer Infantry, of which he was made second lieutenant when it was mustered into the service. Later, he was promoted to a first lieutenancy and transferred to Company E of the same regiment. At different times he was assigned to duty on the staffs of Generals Sills and Rousseau, and was made ordnance officer of division. Among the engagements in which he participated were those of Perryville, Murfreesboro, otherwise known as Stone River, and Hoover's Gap. He also took part in the campaign about Chattanooga. Meantime his eyesight became seriously impaired. Incapacitated for further service, and threatened with total blindness, he resigned his commission and returned to Milwaukee.

A natural fondness for country life and the belief that outdoor occupation would repair his shattered health led him to make his home upon his beautiful farm of four hundred acres in the town of Greenfield. Here he carried out numerous experiments in improved agriculture and engaged extensively in the raising of blooded stock. His intelligent interest in progressive farming was recognized in his election to the presidency of the Wisconsin State Agricultural society and of the Northwestern Trotting Horse Breeders' association. His large and comfortable residence contained a well-selected collection of books in several languages, and some of the choicest paintings by American and European artists of the closing years of the nineteenth century.

Mr. Mitchell was greatly interested in the phase of amateur athletics developed by the revival of Scottish games which began in Milwaukee in 1867 under the auspices of St. Andrew's society. He was a liberal patron of the society for many years and was twice elected to its presidency.

In politics, Mr. Mitchell was a democrat. He served as a member of the state senate in 1872-3 and again in 1876-7. In 1890, he was elected representative in congress and was re-elected in 1892, but resigned to accept the seat in the senate of the United States for the term beginning on the 4th of March 1893, and ending in 1899. He was a member of the democratic state central committee for several years, represented Wisconsin on the democratic national committee from 1888 to 1892, and in the latter year was chairman of the democratic national congressional committee.

As a legislator, Mr. Mitchell was useful and conscientious rather than showy. He made no pretense to the gift of oratory, but when he spoke he commanded attention by reason of his mastery of facts and his candid and practical methods in dealing with public problems. His theory of government inclined him to be a strict party man. Where party issues were not involved, he was conservatively progressive. He enjoyed the confidence and esteem of his fellow senators of all shades of political opinion.

In 1886, he was appointed a member of the board of managers of the national homes for disabled volunteer soldiers, and was elected president of the board in 1895. In his capacity of resident manager of the home at Milwaukee, he endeared himself to the inmates of that institution by his constant and vigilant solicitude for their welfare. A touching spectacle at his funeral was the presence of a body of seven hundred veterans from the home, who had assembled to pay the final tribute of respect to their dead friend.

His interest in public education was manifested in many ways. In 1884-5, he was president of the Milwaukee board of school commissioners. In 1887, he placed with the superintendent of schools an order to supply at his expense free text-books to the children of parents too poor to purchase them, thus originating a worthy charity which he and others following him maintained until the expense was assumed by the city. He was conspicuous in bringing about the establishment of the short course in agriculture at the University of Wisconsin, and instituted at a considerable outlay twenty scholarships for poor boys.

Shortly after his retirement from the United States senate in 1899, Mr. Mitchell went to Europe accompanied by his family, his object being to supervise the education of his children. On this occasion, he spent more than three years abroad.

At the time of his death, Mr. Mitchell was president of the Central Investment company—the corporation which owns the Mitchell building and the Chamber of Commerce building—vice-president of the Marine National bank, director of the Northwestern National Insurance company, director of the Northwestern Trotting association, and a member of the Milwaukee chamber of commerce. He was also a member of the Milwaukee Bankers' club, of the Loyal Legion and of numerous other social and fraternal organizations.

Mr. Mitchell was twice married. His first wife was Bianca Cogswell. Of seven children by this union, but one son reached maturity and is still living. In 1878, Mr. Mitchell married Harriet Danforth Becker, who, with seven children, survived him.

Born to great wealth, Mr. Mitchell had no illusions on the subject of money tending to disqualify him for citizenship in a republic. He instinctively despised vulgar display, yet his expenditures were liberal. His enthusiasms were not sordid. By habits of studious application, which were formed early and never relaxed, he acquired a copious knowledge of many subjects, ranging from agriculture to art. He loved study for its own sake, as was illustrated when toward the close of his life he enrolled himself with his young daughter as a student at a French university, going through a course in French language and literature and at the end being rewarded with a diploma for proficiency.

He is remembered as a man of kindly nature, liberal intellectual attainments, and a lively sense of public duty.

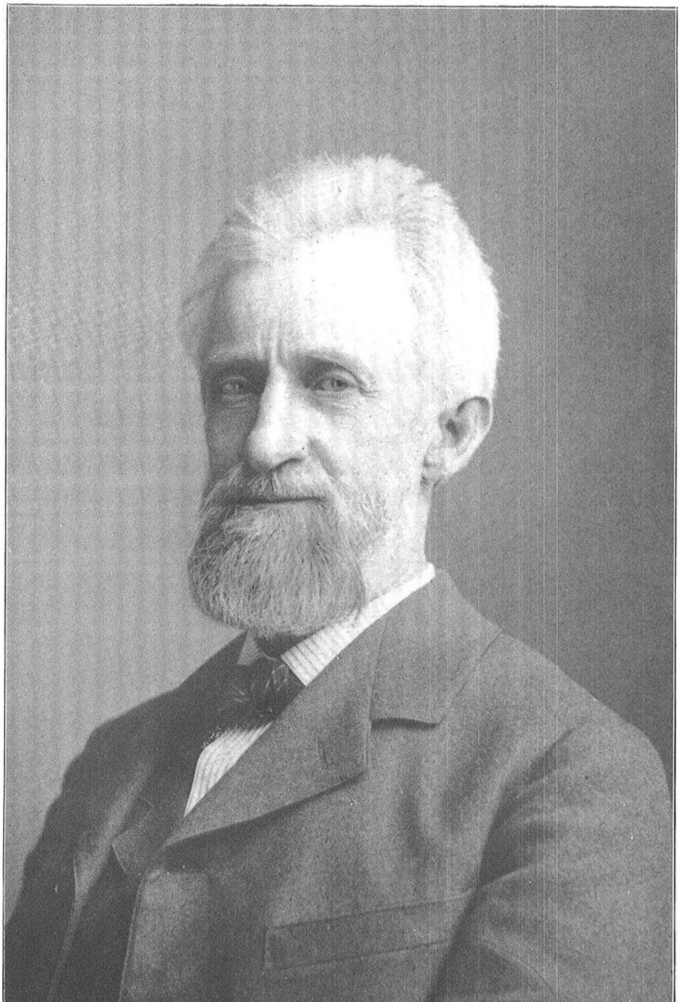
JOHN GOADBY GREGORY.

NATHANIEL SOUTHGATE SHALER.

Of the lives of but few men is it so true that cold recital of facts utterly fails to portray what the man was or what his presence meant to the community of which he was a part. Perhaps no teacher has in recent years so indelibly impressed himself upon the lives of college men as did Dean Shaler. It would be necessary to secure a composite of the memory pictures of literally thousands of students in order adequately to present the characteristics of this truly remarkable man to one who had never known him. Since in college training the spirit of teaching counts for quite as much as its subject matter, a biographical sketch of Professor Shaler, however brief, should deal as much with the characteristic habits of the man and with the incidents growing out of his contact with students, as with his scientific attainments and the honors which came to him through them, important as these were.

Professor Shaler was just past sixty-five years of age at the time of his death on the tenth of April 1906. Though a Kentuckian by birth, he was educated at the Lawrence Scientific school of Harvard university; and upon completion of his course in 1862, he hurried to Kentucky in order to enlist in the Union army. He was commissioned captain of an artillery company afterwards well known as "Shaler's Battery." A particularly active service throughout the war for the Union brought him often into positions of danger and thus contributed not a little to the fund of reminiscences for which he became famous.

While in college, he had come under the instruction of Professor Louis Agassiz, and his natural love for science had thus been greatly stimulated. Returning from the war broken in health, he became instructor in paleontology at Harvard university, and with unusual rapidity was advanced to the full rank of professor. Professor Agassiz, as is well known, did not accept the then new doctrine of evolution, and it is characteristic of Professor Shaler both that he was one of the first to accept the new doctrine, and further, that he had the temer-



NATHANIEL SOUTHGATE SHALER

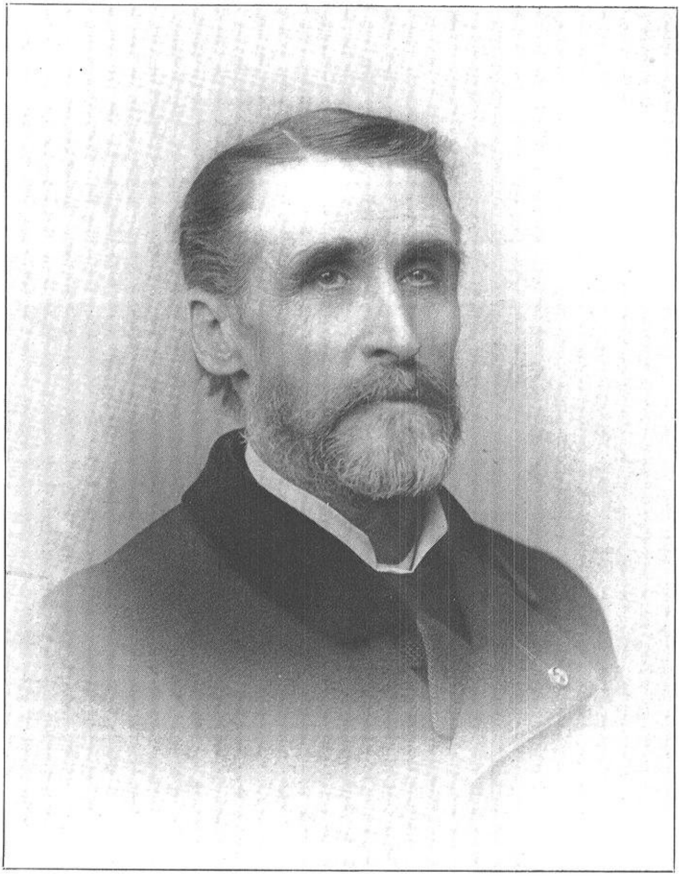
ity to preach it under the very eyes of the man who had been called the "Pope of American science."

In 1891, Professor Shaler became the dean of the Lawrence Scientific school, a position which he held until his death. During these fifteen years, the school not only increased rapidly in numbers, but advanced quite as much in the quality of the work done. Yet it could hardly have been on this account that by a common impulse the flags upon city buildings and students' clubhouses were hung at half-mast and that the shops in "Old Cambridge" were closed, upon the afternoon of Professor Shaler's funeral. Such a tribute has not been paid to any other professor of the university within the past generation. It was rather because each student felt that the dean had taken an interest in him personally and had seen to it that he was squarely dealt with. It has been said that during the last fifteen years, while Professor Shaler was dean, not a student was ill but the dean paid him a call to see that he received proper care, and those more seriously ill received daily visits. It seems also to have been Professor Shaler's custom to look into the justice's court and to inform himself concerning students arrested for pranks of one sort or another. Many a young scapegrace found guilty of sign-stealing or other petty offense, has had to thank the opportune word of the thin, wiry man with the gray pompadour for a clemency which otherwise could not have been procured.

The personality of Professor Shaler was a most striking one. Tall and spare—lanky—his strong features, piercing but kindly eyes, and his shock of iron-gray hair, made him conspicuous in any assembly. He always wore a soft slouch hat and was often heard to say that he would as soon wear an iron pot as a top hat upon his head. He was accustomed to walk with his stick tucked under his arm and his hands deep in the pockets of his coat. Indefatigable as a walker, he took the Indian gait with swinging pelvis whenever he desired to hasten. Some one has happily described his laugh as one of many stops. His lectures were garnished with good stories admirably told, and it was a perhaps unconscious habit for his eye to twinkle and his fingers to be pushed through his shock of hair when the laugh was really due. The language of his lectures was clear and forceful, with many expressive words of his own coining; and if the lectures themselves made the course an over-easy one, they seldom failed to interest, and no work in the university was more popular than the beginning course in geology officially known as "Natural History 4." His written letters had an air of distinction and were notably free from emendations or blemishes, but they could be read only by one who had mastered his personal set of hieroglyphics.

To shoulder the responsibilities of the deanship of the Lawrence school and to conduct his classes in geology and paleontology, with the additional burdens which his personal interest in the students imposed upon him, would seem to require all the time of a busy man. Yet these were but a part of the activities of this versatile man who was accustomed to work sixteen hours in the day. A very much larger circle came into touch with Professor Shaler through his published writings. Possessed of a good literary style, he was the best known popular writer in America upon scientific subjects. The range of his writings was as great as their volume, for they treated almost as much of the humanities as of the sciences. Some twenty-five or thirty volumes, besides unnumbered magazine articles and scientific papers, are left as evidence of the wide range of his thought and his amazing capacity for work.

His reader was more frequently the person of general culture than the specialist in his chosen field; though he published longer or shorter papers in the Reports of the United States Geological survey, the Bulletin of the Geological Society of America, etc. "The Story of Our Continent," "The Interpretation of Nature," "Illustrations of the Earth's Surface," "Sea and Land", "American Highways," "Domesticated Animals," "The United States of America," "Kentucky, a Pioneer Commonwealth," "The Individual," "A Study of Life and Death," "The Citizen," "The Neighbor," and "Man and the Earth," are book titles which indicate the fields where he wrote with greatest success. His system of philosophy is outlined in



STEPHEN VAUGHN SHIPMAN

the works last mentioned. When past sixty he wrote the Phi Beta Kappa poem and also a five-act drama in blank verse issued in five volumes and entitled "Elizabeth of England," to prove that prolonged scientific study does not unfit a man for literary activities.

The more strictly scientific side of Professor Shaler's activities may perhaps be best indicated by the offices which he held. Between 1862 and 1879, he was director of the Geological survey of Kentucky. From 1884 to 1890, he was geologist in charge of the Atlantic division of the United States Geological survey. He was at different times one of the Massachusetts commissioners upon the topographic atlas of the state, upon state highways, upon agriculture, and upon the extermination of the gipsy moth. In 1895 he was elected president of the Geological Society of America. He was a member of the National Academy of Sciences.

The place of Professor Shaler is one not likely soon to be filled, since the peculiar gifts which he possessed are seldom all realized in one man. His loss is one to the country at large as well as to his own community.

WILLIAM HERBERT HOBBS.

STEPHEN VAUGHN SHIPMAN.

The following sketch is taken almost verbatim from a memorial address prepared for the Illinois commandery of the Loyal Legion by Rev. Samuel Fallows, John M. Van Osdal and Obed W. Wallis.

Stephen Vaughn Shipman was born at Montrose, Pennsylvania, January 26, 1825, and received his education in the academy at that place. For several years he worked at the printing business, which was abandoned on account of failing health. He next gave his attention to the study of architecture and was associated with his father, who was a builder and contractor at Montrose, afterward at Pittsburg and finally at Philadelphia. Before leaving his native state, he had designed and superintended the erection of numerous public and private buildings. He moved to Chicago in 1854, but in the following year took up his residence at Madison, Wisconsin, with which city he afterward became prominently identified.

In 1857, he was appointed architect of the Central Wisconsin state hospital for the insane at Madison, and superintended its construction until the commencement of the Civil war. In July 1861, he entered the First Wisconsin cavalry regiment as first lieutenant of Co. G, and was soon detailed as its adjutant. He was successively promoted captain of Co. E, senior major of his regiment, and then became lieutenant-colonel and colonel of U. S. volunteers by brevet. He was wounded May 2, and September 26, 1862, at Cape Girardeau, and again severely, April 24, 1863, in a desperate engagement with overwhelming numbers of the Confederates in General Marmaduke's command, at White Water river, Missouri, which crippled him for life. Here he was captured as a prisoner of war; he was released on parole, and exchanged December 11, 1863.

He recovered sufficiently from his wounds to re-enter the field with his regiment, and participated in the numerous engagements of that command in Kentucky, Tennessee, Alabama and Georgia, ending at Macon, with Wilson's cavalry corps, at the end of the war.

He was then detailed to collect the plans and report on the condition of the extensive Confederate public buildings at Macon and Augusta, and to gather up the records of the military posts, hospitals, etc., in Georgia and western South Carolina. He was ordered to report with them and other rebel archives, including the complete records of the provisional Confederate Congress held at Montgomery, Alabama, to the Secretary of War, at Washington. Here he remained until mustered out by special order of the War department on December 6, 1865. His military record was an honor to Wisconsin and the nation. From official reports and contemporaneous newspapers, it was demonstrated that Colonel Shipman was one of the most efficient, gallant and dashing soldiers commissioned by the Badger state. Three horses were killed under him in battle, and he bore upon his body till his death the scars of many hard-fought engagements.

His famous cavalry charge, when surrounded and cut off from retreat while defending the bridge at the crossing on the White Water river, made through the attacking lines of the vastly superior force of the rebel General Marmaduke, in his celebrated raid on St. Louis, was pronounced one of the most brilliant of the war. By it he saved his whole command except fourteen killed and wounded. This splendid deed won the surprise and admiration of the enemy, and Colonel Shipman was ever afterward held by his fellow officers as a model, soldierly example. His heroic dash confirmed the maxim that cavalry should never surrender.

On returning home, he was elected city treasurer of Madison without opposition. He also resumed his profession of architect, and completed the hospital for the insane on the banks of Lake Mendota. His design for the rotunda and dome of the state capitol was adopted, and he received the appointment of architect for that structure and completed the building. He was supervising architect of the United States courthouse and post office at Madison to its final completion. He designed and superintended the construction of the northern state hospital for the insane at Oshkosh, Wisconsin, and was architect of the Iowa state hospital for the insane at Independence. He also designed and superintended the construction of the Northern Illinois state hospital for the insane at Elgin; and later rebuilt, with important additions and improvements, the Missouri state lunatic asylum, at St. Joseph. He rebuilt portions of the state prison at Waupun; designed and superintended the soldiers' orphans' home school; the Park hotel, the First National Bank building, and many other edifices at Madison, and throughout the state of Wisconsin.

He re-established an office in Chicago in 1870, and in the following year was one of the sufferers by the great fire. When he resumed business, his hands were full of commissions which he carried out with the professional skill and care for which he was noted.

The following are some of the edifices that were erected by him in Chicago: The Williams building, occupied by Edson Keith & Co.; the Presbyterian hospital; the first Academy of Music (which he rebuilt twice); the Gaff building, one of the early tall buildings; and a large number of the finest mercantile and manufacturing buildings, many private and public hospitals, courthouses, schools, churches, banks and residences throughout Chicago and the Northwest, among them the Burlington opera house at Burlington, Iowa, a noble structure.

Colonel Shipman was intimately connected with literary studies and work. He was one of the charter members of the Wisconsin Academy of Sciences, Arts and Letters, and at his death was a corresponding member of that society. He was elected its first secretary of the department of sciences, embracing the mathematical, physical, anthropological, natural and social sciences. He was connected with the State Historical society of Wisconsin since 1855 as a member and curator, and was its recording secretary until his removal to Chicago. He was made a life member and served as honorary vice-president for Illinois, until, by a revision of the constitution of the society, that office for Illinois, as for all the other states, was discontinued.

He was a corresponding member of the New England Historic Genealogical society, and an honorary member of the Bradford (Pennsylvania) Historical society. He was a fellow of the American Institute of Architects; and was twice elected president of the Chicago chapter of that institute. He was a member of the Western Association of Architects until its incorporation with the National Institute; and also of other learned societies.

He was an active member and officer of the Masonic order, and was a past commander of the Knights Templar.

His name appears in Allibone's "Dictionary of Authors," as the author of the "Shipman Family Genealogy."

Colonel Shipman was married at Harrisburg, Pennsylvania,

CHARLES FREDERICK A. ZIMMERMAN

November 4, 1850, to Cornelia, daughter of Hon. E. S. Goodrich, then secretary of state under Governor William Bigler. Of this marriage were born Annie, wife of Hon. E. S. Tomlin, of Los Angeles, California, who died March 19, 1897; Rose W., now wife of J. K. Anderson, Milwaukee, Wis.; Charles Goodrich, M. D., now of Ely, Minnesota; William V., of Bangor, Michigan; and Cornelia, of Chicago. Mrs. Shipman died at Madison, February 27, 1870. Colonel Shipman was married again at Chicago, in 1880, to Mrs. Mary Townsend Towers, who survives him.

Colonel Shipman was a most distinguished example of the power of the mind over the body and of its triumph over outward circumstances. From the hour he received his last serious wound, not a day passed but he experienced pain. Yet uncomplainingly and with marked success he carried on his varied and important work for forty years.

CHARLES FREDERICK A. ZIMMERMAN.

There was universal regret and deep sorrow in Milwaukee on the 20th of June 1906, upon the announcement of the sudden death of Professor C. F. A. Zimmerman, one of the foremost educators in the state, a veritable general of division; and the regrets will not soon cease; the sorrow is permanent.

Mr. Zimmerman was born near Stettin, Prussia, July 21, 1848, and came to Milwaukee at the age of eight years, going through the district and what is now known as the high school, and then graduating from the Platteville Normal school. He adopted teaching as a profession twenty-five years ago. For more than seventeen years, he had been principal of the seventeenth district school, Milwaukee. It would be difficult to find a flaw in his record as principal, teacher, citizen and patriot during those seventeen years. He centered his thought, his heart, his very life upon the work in hand, and the work he did during that long term will live longer than I dare to mention. Every pupil felt his influence and greatly to the benefit of each boy and girl, young woman and young man.

There was nothing superficial in his work; there was an earnestness, a devotion to duty, a desire to bring substantial and lasting results that ought to be witnessed in every one who adopts that high calling. It was superb. Hundreds of high type men and women, people of broadened minds, patriotic people, educated people, genuine lovers of their country, give this fallen soldier credit for what they are. Mr. Zimmerman was one of the earliest of Milwaukee principals to introduce the custom of patriotic services in the public schools. He not only held interesting services on the Friday before Memorial day, but had them on Washington's birthday, Lincoln's birthday, and on other occasions. He realized that the surest way to make good American citizens was to fill the hearts of the boys and girls with love for the country and the country's beautiful emblem.

The value of such a teacher as Mr. Zimmerman proved himself to be cannot be overestimated. The loss of such a teacher cannot be overestimated. There may be no towering monument at his grave, but he builded a monument a thousand times more telling than marble could make, in the building of character, as a real teacher and a genuine educator.

He never ceased to be a student. There were few if any better read men in the city. He had a ready reading knowledge of four languages, and books formed one of the great interests of his life. He could not resist the desire to own many and good books, and his private library furnishes splendid testimony to the wide range of his interests and to his discriminating taste. For a number of years previous to his death he had taken correspondence courses under the direction of the Illinois Wesleyan university. He had earned in this way the degree of A. M., and in a short time would have completed the work required for the Ph. D. degree. There was no official position in Wisconsin, outside of the judiciary, which he would not have graced. He was modest, retiring, gentle, lovable. No one could know him without admiring him. He was a firm believer in educating the people. His own six children were well educated. They all passed through his own school, graduating with honors. The three sons, Oliver Brunner, Clarence Irving and James Garfield, and one of the daughters, Viola May, were graduates of the University of Wisconsin. Oliver B. was a teacher in the College of Engineering for five years after graduation. One daughter is married, and Lillian, the youngest, is studying art. Mr. Zimmerman was married to Elizabeth Brunner, July 28, 1870. She was educated in the public schools and the Normal school at Platteville, and was a most worthy companion of a noble man.

E. B. Wolcott Post, some of whose members had been called upon to participate in the patriotic exercises of the seventeenth district school during the past fifteen years, adopted resolutions manifesting the deep sorrow its members felt at the loss of their friend and the good friend of education and the country. Dr. James C. Hodgins, pastor of the church of which Mr. Zimmerman was a member, in writing to Mrs. Zimmerman, said:—

"Your dear husband will always dwell in my memory as a perfect type of the simple-minded, pure-hearted scholar. He loved the truth as every reverent soul does, and he was so unselfish, so eager to be of noble use in God's world. What a blessed memory he leaves to you and his children! To think of such men makes the kingdom of God seem near."

And another friend wrote:—

"There are many men who have received more notoriety during their lives, but there are few who have done more for the fundamental welfare of society than this kind, great-hearted teacher."

J. A. Watrous, *Lieut.-Col. U. S. Army.*

WISCONSIN ACADEMY OF SCIENCES, ARTS, AND LETTERS.

LIST OF OFFICERS AND MEMBERS, CORRECTED TO AUGUST 1, 1907.

OFFICERS.

President,

LOUIS KAHLENBERG, University of Wisconsin, Madison.

Vice-President of Sciences,

ERMINE C. CASE, University of Michigan, Ann Arbor, Mich.

Vice-President of Arts,

CHARLES H. CHANDLER, Ripon College, Ripon.

Vice-President of Letters,

HENRY E. LEGLER, Madison.

Secretary,

CHARLES E. ALLEN, University of Wisconsin, Madison.

Treasurer,

ROLLIN H. DENNISTON, University of Wisconsin, Madison.

Librarian,

WALTER M. SMITH, University of Wisconsin, Madison.

Curator,

CHARLES E. BROWN, Milwaukee.

Council,

The President, Vice-Presidents, Secretary, Treasurer, and Past Presidents retaining their residence in Wisconsin.

Committee on Publication.

LOUIS KAHLENBERG, Madison, *President.*
CHARLES E. ALLEN, Madison, *Secretary.*
ERNEST B. SKINNER, Madison.

Committee on Library.

WALTER M. SMITH, Madison, *Librarian.*
HERBERT J. FARLEY, Appleton.
GEORGE W. PECKHAM, Milwaukee.
GEORGE WAGNER, Madison.

Committee on Membership.

CHARLES E. ALLEN, Madison, *Secretary.*
HARRIET B. MERRILL, Milwaukee.
DANA C. MUNRO, Madison.
LEWIS A. YOUTZ, Appleton.

Past Presidents.

HONORABLE JOHN W. HOYT, M. D., LL. D., Washington, D. C., 1870–75.

DR. P. R. HOY, M. D.,* 1876–78.

PRESIDENT A. L. CHAPIN, D. D.,* 1879-81.

PROFESSOR ROLAND D. IRVING, Ph. D.,* 1882-84.

PROFESSOR THOMAS C. CHAMBERLIN, Ph. D., Sc. D., LL. D., Chicago, Ill., 1885–87.

PROFESSOR WILLIAM F. ALLEN,** 1888–89.

PROFESSOR EDWARD A. BIRGE, Ph. D., Sc. D., LL. D., Madison, 1889-90.

LIBRARIAN GEORGE W. PECKHAM, LL. D., Milwaukee, 1891–93.

PRESIDENT CHARLES R. VAN HISE, Ph. D., LL. D., Madison, 1894–96.

PROFESSOR C. DWIGHT MARSH, A. M., Ph. D., Washington, D. C., 1897–99.

PROFESSOR CHARLES S. SLICHTER, M. S., Madison, 1900–1902.

DR. JOHN J. DAVIS, M. D., Racine, 1903–1905.

---

*Deceased. **Deceased December 9, 1889. Professor Birge elected to fill unexpired term.

HONORARY MEMBERS.

Agassiz, Alexander,
Harvard University, Cambridge, Mass.

A. B., S. B., LL. D. (Harvard). Director of the Museum of Comparative Zoology Emeritus, and Director of the University Museum, Harvard University.

Chamberlin, Thomas Chrowder, Hyde Park Hotel,
Chicago, Ill.

A. B. (Beloit); Ph. D. (Wisconsin, Michigan); LL. D. (Michigan, Beloit, Columbian, Wisconsin); Sc. D. (Illinois). Head of Geological Department and Director of Walker Museum, University of Chicago; Geologist in Charge of Pleistocene Work, U. S. Geological Survey; Consulting Geologist, Wisconsin Natural History Survey; Geological Commissioner, Illinois Geological Survey; Editor, *Journal of Geology*.

Gilman, Daniel Coit, 614 Park Av., Baltimore, Md.

A. B., A. M. (Yale); LL. D. (Yale, Harvard, William and Mary, Princeton, St. Johns, Columbia, North Carolina, Toronto, Wisconsin, Clark). President Emeritus, Johns Hopkins University.

Harris, William Torrey, 1360 Yale St., N. W.,
Washington, D. C.

A. M. (Yale); Ph. D. (Brown, Jena); LL. D. (Missouri, Yale, Princeton, Pennsylvania). Officier de l'Instruction Publique, France; Editor, *Journal of Speculative Philosophy;* Editor-in-Chief, Webster's International Dictionary of the English Language.

Whitman, Charles Otis, University of Chicago, Chicago, Ill.

A. B., A. M. (Bowdoin); Ph. D. (Leipzig); LL. D. (Nebraska). Head Professor of Zoology, University of Chicago; Director of Marine Biological Laboratory, Woods Holl, Mass.

LIFE MEMBERS.

BARNES, Charles Reid, University of Chicago, Chicago, Ill.

A. B., A. M., Ph. D. (Hanover). Professor of Plant Physiology, University of Chicago.

BIRGE, Edward Asahel, 744 Langdon St., Madison.

A. B., A. M. (Williams); Ph. D. (Harvard); Sc. D. (Western University of Pennsylvania); LL. D. (Williams). Professor of Zoology and Dean of the College of Letters and Science, University of Wisconsin; Secretary of Commissioners of Fisheries, Wisconsin; Director and Superintendent, Wisconsin Geological and Natural History Survey; Member, Wisconsin State Board of Forestry; President, Board of Directors, Madison Free Library.

DAVIS, John Jefferson, 504 Monument Square, Racine.

B. S. (Illinois); M. D. (Hahnemann). Physician.

FLINT, Albert Stowell, 450 Charter St., Madison.

A. B. (Harvard); A. M. (Cincinnati). Astronomer, Washburn Observatory, University of Wisconsin.

HOBBS, William Herbert, 1405 Hill St., Ann Arbor, Mich.

B. S. (Worcester Polytechnic Institute); A. M., Ph. D. (Johns Hopkins). Professor of Geology, University of Michigan.

HOYT, John Wesley, The Victoria, Washington, D. C.

A. M. (Ohio Wesleyan); M. D. (Cincinnati); LL. D. (Missouri). Chairman of the National Committee of Four Hundred to Promote the Establishment of the University of the United States.

MARSH, Charles Dwight, 3525 10th St., N. W., Washington, D. C.

A. B., A. M. (Amherst); Ph. D. (Chicago). Expert in Bureau of Plant Industry, United States Department of Agriculture.

PECKHAM, George Williams, 646 Marshall St., Milwaukee.

LL. D. (Wisconsin). Librarian, Public Library.

SHARP, Frank Chapman, 27 Mendota Court, Madison.

A. B. (Amherst); Ph. D. (Berlin). Professor of Philosophy, University of Wisconsin.

SKINNER, Ernest Brown, 210 Lathrop St., Madison.

A. B. (Ohio); Ph. D. (Chicago). Assistant Professor of Mathematics, University of Wisconsin.

SLICHTER, Charles Sumner, 636 Frances St., Madison.

B. S., M. S. (Northwestern). Professor of Applied Mathematics, University of Wisconsin; Consulting Engineer.

VAN CLEEF, Frank Louis, 39 Fort Greene Place, Brooklyn, N. Y.

A. B. (Oberlin, Harvard); Ph. D. (Bonn). Expert in Office of Commissioner of Records, Kings County.

VAN HISE, Charles Richard, 772 Langdon St., Madison.

B. Met. E., B. S., M. S., Ph. D. (Wisconsin); LL. D. (Chicago, Yale). President, University of Wisconsin; Geologist in Charge of Division of Pre-Cambrian and Metamorphic Geology, United States Geological Survey; President, Board of Commissioners, Wisconsin Geological and Natural History Survey; President, Wisconsin State Board of Forestry.

ACTIVE MEMBERS.

ALLEN, Bennet Mills, 710 Conklin Place, Madison.

Ph. B. (De Pauw); Ph. D. (Chicago). Instructor in Anatomy, University of Wisconsin.

ALLEN, Charles Elmer, 810 West Johnson St., Madison.

B. S., Ph. D. (Wisconsin). Associate Professor of Botany, University of Wisconsin.

ALLEN, Florence Eliza, 1212 West Johnson St., Madison.

B. L., M. L., Ph. D. (Wisconsin). Instructor in Mathematics, University of Wisconsin.

ALLEN, Ruth Florence, 450 Charter St., Madison.

A. B., A. M. (Wisconsin). Assistant in Botany, University of Wisconsin.

ARMSTRONG, Mary, Wauwatosa.

B. S. (Wisconsin). Teacher of Science, Wauwatosa High School.

ARZBERGER, Emil Godfrey, 224 Brooks St., Madison.

Ph. B. (Wisconsin). Assistant in Botany, University of Wisconsin.

BAETZ, Henry, 2820 Highland Boulevard, Milwaukee.

Ex-Treasurer, State of Wisconsin. Retired.

BARDEEN, Charles Russell, 625 Mendota Court, Madison.

A. B. (Harvard); M. D. (Johns Hopkins). Professor of Anatomy, and Dean of the College of Medicine, University of Wisconsin.

BARNETT, James Duff, Norman, Okla.

A. B. (Emporia); Ph. D. (Wisconsin). Instructor in Political Science, University of Oklahoma.

BARTLETT, James L., 615 State St., Madison.

B. S. (Massachusetts Agricultural and Boston). Observer, United States Weather Bureau.

BEATTY, Arthur, 1822 Jackson St., Madison.

A. B. (Toronto); Ph. D. (Columbia). Assistant Professor of English, University of Wisconsin.

BEEBE, Murray Charles, 211 Langdon St., Madison.

B. S. (Wisconsin). Associate Professor of Electrical Engineering, University of Wisconsin.

BENNER, Raymond Calvin, Tucson, Arizona.

B. S. (Minnesota); A. M. (Wisconsin). Instructor in Chemistry, University of Arizona.

BENNETT, William Chase, 936 Hackett Av., Milwaukee.

B. S. (Wisconsin); M. D. (Rush). Professor of Embryology, Wisconsin College of Physicians and Surgeons; Registrar of Vital Statistics, Milwaukee Health Department.

BLACKSTONE, Dodge Pierce, 921 Wisconsin St., Berlin.

A. B., A. M., C. E. (Union).

BLAIR, Emma Helen, 131 W. Gorham St., Madison.

B. S., A. M. (Ripon). Editor of "The Philippines, 1493-1898."

BLAKE, William Phipps, Mill Rock, New Haven, Conn., and Tucson, Arizona.

A. M. (Dartmouth); Ph. B. (Yale). Professor Emeritus of Geology and Mining, University of Arizona; Director, Arizona School of Mines; State Geologist, Arizona; Consulting Engineer and Mine Manager.

BLEYER, Willard Grosvenor, 625 Langdon St., Madison.

B. L., M. L., Ph. D. (Wisconsin). Assistant Professor of English, University of Wisconsin.

BONES, Katharine Herkimer, Box 49, Route 4, Racine.

Ph. B. (Chicago). Teacher of English and Sciences, Genoa Junction High School.

BRADLEY, Harold Cornelius, 701 Langdon St., Madison.

A. B. (California); Ph. D. (Yale). Assistant Professor of Physiological Chemistry, University of Wisconsin.

BRANDEL, Irving Walter, University Station, Seattle, Wash.

Ph. G.. M. S., Ph. D. (Wisconsin). Assistant Professor of Pharmacy, University of Washington.

BRAUN, Adolph R., 735 Eighth St., Milwaukee.

Graduate of National German-American Teachers' Seminary, Milwaukee. Teacher of German, Milwaukee Public Schools.

BRINCKLEY, William Joshua, 505 John St., Appleton.

A. B. (Salina); B. S., A. M. (De Pauw); Ph. D. (Austin). Professor of Biology, Lawrence University.

BRITTINGHAM, Thomas Evans,
640 North Henry St., Madison.

Lumber Manufacturer.

BROWN, Charles E., 1214 Chestnut St., Milwaukee.

Secretary and Curator, Wisconsin Archaeological Society.

BROWN, Charles Newton, 271 Langdon St., Madison.

LL. B. (Wisconsin). Lawyer.

BROWN, Eugene Anson, 152 East Johnson St., Madison.

M. D. (Hahnemann). Physician and Surgeon; Secretary of Board of Federal Pension Examiners, Madison District.

BROWNE, Edward Everts, Waupaca.

B. L., LL. B. (Wisconsin). District Attorney, Waupaca County; State Senator, 21st Senatorial District; Vice-President, Wisconsin State Bar Association.

BRUES, Charles Thomas, Milwaukee.

B. S., M. S. (Texas). Curator of Invertebrate Zoology, Milwaukee Public Museum.

BUEHLER, Henry Andrew, Rolla, Mo.

B. S. (Wisconsin). Geologist, Federal Lead Company.

BURGESS, Arthur Joseph, 1102 Grand Av., Milwaukee.

M. D. (Harvard). Physician; Professor of Gynecology and Clinical Gynecology, Wisconsin College of Physicians and Surgeons.

BURGESS, Charles Frederick, 1609 Adams St., Madison.

B. S., E. E. (Wisconsin). Professor of Applied Electrochemistry, University of Wisconsin.

BURKE, John F., 904 Pabst Building, Milwaukee.

BURNETT, Earle Smead, 1913 Madison St., Madison.

B. S. (Wisconsin). Research Assistant in Mechanical Engineering, University of Wisconsin.

CAIRNS, William B., 2010 Madison St., Madison.

A. B., Ph. D. (Wisconsin). Assistant Professor of American Literature, University of Wisconsin.

CARRIER, Wilbur Oscar, Waukesha.

A. B., A. M. (Albion); D. D. (Ripon). President, Carroll College.

CASE, ERMINE C., Ann Arbor, Mich.

Ph. D. (Chicago). Assistant Professor of Geology, University of Michigan.

CHANDLER, Charles Henry, Ripon.

A. B., A. M. (Dartmouth). Professor Emeritus of Mathematics and Astronomy, Ripon College.

CHANDLER, Elwyn Francis, University, N. D.

A. B.. A. M. (Ripon). Professor of Mathematics, University of North Dakota; Assistant Engineer, United States Geological Survey.

CHAPIN, Robert Coit, 7099 College Av., Beloit.

A. B., A. M. (Beloit); D. B. (Yale). Professor of Political Economy and Secretary of the Faculty, Beloit College.

CHENEY, Lellen Sterling, Barron.

B. S., M. S. (Wisconsin). Farmer.

CHRISTMAN, Arthur Henry, Menomonee Falls.

B. S. (Wisconsin).

CLAS, Alfred Charles, 640 Van Buren St., Milwaukee.

Architect (Ferry & Clas), 419 Broadway, Milwaukee; Member, Board of Park Commissioners; Director, Merchants' and Manufacturers' Association, Milwaukee; Director, Milwaukee Industrial Exposition.

CLAWSON, Arthur Brooks, 431 Lake St., Madison.

A. B. (Michigan). Assistant in Zoology, University of Wisconsin.

COFFIN, Victor, 22 Mendota Court, Madison.

Ph. D. (Cornell). Assistant Professor of European History, University of Wisconsin.

COMSTOCK, George Cary, Observatory Hill, Madison.

Ph. B. (Michigan); LL. B. (Wisconsin); Sc. D. (Michigan); LL. D. (Illinois); Professor of Astronomy, Director of Washburn Observatory and Director of Graduate School, University of Wisconsin; Secretary, Astronomical and Astrophysical Society of America.

CONGDON, Russell T., 129 Beacon St., Boston, Mass.

A. B. (Ripon). Student, Harvard Medical School.

CROSBY, Henry A., 453 Van Buren St., Milwaukee.

Clerk, Loan Department, Northwestern Mutual Life Insurance Company; Vice-President, Wisconsin Archaeological Society; Director, The Century Corporation.

CULVER, Garry Eugene, 1103 Main St., Stevens Point.

A. M. (Denison). Professor of Physical Science, State Normal School.

DANIELLS, William Willard, 515 North Carroll St., Madison.

M. S., Sc. D. (Michigan Agricultural). Professor Emeritus of Chemistry, University of Wisconsin.

DEAN, Alletta F., Madison.

Ph. B., Ph. M. (Wisconsin). Instructor in Biology, Madison High School.

DEARBORN, Walter Fenno, 218 West Gilman St., Madison.

A. B., A. M. (Wesleyan); Ph. D. (Columbia). Assistant Professor of Education, University of Wisconsin.

DENNIS, Alfred Lewis Pinneo, 518 Wisconsin Av., Madison.

A. B. (Princeton); Ph. D. (Columbia). Professor of European History, University of Wisconsin.

DENNISTON, Rollin Henry, Science Hall, Madison.

Ph. G., B. S., Ph. D. (Wisconsin). Assistant Professor of Botany, University of Wisconsin.

DERNEHL, Paul Herman, 942 Second St., Milwaukee.

B. S. (Wisconsin). Student, Johns Hopkins University Medical School.

DESMOND, Humphrey J., 395 East Water St., Milwaukee.

B. L. (Wisconsin); A. M. (Notre Dame). Lawyer.

DIETRICH, Otto, 730 Grand Av., Milwaukee.

Ph. D. (Halle). Director, Milwaukee University School.

DODGE, Robert Elkin Neil, 15 W. Gorham St., Madison.

A. B., A. M. (Harvard), Assistant Professor of English, University of Wisconsin.

DOWLING, Linnaeus Wayland, 234 Breese Terrace, Madison.

Ph. D. (Clark). Assistant Professor of Mathematics, University of Wisconsin.

DOWNES, Robert Hugh, 53 West Algoma St., Oshkosh.

B. L. (Wisconsin).

DRESDEN, Benjamin Mack, 229 New York Av., Oshkosh.

Ph. B. (Baldwin); A. M. (Wooster). Instructor in German and Director of Summer Session, State Normal School.

DUDLEY, William H., Platteville.

Instructor in Biology, State Normal School.

DUVAL, Edmund Pendleton Randolph,
214 Brooks St., Madison.

B. S. (Texas); A. M. (Harvard). Instructor in Mathematics, University of Wisconsin.

ELLIOTT, Edward Charles, 407 Wisconsin Av., Madison.

B. S., A. M. (Nebraska); Ph. D. (Columbia). Associate Professor of Education, University of Wisconsin.

ELLSWORTH, William H., 3302 Wells St., Milwaukee.

President, Ellsworth and Thayer Manufacturing Company.

ELY, Richard Theodore, 237 Prospect Av., Madison.

A. B., A. M. (Columbia); Ph. D. (Heidelberg); LL. D. (Hobart). Professor of Political Economy, University of Wisconsin; President, American Association for Labor Legislation.

ERICKSON, Frank Morton, 529 Woodside Av., Ripon.

A. B. (Wabash); A. M. (Chicago). Professor of Greek, Ripon College.

ERLANGER, Joseph, 301 Johnson Court, Madison.

B. S. (California); M. D. (Johns Hopkins). Professor of Physiology, University of Wisconsin.

FALGE, Louis, Manitowoc.

B. S. (Wisconsin); M. D. (Rush). Physician; Vice-President, Wisconsin Archaeological Society.

FARLEY, John Herbert, 637 Durkee St., Appleton.

M. S. (Lawrence). Instructor in Philosophy, Lawrence University.

FENNEMAN, Nevin Melancthon, Cincinnati, O.

A. B. (Heidelberg); A. M., Ph. D. (Chicago). Professor of Geology, University of Cincinnati.

FERRY, George Bowman, 19 Woodland Court, Milwaukee.

Architect (Ferry and Clas).

FINGER, William, 297 12th St., Milwaukee.

Insurance, Loans and Real Estate Broker.

FINKLER, Adolph, 612 Commerce St., Milwaukee.

Assistant Manager, Albert Trostel and Sons; President, Board of Trustees, National German-American Teachers' Seminary; President, German-English Academy.

FISCHER, Richard, 119 East Johnson St., Madison.

Ph. C., B. S. (Michigan); Ph. D. (Marburg). Assistant Professor of the Theory and Practice of Pharmacy, University of Wisconsin; State Chemist, Wisconsin.

FISH, Carl Russell, 625 Mendota Court, Madison.

A. B. (Brown); A. M., Ph. D. (Harvard). Associate Professor of American History, University of Wisconsin.

FLING, Harry R., 601 Jackson St., Oshkosh.

A. B. (Bowdoin); Professor of Biology, State Normal School.

FOLKMAR, Daniel, 368 Cass St., Milwaukee.

A. B., A. M. (Western); S. D. (Brussels); D. O. (Paris).

FROST, William Dodge, 310 Bruen St., Madison.

B. S., M. S. (Minnesota); Ph. D. (Wisconsin). Associate Professor of Bacteriology, University of Wisconsin.

GAY, Lucy Maria, 216 North Pinckney St., Madison.

B. L. (Wisconsin). Assistant Professor of Romance Languages, University of Wisconsin.

GIESE, William Frederick, 2022 Jefferson St., Madison.

A. B., A. M. (Harvard). Associate Professor of Romance Languages, University of Wisconsin.

GILBERT, Edward Martinius, Superior.

A. B. (Wisconsin). Instructor in Botany, State Normal School.

GILMORE, Eugene Allen, 1607 Adams St., Madison.

A. B. (De Pauw); LL. B. (Harvard). Professor of Law, University of Wisconsin.

GODDARD, Henry N., 501 College Av., Waukesha.

Ph. B. (Michigan). Professor of Biology, Carroll College.

GORDON, Mrs. George, 1144 Humboldt Av., Milwaukee.

GRAENICHER, Sigmund, 551 Seventh St., Milwaukee.

Ph. D. (Basel); M. D. (München). Physician.

GREGORY, John Goadby, 717 Jefferson St., Milwaukee.

Associate Editor, *Evening Wisconsin*.

GRIFFITH, Edward Merriam,
205 South Hamilton St., Madison.

State Forester; Member, Wisconsin State Park Commission; Lecturer in Forestry, University of Wisconsin.

HAASE, Ewald, 621 Farwell Av., Milwaukee.

Secretary, Milwaukee Gas Light Company.

HABERSTICH, Félicie M., Milwaukee.

Diploma, Academy of Neuchatel; A. M. (Coates). Professor of French and Head of Johnston Hall, Milwaukee-Downer College.

HAERTEL, Martin Henry, 1104 West Johnson St., Madison.

Ph. B. (Chicago); Ph. D. (Wisconsin). Instructor in German, University of Wisconsin.

HAESSLER, Luise,
Whittier Hall, 1230 Amsterdam Av., New York, N. Y.

A. B. (Chicago). Instructor in German, Normal College of the City of New York.

HALL, Edward Bennington, Madison.

B. S. (Drury). Assistant Geologist, Wisconsin Geological and Natural History Survey.

HANCOCK, Edward Lee, La Fayette, Ind.

B. S., M. S. (Wisconsin). Assistant Professor of Applied Mechanics, Purdue University.

HARDENBERG, Christian Bernhardus, Philadelphia, Pa.

A. B., A. M. (Wisconsin). Harrison Fellow in Zoology, University of Pennsylvania.

HARPER, Robert Almer, 444 Charter St., Madison.

A. B. (Oberlin); Ph. D. (Bonn). Professor of Botany, University of Wisconsin.

HARWOOD, Mary Corinthia, 121 Thorn St., Ripon.

B. L., M. L. (Lawrence). Professor of French and German and Dean of Women, Ripon College.

HILLYER, Homer Winthrop, Farmington, Conn.

B. S. (Wisconsin); Ph. D. (Johns Hopkins).

HOHLFELD, Alexander Rudolph, 621 Frances St., Madison.

Ph. D. (Leipzig). Professor of German, University of Wisconsin; Member of Executive Council, Modern Language Association of America; Member of Board of Administration, National German-American Teachers' Seminary, Milwaukee.

HOLLISTER, Albert Henry, 17 Langdon St., Madison.

Pharmacist.

HOLMES, Samuel Jackson, 133 East Gorham St., Madison.

B. S., M. S. (California); Ph. D. (Chicago). Assistant Professor of Zoology, University of Wisconsin.

HUBBARD, Frank Gaylord, 277 Langdon St., Madison.

A. B. (Williams); Ph. D. (Johns Hopkins). Professor of the English Language, University of Wisconsin.

HUTTON, Andrew J., Box 378, Waukesha.

Superintendent, Wisconsin Industrial School for Boys.

HYER, Frank S., 307 Division St., Stevens Point.

Institute Conductor, State Normal School.

JANA, Ashutosh,

Birulia, Haria P. O., District of Midnapur, India.

Vidyaranya. Physician; Librarian, Medinapur Scientific Library.

JASTROW, Joseph, 222 Langdon St., Madison.

A. B., A. M. (Pennsylvania); Ph. D. (Johns Hopkins). Professor of Psychology, University of Wisconsin.

JOHNSON, Arden Richard, 308 Mills St., Madison.

B. S. (Wisconsin). Assistant in Organic Chemistry, University of Wisconsin.

JOHNSON, Warren Seymour, Milwaukee Club, Milwaukee.

Mechanical Engineer.

JONES, James Lloyd, Hillside.

Dairyman and Farmer; Regent, University of Wisconsin.

JUDAY, Chancey, 610 Lake St., Madison.

A. M. (Indiana). Biologist, Wisconsin Geological and Natural History Survey.

KAHLENBERG, Louis, 234 Lathrop St., Madison.

B. S., M. S. (Wisconsin); Ph. D. (Leipzig). Professor of Chemistry, University of Wisconsin; Vice-President, American Electrochemical Society; Councilor-at-large, American Chemical Society.

KIMBALL, Mather Dean, 900 Summit Av., Milwaukee.

A. B., A. M. (Northwestern).

KIND, John Louis, The Irving, Sterling Court, Madison.

A. B., A. M. (Nebraska); Ph. D. (Columbia). Instructor in German, University of Wisconsin.

KING, Franklin Hiram, 1540 University Av., Madison.

KOELKER, William F., 422 North Henry St., Madison.

Ph. D. (Berlin). Instructor in Organic Chemistry, University of Wisconsin.

KREMERS, Edward, 1720 Jackson St., Madison.

Ph. G., B. S. (Wisconsin); Ph. D. (Göttingen). Director of Course in Pharmacy and Professor of Pharmaceutical Chemistry, University of Wisconsin.

KRUEGER, Henry, 385 27th Av., Milwaukee.

Principal, Twelfth District School, No. 1.

KUHN, Harry, Toledo, Ohio.

Clerk, with Franc, Heyn and Company.

KUTCHIN, Mrs. Harriet Lehmann,
804 Chestnut St., Missoula, Mont.

A. B. (Ripon); A. M. (Northwestern). Engaged in zoological research.

LAIRD, Arthur Gordon, 21 Mendota Court, Madison.

Ph. D. (Cornell). Assistant Professor of Greek and Comparative Philology, University of Wisconsin.

LAMB, Francis Jones, 212 North Carroll St., Madison.

Lawyer.

LANNERD, Willard, 1750 Grand Av., Racine.

B. S. (Purdue). Instructor in Science and Mathematics, Racine High School.

LEGLER, Henry E., 215 North Pinckney St., Madison.

Secretary, Wisconsin Free Library Commission; Secretary of University Extension, University of Wisconsin.

LEITH, Charles Kenneth, 240 Langdon St., Madison.

B. S., Ph. D. (Wisconsin). Professor of Geology, University of Wisconsin; Non-resident Professor of Structural and Metamorphic Geology, University of Chicago; Assistant Geologist, United States Geological Survey.

LENHER, Victor, 158 Summit Av., Madison.

Ph. D. (Pennsylvania). Professor of Chemistry, University of Wisconsin.

LIBBY, Orin Grant, 409 South Sixth St., Grand Forks, N. D.

B. L., M. L., Ph. D. (Wisconsin). Professor of History, University of North Dakota; Secretary, State Historical Society of North Dakota.

LIGHTY, William Henry, 1610 Madison St., Madison.

Ph. B. (Cornell). Secretary of Correspondence Work, University of Wisconsin.

LLOYD-JONES, Thomas R., Menomonie.

B. S. (Wisconsin). Principal, Menomonie High School.

LUTMAN, Benjamin Franklin, 310 Bruen St., Madison.

A. B. (Missouri); A. M. (Wisconsin). Fellow in Botany, University of Wisconsin.

MARCH, Herman William, 625 Langdon St., Madison.

A. B., A. M. (Michigan). Instructor in Mathematics, University of Wisconsin.

MARKS, Solon, 6 Prospect Av., Milwaukee.

M. D. (Rush). Professor Emeritus of Fractures and Dislocations and Military Surgery, Wisconsin College of Physicians and Surgeons.

MARQUETTE, William George, 542 West Johnson St., Madison.

Ph. G. (Northwestern); B. S., Ph. D. (Wisconsin). Instructor in Botany, University of Wisconsin.

MARSHALL, Ruth, Appleton.

M. S. (Wisconsin). Teacher, Appleton High School.

MARSHALL, William Stanley, 116 East Gorham St., Madison.

B. S. (Swarthmore); Ph. D. (Leipzig). Associate Professor of Entomology, University of Wisconsin.

MARSTON, Oliver Jones, 234 Elm St., Ripon.

A. B., A. M. (Greer). Professor of History and Political Economy, Ripon College.

MAURER, Edward Rose, 215 Prospect Av., Madison.

B. C. E. (Wisconsin). Professor of Mechanics, University of Wisconsin.

MCGILVARY, Evander Bradley, 1902 Arlington Place, Madison.

A. B. (Davidson); A. M. (Princeton); Ph. D. (California). Professor of Philosophy, University of Wisconsin.

MCKENNA, Maurice, 114 Third St., Fond du Lac.

Lawyer; President, Bar Association of Fond du Lac County.

MCKENNY, Charles, 2444 Prairie St., Milwaukee.

B. S. (Michigan Agricultural); A. B.. A. M. (Olivet). President, State Normal School.

MCLEOD, Andrew Fridley, 313 Mills St., Madison.

Ph. D. Instructor in Soils, University of Wisconsin.

MCMINN, Amelia, 172 21st St., Milwaukee.

B. S. (Wisconsin). Instructor in Biology, Milwaukee West Side High School.

MEACHEM, John Goldesbrough, Jr., 745 College Av., Racine.

M. D. (Rush). Physician.

MERRILL, Harriet Bell, Milwaukee Public Museum, Milwaukee.

B. S., M. S. (Wisconsin). Lecturer to Milwaukee Schools.

MERRILL, J. A., Superior.

B. S. (Harvard). Director of Science Courses, State Normal School.

MERRILL, Mrs. Sherburne S., 3355 Grand Av., Milwaukee.

First Vice-President, Wisconsin Humane Society; Second Vice-President, Woman's Club of Wisconsin; President, Public School Art League.

METZDORF, William, St. Francis.

Professor of Natural Sciences, St. Francis Seminary.

MEYER, Balthasar Henry, 1937 Arlington Place, Madison.

B. L., Ph. D. (Wisconsin). Professor of Political Economy, University of Wisconsin; Member, Wisconsin State Railroad Commission.

MILLER, William Snow, 422 North Henry St., Madison.

M. D. (Yale). Associate Professor of Anatomy, University of Wisconsin.

MITCHELL, Irving N., 2921 Cedar St., Milwaukee.

Ph. B. (Michigan). Professor of Biology, State Normal School.

MONROE, C. E., 436 Jackson St., Milwaukee.

MOODY, Seth Enoch, 919 West Johnson St., Madison.

B. S. (Dartmouth); M. S., Ph. D. (Yale). Instructor in Analytical Chemistry, University of Wisconsin.

MORRIS, William Augustus Pringle, Howard Place, Madison.

A. B. (Hamilton). Lawyer.

MUNRO, Dana Carleton, 630 Frances St., Madison.

A. B., A. M. (Brown). Professor of European History, University of Wisconsin.

NADER, John, 302 West Main St., Madison.

Architect and Civil Engineer.

NEIDIG, William Jonathan, 435 Hawthorne Place, Madison.

A. B. Instructor in English, University of Wisconsin.

NEILSON, Walter Hopper, 114 Garfield Av., Milwaukee.

M. D. (Rush). Dean of the Medical Faculty and Professor of the Principles and Practice of Medicine and Clinical Medicine, Milwaukee Medical College.

NICHOLS, Susie Percival, Shelbyville, Kentucky.

B. S. (Cornell); Ph. D. (Wisconsin).

NICHOLSON, Dexter Putnam, 534 John St., Appleton.

B. S., M. S. (Lawrence). Professor of Geology, Lawrence University.

NORTON, Richard Greenleaf, 117 West Mifflin St., Madison.

Mechanician.

NOYES, George Henry, 204 Prospect Av., Milwaukee.

A. B., LL. B., LL. D. (Wisconsin). Lawyer; General Counsel, Northwestern Mutual Life Insurance Company.

OLIN, John Myers, 762 Langdon St., Madison.

A. B., A. M. (Williams); LL. B. (Wisconsin). Lawyer; Professor of Law, University of Wisconsin.

OLIVE, Edgar William, Brookings, S. D.

B. S., M. S. (Wabash); A. M., Ph. D. (Harvard). Professor of Botany, South Dakota Agricultural College.

O'SHEA, M. Vincent, 140 Langdon St., Madison.

B. L. (Cornell). Professor of the Science and Art of Education, University of Wisconsin.

OTIS, Daniel Henry, 1717 Madison St., Madison.

M. S. (Kansas Agricultural). Assistant to the Dean of the College of Agriculture and Associate Professor of Animal Nutrition, University of Wisconsin.

OVERTON, James Bertram, 512 Wisconsin Av., Madison.

Ph. B. (Michigan); Ph. D. (Chicago). Assistant Professor of Botany, University of Wisconsin.

OWEN, Edward Thomas, 614 State St., Madison.

A. B., Ph. D. (Yale). Professor of French and Linguistics, University of Wisconsin.

PAETOW, Louis John, 972 Ninth St., Milwaukee.

B. L. (Wisconsin); Ph. D. (Pennsylvania). Instructor in History, University of Wisconsin.

PARKER, Fletcher Andrew, 14 W. Gilman St., Madison.

Professor Emeritus of Music, University of Wisconsin; Vice-President, Music Teachers' National Association.

PARKINSON, John Barber, 516 Wisconsin Av., Madison.

A. B., A. M. (Wisconsin). Vice-President and Professor Emeritus of Constitutional and International Law, University of Wisconsin.

PATTERSON, David Leslie, 621 Frances St., Madison.

B. S. (Pennsylvania State College). Instructor in History, University of Wisconsin.

PATZER, Otto, Seattle, Wash.

B. L., M. L., Ph. D. (Wisconsin). Assistant Professor of French, University of Washington.

PAULY, Hugo Albert, 536 29th St., Milwaukee.

B. S. (Wisconsin). Superintendent of Schools, Milwaukee County.

PEABODY, Arthur, 630 Frances St., Madison.

B. S. (Illinois). Supervising Architect, University of Wisconsin.

PENCE, William David, 212 West Gilman St., Madison.

C. E. (Illinois). Professor of Railway Engineering, University of Wisconsin; Engineer, Wisconsin State Board of Assessment and Wisconsin State Railroad Commission.

PEPPELL, S. V., 1538 North High St., Columbus, Ohio.

Chemical Engineer.

PERELES, James Madison, 529 Astor St., Milwaukee.

LL. B. (Wisconsin). Lawyer; President, Milwaukee Public Library; Chairman, Wisconsin Free Library Commission; President, Citizens' Trust Company.

PERELES, Jennie W. (Mrs. J. M.), 529 Astor St., Milwaukee.

Secretary, Milwaukee Flower Mission and Mission Kindergarten.

PERELES, Nellie W. (Mrs. T. J.), 535 Astor St., Milwaukee.

PERELES, Thomas Jefferson, 535 Astor St., Milwaukee.

LL. B. (Wisconsin). Lawyer; Vice-President, Citizens' Trust Company.

PERISHO, Ellwood Chappelle, Vermillion, S. D.

B. S., M. S. (Earlham); M. S. (Chicago). Professor of Geology, University of South Dakota; State Geologist, South Dakota.

PHILLER, Hugo, Waukesha.

M. D. (Greifswald). Physician; Health Commissioner, City of Waukesha.

PHILLIPS, James David, 444 Charter St., Madison.

B. S. (Illinois). Professor of Drawing, University of Wisconsin.

PLANTZ, Samuel, 545 Union St., Appleton.

A. M. (Lawrence); Ph. D. (Boston); D. D. (Albion); LL. D. (Baker). President, Lawrence University.

PORTER, William, 735 College Av., Beloit.

A. B., A. M., D. D. (Williams). Professor Emeritus of Latin, Beloit College.

POST, Harriet L., 1182 Humboldt Av., Milwaukee.

M. D. (Woman's Medical College of New York Infirmary). Instructor in Biology, East Side High School.

PRETTS, William Walter, Platteville.

B. S. (Wisconsin); M. D. (Northwestern). Physician and Surgeon; Commissioner of Health.

PRINGLE, Ralph W., Appleton.

A. B. (Harvard); M. S. (St. Lawrence). Principal, Appleton High School.

PULS, Arthur John, Wells Building, Milwaukee.

B. L. (Wisconsin); M. D. (Heidelberg). Physician; Regent, University of Wisconsin.

PUTNEY, Frank Howell, 215 Wisconsin Av., Waukesha.

Lawyer; President, Waukesha Malleable Iron Company; President, Waukesha Gas and Electric Company; President, Waukesha Springs Sanitarium; Vice-President, Waukesha National Bank.

REED, George Matthew, Columbia, Mo.

A. B. (Geneva); A. M., Ph. D. (Wisconsin). Assistant Professor of Botany, University of Missouri.

REGAN, Katherine Patricia, 123 North Butler St., Madison.

B. L. (Wisconsin). Assistant Principal, Fond du Lac High School.

REUL, Matilda E., 138 First St., Baraboo.

B. S., M. S. (Wisconsin).

RICE, Ole S., Deerfield.

B. S. (Wisconsin). Principal, Deerfield High School.

ROBINSON, Henry Douglas, Racine.

A. B., A. M. (Racine); D. D. Warden of the Grammar School, Racine College.

ROESELER, John Samuel, 316 Arlington St., Waukesha.

B. L. (Wisconsin). Principal, State Industrial School for Boys.

ROGERS, Augustus J., 318 Ogden Av., Milwaukee.

Ph. B. (Cornell). Principal, South Division High School.

ROHDE, Hugo William, 635 Second St., Milwaukee.

B. S. (Wisconsin). Chemist, with Industrial Chemical Institute.

RUENZEL, Henry Gottlieb, 733 Third St., Milwaukee.

Ph. G. (Wisconsin). Pharmacist; Member, State Board of Pharmacy.

RUSSELL, Harry Luman, 1532 University Av., Madison.

B. S., M. S. (Wisconsin); Ph. D. (Johns Hopkins). Dean, College of Agriculture, University of Wisconsin; Director, State Hygienic Laboratory.

SAGE, Adolphus H., 130 Elm St., Oshkosh.

B. S. (Cornell). Teacher of Physics, State Normal School.

SALMON, Edward Payson, 618 Church St., Beloit.

A. M. (Beloit). Congregational Minister; Second Vice-President, Board of Trustees, Beloit College.

SANBORN, John Bell, 8 West Gilman St., Madison.

B. L., M. L., Ph. D. (Wisconsin). Lawyer; Treasurer, Wisconsin State Bar Association.

SANDSTEN, Emil Peter, 221 Brooks St., Madison.

B. S., M. S. (Minnesota); Ph. D. (Cornell). Professor of Horticulture, University of Wisconsin.

SANFORD, Albert Hart, 1052 Clark St., Stevens Point.

B. L. (Wisconsin); A. B. (Harvard). Instructor in History and Civics, State Normal School.

SCHINNER, Augustin F., 628 Bay St., Superior.

D. D. Bishop.

SCHLUNDT, Herman, Columbia, Mo.

B. S., M. S., Ph. D. (Wisconsin). Assistant Professor of Physical Chemistry, University of Missouri.

SCOTT, Winfield G., 1109 Park Av., Racine.

Director, Private Testing Laboratory.

SEIFERT, Paul A., Gotham.

Ac. De. (Academy of Forestry, Tharandt, Saxony). Taxidermist.

SESSINGHAUS, Gustavus, Farrington, Mo.

M. E. (Columbia); M. S. (Wisconsin). Mining Engineer.

SEVERSON, Henry P., Winneconne.

SHELDON, Nina Mary, 421 Watson St., Ripon.

A. B. (Ripon); Fellow in English, Ripon College.

SHEPHARD, William Henry,
1623 Aldrich Av. N., Minneapolis, Minn.

Ph. B., A. M. (Wisconsin). Instructor in History, Central High School.

SHERMAN, Helen, 176 Mason St., Milwaukee.

B. S., A. M. (Wisconsin). Teacher of Science, Milwaukee East Division High School.

SHERMAN, Lewis, 176 Mason St., Milwaukee.

B. S., A. M. (Union); M. D. (New York). Physician and Pharmacist.

SIEKER, William Christian, 251 Seventeenth St., Milwaukee.

B. S. (Wisconsin). Secretary and Treasurer, Manthey-Sieker Company.

SLAUGHTER, Moses Stephen, 633 Frances St., Madison.

A. B., A. M. (De Pauw); Ph. D. (Johns Hopkins). Professor of Latin, University of Wisconsin.

SMALL, Maurice H., 190 Lincoln Av., Oshkosh.

A. B. (Colby). Professor of Psychology and Pedagogy, State Normal School.

SMITH, Edwin Raymond, 1029 University Av., Madison.

A. B. (Illinois). Instructor in Mathematics, University of Wisconsin.

SMITH, Erastus Gilbert, 649 Harrison Av., Beloit.

A. B., A. M. (Amherst); A. M., Ph. D. (Göttingen). Professor of Chemistry, Beloit College.

SMITH, Hugh Allison, 1804 Madison St., Madison.

A. B., A. M. (Missouri). Professor of Romance Languages, University of Wisconsin.

SMITH, Leonard Sewell, 939 University Av., Madison.

B. C. E., C. E. (Wisconsin). Associate Professor of Topographic and Geodetic Engineering, University of Wisconsin; Engineer State Levee Commission; In Charge of Hydrography, Wisconsin Geological and Natural History Survey; Hydrographer, United States Geological Survey.

SMITH, Walter McMynn, 112 Langdon St., Madison.

A. B. (Wisconsin). Librarian, University of Wisconsin.

SMYTHE, Sidney T., Delafield.

A. B., A. M. (St. Stephen's); B. D. (Nashotah); D. D., Ph. D. (Hobart). President, St. John's Military Academy; Member, Committee on Canons, Protestant Episcopal Church.

SNOW, Benjamin Warner, 135 West Gilman St., Madison.

Ph. D. (Berlin). Professor of Physics, University of Wisconsin.

SPARLING, Samuel Edward, 505 North Carroll St., Madison.

A. B. (Indiana); Ph. D. (Wisconsin). Assistant Professor of Political Science, University of Wisconsin; Member, National Municipal League; Member, Committee on Administration, American Political Science Association; Editor, *The Municipality;* Secretary, League of Wisconsin Municipalities.

SQUIER, George Hull, Trempealeau.

Dairyman.

STARR, William J., 135 Marston Av., Eau Claire.

LL. B. (Columbia). Member, Board of Commissioners of Fisheries, Wisconsin; President, Eau Claire Public Library.

STODDART, Charles William, 102 Spooner Av., Madison.

A. B., A. M. (Columbia). Assistant Professor of Soils, University of Wisconsin.

STOUT, Arlow Burdette, 224 Brooks St., Madison.

Student, University of Wisconsin.

TALBERT, George A., 1060 Main St., Stevens Point.

B. S., M. S. (Ohio Wesleyan). Instructor in Biology, State Normal School.

TAWNEY, Guy Allen, 717 Chapin St., Beloit.

A. B., A. M. (Princeton); Ph. D. (Leipzig). Professor of Mental Science and Philosophy, Beloit College.

TAYLOR, Albert Hoyt, Science Hall, Madison.

B. S. (Northwestern). Assistant Professor of Physics, University of Wisconsin.

TELLER, Edgar Eugene, 165 27th St., Milwaukee.

President, Wisconsin Natural History Society.

THOMAS, Edward Kirby, Superior.

B. L. (Wisconsin).

THORKELSON, Halsten Joseph Berford, 311 Charter St., Madison.

B. S., M. E. (Wisconsin). Assistant Professor of Steam Engineering, University of Wisconsin.

THWAITES, Reuben Gold, 260 Langdon St., Madison.

LL. D. (Wisconsin). Secretary and Superintendent, State Historical Society of Wisconsin; Chairman, Wisconsin Free Library Commission.

TIBBALS, Charles Austin, Jr., 515 North Henry St., Madison.

A. B. (Wisconsin). Instructor in Chemistry and Assaying, University of Wisconsin.

TITUS, Winifred, Milwaukee.

B. S., M. S. (Wisconsin). Professor of Chemistry, Milwaukee-Downer College.

TORELLE, Ellen, Milwaukee.

Ph. B., A. M. (Minnesota). Dean and Professor of Biology, Milwaukee-Downer College.

TURNEAURE, Frederick Eugene, 166 Prospect Av., Madison.

C. E. (Cornell). Professor of Engineering and Dean of the College of Engineering, University of Wisconsin.

TURNER, Frederick Jackson, 629 Frances St., Madison.

A. B., A. M. (Wisconsin); Ph. D. (Johns Hopkins). Professor of American History, University of Wisconsin; Member of Council, American Historical Association.

TYLER, Abram Ray, 920 College Av., Beloit.

A. G. O. (American Guild of Organists). Professor of Music and College Organist, Beloit College.

UIHLEIN, August, 332 Galena St., Milwaukee.

President, Second Ward Savings Bank; Secretary, Joseph Schlitz Brewing Company.

UPDIKE, Eugene Grover, 148 Langdon St., Madison.

B. S., M. S., D. D. (Lawrence). Pastor, First Congregational Church, Madison.

VAN VLECK, Edward Burr, 504 Wisconsin Av., Madison.

A. B., A. M. (Wesleyan); Ph. D. (Göttingen). Professor of Mathematics, University of Wisconsin; Editor, *Transactions of the American Mathematical Society*.

VIEBAHN, Charles Frederick, 703 Western Av., Watertown.

Superintendent of Schools and Principal of High School.

VOGEL, Guido Charles, 583 Cass St., Milwaukee.

B. S. (Wisconsin).

VORHIES, Charles Taylor, 818 West Johnson St., Madison.

B. S. (Iowa Wesleyan). Assistant in Zoology, University of Wisconsin.

VOSS, Ernst Karl Johann Heinrich,
218 West Gilman St., Madison.

Ph. D. (Leipzig). Professor of German Philology, University of Wisconsin; Vice-President, Germanic Museum Association.

WADMOND, Samuel C., Delavan.

WAGNER, George, 1901 Jefferson St., Madison.

Ph. C. (Michigan); A. B. (Kansas); A. M. (Michigan). Instructor in Zoology, University of Wisconsin.

WARD, Henry Levi, Milwaukee Public Museum, Milwaukee.

Director, Milwaukee Public Museum; Vice-President, Wisconsin Natural History Society.

WATSON, Walter S., Whitewater.

Ph. B., M. S. (Wesley). Professor of Biology and German, State Normal School.

WATTS, Oliver Patterson, 313 Johnson Court, Madison.

A. B. (Bowdoin); Ph. D. (Wisconsin). Instructor in Chemical Engineering, University of Wisconsin.

WEIDMAN, Samuel, 410 North Henry St., Madison.

B. S., Ph. D. (Wisconsin). Geologist, Wisconsin Geological and Natural History Survey.

WEST, George A., 97 Wisconsin St., Milwaukee.

Lawyer; Trustee, Milwaukee Public Museum.

WHITCOMB, Annabell Cook (Mrs. Henry F.),
721 Franklin St., Milwaukee.

President, Board of Directors, Boys' Busy Life Club.

WHITSON, Andrew Robinson, 1920 Arlington Place, Madison.

B. S. (Chicago). Professor of Soils and Drainage, University of Wisconsin; Expert in Irrigation, United States Department of Agriculture.

WILSON, Wilford M.,
Linculin Hall, Cornell University, Ithaca, N. Y.

Section Director, United States Department of Agriculture, Climate and Crop Service of the Weather Bureau.

WINGATE, Uranus O. B.,
Hotel Aberdeen, Grand Av., Milwaukee.

M. D. (Dartmouth). Professor of Nervous and Mental Diseases, Wisconsin College of Physicians and Surgeons.

WINSLOW, John Bradley, 131 Langdon St., Madison.

A. B., A. M. (Racine); LL. B., LL. D. (Wisconsin). Justice, Supreme Court of Wisconsin; President, Board of Visitors, University of Wisconsin; Trustee, Racine College.

WINTERBOTHAM, John Miller, State Capitol, Madison.

LL. B. (Wisconsin). Secretary, Wisconsin State Railroad Commission.

WOLFF, Henry Charles, 1025 University Av., Madison.

B. S., M. S. (Wisconsin). Instructor in Mathematics, University of Wisconsin.

WOLL, Fritz Wilhelm, 424 Charter St., Madison.

B. S., Ph. B. (Christiania); M. S., Ph. D. (Wisconsin). Professor of Agricultural Chemistry and Chemist to the Agricultural Experiment Station, University of Wisconsin.

WRIGHT, Clement Blake Bergin, 284 Martin St., Milwaukee.

A. B., A. M. (Toronto); B. D. (Nashotah); Ph. D. (Kansas City); Clergyman; Canon, Milwaukee Cathedral; Secretary, Diocese of Milwaukee; Librarian, Diocesan Library; Examining Chaplain; Editor, *Church Times.*

YOUTZ, Lewis Addison, Appleton.

Ph. B., M. S. (Simpson); Ph. D. (Columbia). Professor of Chemistry, Lawrence University.

ZIMMERMAN, Oliver Brunner, 201 Kelley St., Charles City, Ia.

B. S., M. E. (Wisconsin). Mechanical Engineer, with Hart-Parr Company; Honorary Vice-President, Wisconsin Audubon Society.

CORRESPONDING MEMBERS.

ABBOTT, Charles Conrad, Trenton, N. J.

M. D. (Pennsylvania).

ARMSBY, Henry Prentiss, State College, Pa.

B. S. (Worcester Polytechnic); Ph. B., Ph. D. (Yale); LL. D. (Wisconsin). Director of Experiment Station; Expert in Animal Nutrition, United States Department of Agriculture.

BASCOM, John, Park St., Williamstown, Mass.

A. B., A. M. (Williams); D. D. (Iowa); LL. D. (Amherst, Williams, Wisconsin). Greylock Commissioner.

BENNETT, Charles Edwin, 1 Grove Place, Ithaca, N. Y.

A. B., Litt. D. (Brown). Professor of Latin Language and Literature, Cornell University.

BRIDGE, Norman, Auditorium Building, Los Angeles, Cal.

A. M. (Lake Forest); M. D. (Northwestern, Rush). Emeritus Professor of Medicine, Rush Medical College.

BUCKLEY, Ernest Robertson, Rolla, Mo.

B. S., Ph. D. (Wisconsin). State Geologist and Director of the Missouri Bureau of Geology and Mines.

CAVERNO, Charles, Lombard, Ill.

A. B., A. M. (Dartmouth); LL. D. (Colorado). Clergyman, retired.

COULTER, John Merle, University of Chicago, Chicago, Ill.

A. B., A. M., Ph. D. (Hanover); Ph. D. (Indiana). Head Professor of Botany, University of Chicago.

CROOKER, Joseph Henry,
820 South St., Roslindale, Boston, Mass.

D. D. (St. Lawrence, Nashville). Minister, Unitarian Church.

DAVIS, Floyd,
317 Iowa Loan and Trust Building, Des Moines, Iowa.

Ph. B., C. E., E. M. (Missouri); Ph. D. (Miami). Analytical and Consulting Chemist.

EATON, Edward Dwight, St. Johnsbury, Vermont.

A. B., A. M. (Beloit); B. D. (Yale); LL. D. (Wisconsin); D. D. (Northwestern, Yale). Pastor, North Congregational Church, St. Johnsbury.

ECKELS, William Alexander, Oxford, Ohio.

A. B., A. M. (Dickinson); Ph. D. (Johns Hopkins). Professor of Greek, Miami University.

FALLOWS, Samuel, 967 West Monroe Av., Chicago, Ill.

A. B., A. M., LL. D. (Wisconsin); D. D. (Lawrence, Marietta). Presiding Bishop, Reformed Episcopal Church; President, Board of Managers, Illinois State Reformatory.

HENDRICKSON, George Lincoln,
5609 Monroe Av., Chicago, Ill.

A. B. (Johns Hopkins); L. H. D. (Western Reserve). Professor of Latin, University of Chicago.

HIGLEY, William Kerr, Lincoln Park, Chicago, Ill.

Ph. M. (Michigan). Secretary, Chicago Academy of Sciences; Editor, *Birds and Nature.*

HODGE, Clifton Fremont, 3 Charlotte St., Worcester, Mass.

A. B. (Ripon); Ph. D. (Johns Hopkins). Professor of Physiology and Neurology, and Professor of Biology in the Collegiate Department, Clark University.

HOLDEN, Edward Singleton,
United States Military Academy, West Point, N. Y.

B. S., A. M. (Washington); S. D. (Pacific); LL. D. (Wisconsin, Columbia). Astronomer.

HOLLAND, Frederic May, Main St., Concord, Mass.

A. B. (Harvard). Retired Clergyman.

HOSKINS, Leander Miller, 365 Lincoln Av., Palo Alto, Cal.

M. S., C. E. (Wisconsin). Professor of Applied Mathematics, Leland Stanford Jr. University.

IDDINGS, Joseph Paxson, 5730 Woodlawn Av., Chicago, Ill.

Ph. B. (Yale). Professor of Petrology, University of Chicago; Geologist, United States Geological Survey.

KINLEY, David, Urbana, Ill.

A. B. (Yale); Ph. D. (Wisconsin). Dean of the Graduate School and Professor of Economics, University of Illinois.

LEVERETT, Frank, Ann Arbor, Mich.

B. Sc. (Iowa Agricultural). Geologist, United States Geological Survey.

LURTON, Freeman Ellsworth, Fergus Falls, Minn.

B. S., M. S. (Carleton); A. M. (Upper Iowa); Ph. D. (Gale). Superintendent of Public Schools; Member, Board of Directors, Fergus Falls Public Library.

LUTHER, George Elmer,
262 South College Av., Grand Rapids, Mich.

Cashier, Peoples' Savings Bank; Treasurer, Historical Society of Grand Rapids.

MARX, Charles David, Palo Alto, Cal.

B. C. E. (Cornell); C. E. (Karlsruhe). Professor of Civil Engineering, Leland Stanford Jr. University.

McCLUMPHA, Charles Flint,
180 East Main St., Amsterdam, N. Y.

A. B., A. M. (Princeton); Ph. D. (Leipzig).

MOOREHOUSE, George Wilton,
2069 East 96th St., Cleveland, O.

B. L., M. L. (Wisconsin); M. D. (Harvard). Physician to the Dispensary of Lakeside Hospital and Western Reserve University.

NEHRLING, Henry, Palm Cottage Experiment Garden,
Gotha, Orange County, Fla.

PEET, Stephen Denison, 438 57th St., Chicago, Ill.

A. M., Ph. D. (Beloit). Clergyman; Editor, *American Antiquarian and Oriental Journal.*

POTTER, William Bleecker, 1225 Spruce St., St. Louis, Mo.

A. B., A. M., M. E., Sc. D. (Columbia). Mining Engineer and Metallurgist.

POWER, Frederick Belding, 535 Warren St., Hudson, N. Y.

Ph. G. (Philadelphia College of Pharmacy); Ph. D. (Strassburg). Director of Wellcome Chemical Research Laboratories, London, England.

SALISBURY, Rollin D., University of Chicago, Chicago, Ill.

A. M., LL. D. (Beloit). Professor of Geographic Geology, Head of the Department of Geography and Dean of the Graduate School of Science, University of Chicago; Geologist, United States Geological Survey and State Geological Survey of New Jersey.

SAWYER, Wesley Caleb, 725 Asbury St., San Jose, Cal.

A. B., A. M. (Harvard); A. M., Ph. D. (Göttingen). Professor of French and German and Lecturer on Teutonic Mythology, University of the Pacific.

STONE, Ormond, University Station, Charlottesville, Va.

A. M. (Chicago). Director of the Leander McCormick Observatory and Professor of Practical Astronomy, University of Virginia.

TOLMAN, Albert Harris, 5407 Woodlawn Av., Chicago, Ill.

A. B. (Willia[illegible]); Ph. D. (Strassburg). Assistant Professor of English Literature, Un[illegible]rsity of Chicago.

TOLMAN, Herbert Cushing, Nashville, Tenn.

A. B., Ph. D. (Yale); D. D. (Nashville). Professor of Greek, Vanderbilt University; Canon, All Saints' Cathedral.

TOWNLEY, Sidney Dean, Ukiah, Cal.

B. S., M. S. (Wisconsin); Sc. D. (Michigan). Astronomer in Charge of International Latitude Observatory; Lecturer in Astronomy, University of California; Editor of Publications, Astronomical Society of the Pacific.

TRELEASE, William, Botanical Garden, St. Louis, Mo.

B. S. (Cornell); S. D. (Harvard); LL. D. (Wisconsin, Missouri, Washington University). Director of Missouri Botanical Garden and Henry Shaw School of Botany; Engelmann Professor of Botany, Washington University; Vice-President, Academy of Science of St. Louis; Secretary, The Round Table, St. Louis; Honorary President, Engelmann Botanical Club, St. Louis; Chairman, City Plans Committee, Civic League, St. Louis.

VAN DE WARKER, Ely, 404 Fayette Park, Syracuse, N. Y.

M. D. (Albany Medical and Union). Surgeon, Central New York Hospital for Women; Consulting Physician, St. Ann's Maternity Hospital; Senior Surgeon, Women's and Children's Hospital; Commissioner of Education, Syracuse.

VERRILL, Addison Emery, 86 Whalley Av., New Haven, Conn.

B. S. (Harvard); A. M. (Yale). Professor of Zoology, Yale University; Curator of Zoology, Yale University Museum; President, Connecticut Academy of Arts and Sciences.

WINCHELL, Newton Horace,
113 State St., Minneapolis, Minn.

A. M. (Michigan). Geologist and Archaeologist.

YOUNG, Albert Adams,
531 South Claremont Av., Chicago, Ill.

A. B., A. M. (Dartmouth); B. D. (Andover). Clergyman.

MEMBERS DECEASED

Information of whose decease has been received since the issue of Volume XIV.

ANDREWS, Edmund, January 1904, at Chicago, Ill.

A. B., A. M., M. D., LL. D. (Michigan). Professor of Clinical Surgery, Northwestern University; Surgeon, Mercy Hospital; Consulting Surgeon, Michael Reese Hospital and Illinois Hospital for Women and Children.

BUTLER, James Davie, November 20, 1905, at Madison.

A. B., A. M., LL. D. (Middlebury). Minister and Teacher.

FRANKENBURGER, David Bower, February 6, 1906, at Madison.

Ph. B., LL. B., A. M. (Wisconsin). Professor of Rhetoric and Oratory, University of Wisconsin.

HALSEY, Rufus H., July 25, 1907, at Gogebic, Mich.

A. B. (Williams). President, State Normal School, Oshkosh.

KNOWLTON, Amos Arnold, April 14, 1906, at Madison.

A. B., A. M. (Bowdoin).

LUEDERS, Herman Frederick, July 2, 1904, at Sauk City.

B. S. (Wisconsin).

SHALER, Nathaniel Southgate, April 10, 1906, at Cambridge, Mass.

B. S., S. D., LL. D. (Harvard). Professor of Geology, Harvard University; Dean of the Lawrence Scientific School.

SHIPMAN, Stephen Vaughn, November 12, 1905, at Chicago, Ill.

Architect.

ZIMMERMAN, Charles Frederick A., June 20, 1906, at Milwaukee.

Ph. B. (Illinois Wesleyan); A. M. (Charles City). Principal, Seventeenth District School.

LIST OF EXCHANGES

OF THE

WISCONSIN ACADEMY OF SCIENCES, ARTS, AND LETTERS.

GEORGE WAGNER.

The following list contains the names of all the organizations and publications with which the Wisconsin Academy has exchange relations at this date, July 1, 1907. The organizations marked with an asterisk are those whose publications are received through the Wisconsin Geological and Natural History survey. They do not, however, in any way represent the full extent of cooperation between the Academy and the Survey. It is only by such cooperation that we are enabled to arrange exchanges with many societies, and to receive the entire publications of others. In such cooperation, moreover, the University of Wisconsin also has taken a prominent part.

It is highly desirable that those who may use this list should submit the names of any organizations not found therein, which they know to publish material of scientific value.

It should also be remembered that the Academy owns many sets of publications of organizations now defunct or no longer publishing, and whose names therefore are not to be found in this list.

NORTH AMERICA.

UNITED STATES.

Albany, N. Y.
New York State Library.

Ann Arbor, Mich.
Michigan Academy of Sciences.

Austin, Tex.
Texas Academy of Science.

Baltimore, Md.
Johns Hopkins University.

Beloit, Wis.
Library of Beloit College.

Berkeley, Cal.
University of California.

Boston, Mass.
American Academy of Arts and Sciences.
Boston Society of Natural History.
Massachusetts Institute of Technology.
Psyche, an Entomological Journal.

Brooklyn, N. Y.
Brooklyn Institute of Arts and Sciences.
New York Entomological Society.

Buffalo, N. Y.
Buffalo Society of Natural Sciences.

Cambridge, Mass.
American Ornithological Union.
Library of Harvard University.
*Museum of Comparative Zoology, Harvard University.

Champaign, Ill.
Illinois State Laboratory of Natural History.

Chapel Hill, N. C.
The Elisha Mitchell Scientific Society.

Chicago, Ill.
Chicago Academy of Sciences.
Field Columbian Museum.
John Crerar Library.
Journal of Geology, University of Chicago.

Cincinnati, O.
Cincinnati Society of Natural History.
Lloyd Museum and Library.

Cold Spring Harbor, N. Y.
Station for Experimental Evolution.

Colorado Springs, Colo.
Colorado College Scientific Society.

Columbia, Mo.
University of Missouri.

Columbus, O.
*Geological Survey of Ohio.
Mycological Bulletin.
Ohio Academy of Sciences.
Ohio Archaeological and Historical Society.
Ohio State University.

Davenport, Iowa.
Davenport Academy of Natural Science.

Denver, Colo.
The Colorado Scientific Society.

Des Moines, Iowa.
Iowa Academy of Sciences.

Granville, O.
Denison University.

Hartford, Conn.
*State Geological and Natural History Survey of Connecticut.

Indianapolis, Ind.
*Geological Survey of Indiana.
Indiana Academy of Science.

Iowa City, Iowa.
State University of Iowa, Natural History Laboratory.

Ithaca, N. Y.
Cornell University.

Joliet, Ill.
Fern Bulletin.

Lawrence, Kan.
University of Kansas.

Lincoln, Neb.
Nebraska Academy of Sciences.
University of Nebraska.

Medford, Mass.
Tufts College.

Milwaukee, Wis.
Public Library.
Public Museum.
Wisconsin Archaeological Society.
Wisconsin Natural History Society.

Minneapolis, Minn.
*Geological and Natural History Survey.
Minnesota Academy of Natural Science.

Montgomery, Ala.
*Geological Survey of Alabama.

New Brighton, N. Y.
Natural Science Association of Staten Island.

New Haven, Conn.
Connecticut Academy of Arts and Sciences.

New York, N. Y.
American Geographical Society.
American Museum of Natural History.
Apotheker Zeitung.
Columbia University, School of Mines.
Linnean Society.
New York Academy of Sciences.
New York Botanical Garden.

Northfield, Minn.
Goodsell Observatory.

Oberlin, O.
Wilson Bulletin.

Pasadena, Cal.
Cooper Ornithological Club.

Philadelphia, Pa.
Academy of Natural Science.
American Philosophical Society.
Association of Engineering Societies.
Franklin Institute.
Philadelphia Commercial Museum.
University of Pennsylvania.

Pittsburg, Pa.
Carnegie Museum.

Portland, Me.
Portland Society of Natural History.

Poughkeepsie, N. Y.
Vassar Brothers Institute.

Providence, R. I.
Roger Williams Park Museum.

Ripon, Wis.
Ripon College.

Rochester, N. Y.
Rochester Academy of Sciences.

Rolla, Mo.
*Missouri Geological Survey.

Salem, Mass.
Essex Institute.

St. Louis, Mo.
Academy of Science of St. Louis.
Missouri Botanical Garden.

San Francisco, Cal.
California Academy of Sciences.

Sioux City, Iowa.
Academy of Sciences and Letters.

Syracuse, N. Y.
Zoological Laboratory, Syracuse University.

Topeka, Kan.
Kansas Academy of Sciences.

Trenton, N. J.
*Geological Survey of New Jersey.

Washington, D. C.
Bureau of Ethnology.
Department of Agriculture.
Entomological Society of Washington.
National Academy of Sciences.
National Geographical Society.
Philosophical Society of Washington.
Smithsonian Institution.
United States Geological Survey.
United States National Museum.
United States Weather Bureau.
Washington Academy of Sciences.

Worcester, Mass.
American Antiquarian Society.
Worcester Natural History Society.

BRITISH AMERICA.

Guelph, Ont.
Wellington Field Naturalists' Club.

Halifax, N. S.
Nova Scotian Institute of Science.

Hamilton, Ont.
Hamilton Scientific Association.

London, Ont.
Entomological Society of Ontario.

Montreal, Que.
McGill University Library.
Natural History Society.

Ottawa, Ont.
Literary and Scientific Society.
Ottawa Field Naturalists' Club.
Royal Society of Canada.

St. Johns, N. B.
Natural History Society of New Brunswick.

Toronto, Ont.
Astronomical and Physical Society.
Canadian Institute.

Winnipeg, Man.
Manitoba Historical and Scientific Society.

MEXICO.

Mexico.
*Instituto Geológico de México.
Museo Nacional.
Sociedad Cientifica "Antonio Alzate."
Sociedad Farmaceutica Mexicana.
*Sociedad Geologica Mexicana.
Sociedad Mexicana de Historia Natural.

Tacubaya.
Observatorio Astronomico Nacional.

Toluca.
Instituto Cientifico y Literario "Porfirio Diaz."

SOUTH AMERICA.

Buenos Aires, Argentina.
Instituto Geografico Argentino.
Museo Nacional de Buenos Aires.
Sociedad Cientifica Argentina.

Cordoba, Argentina.
Academia Nacional de Ciencias.
Oficina Meteorologica Argentina.

La Plata, Argentina.
Direccion General de Estadistica de la Provincia de Buenos Aires.

Lima, Peru.
Revista de Ciencias.
Sociedad Geográfica.

Montevideo, Uruguay.
Museo Nacional.

Para, Brazil.
Museu Göldi.

Rio de Janeiro, Brazil.
Instituto Historico Geographico y Ethnographico.
Museo Nacional.

San Paulo, Brazil.
Sociedade Scientifica.
Museu Paulista.

Santiago, Chile.
Deutscher Wissenschaftlicher Verein.
Sociedad Cientifica de Chile.

AFRICA.

Bone, Algeria.
Académie d'Hippone. Société de Recherche Scientifique et d' Acclimatation.

Cairo, Egypt.
Institut Egyptien.

Cape Town, South Africa.
*Geological Commission of South Africa.
South African Philosophical Society.

Grahamstown, South Africa.
Albany Museum.

Pietermaritzburg, Natal.
Geological Survey of Natal and Zululand.
Government Museum of Natal.

ASIA AND AUSTRALASIA.

Adelaide, South Australia.
Royal Geographical Society.

Batavia, Java.
Koninklijke Naturkundige Vereeniging in Nederlandsch-Indië.

Brisbane, Queensland.
*Geological Survey of Queensland.
Queensland Museum.
Royal Geographical Society of Australasia, Queensland Branch.
Royal Society of Queensland.

Buitenzorg, Java.
Departement de l'Agriculture. (Formerly 's Lands Plantentuin.)

Calcutta, British India.
Asiatic Society of Bengal.
Geological Survey of India.
Indian Museum.

Colombo, Ceylon.
Government of Ceylon.

Madras, British India.
Agri-Horticultural Society.
Government Central Museum and Library.

Manila, P. I.
*Government Bureau of Sciences.
*Government Ethnological Survey.

Melbourne, Victoria.
Field Naturalists' Club.
Geological Society of Australasia.
Royal Geographical Society of Australasia, Victorian Branch.
Royal Society of Victoria.

New Plymouth, New Zealand.
Polynesian Society.

Peradeniya, Ceylon.
Royal Botanic Gardens.

Perth, West Australia.
Geographical Society of West Australia.
Geological Survey of West Australia.

Saharanpur, British India.
Government Botanical Garden.

Sapporo, Japan.
Sapporo Natural History Society.

Shanghai, China.
Royal Asiatic Society, China Branch.

Singapore, Straits Settlements.

Royal Asiatic Society, Straits Branch.

Sydney, New South Wales.

Australian Association for the Advancement of Science.
Australian Museum.
Geological Survey of New South Wales.
Linnean Society of New South Wales.
Royal Society of New South Wales.

Tokyo, Japan.

Anthropological Society.
Asiatic Society of Japan.
College of Agriculture, Imperial University.
College of Science, Imperial University.
Department of Natural History, Imperial Museum.
Deutsche Gesellschaft für Natur- und Völkerkunde Ostasiens.
*Imperial Geological Survey.
Tokyo Botanical Society.
Tokyo Geographical Society.
Tokyo Zoological Society.

Wellington, New Zealand.

New Zealand Institute.
*Colonial Museum and Geological Survey Department.

EUROPE.

AUSTRO-HUNGARY.

Agram (Zagreb).

Kroatische Naturwissenschaftliche Gesellschaft.
Südslavische Akademie der Wissenschaften und Künste.

Brünn.

Naturforschender Verein.

Budapest.

Geologische Gesellschaft für Ungarn. (Magyarhoni Földtani Társulat.)
K. Ungar. Geologische Anstalt. (Magyar Királyi Földtani Intézet.)
Magyar Namzeti Museum. (Hungarian National Museum.)
Magyar Természettudományi Társulat. (Royal Hungarian Society of Natural Sciences.)
Magyar Tudomânyos Akademia. (Hungarian Academy of Sciences.)
Société Hongroise de Geographie.
Statistisches Bureau der Haupt- und Residenzstadt.

Graz.

Naturwissenschaftlicher Verein für Steiermark.

Hermannstadt.

Siebenbürgischer Verein für Naturwissenschaften.
Verein für Siebenbürgische Landeskunde.

Innsbruck.

Naturwissenschaftlich-Medizinischer Verein.
Tiroler Landes-Museum, Ferdinandeum.

Klagenfurth.

Naturhistorisches Landes-Museum in Kärnten.

Klausenburg.

Medizinisch-Naturwissenschaftliche Section des Siebenbürgischen Museum-Vereins.

Krakau.

Akademija Umiejetnósic (Academy of Sciences).

Leipa.

Nord-Böhmischer Excursions-Club.

Lemberg.

Sevcenko Gesellschaft der Wissenschaften.

Linz.

Verein für Naturkunde.

Paskau.

Wiener Entomologische Zeitung.

Prag.

*Comité für Naturwissenschaftliche Landesdurchforschung.
K. Böhmische Gesellschaft der Wissenschaften (Král. Ceské Spolecnosti Nauk).
Naturwissenschaftlicher Verein "Lotos."
Societas Entomologica Bohemiae.

Reichenberg.

Verein der Naturfreunde.

Trencsin.

Naturwissenschaftlicher Verein des Trencsiner Comitates.

Trieste.

K. K. Astronomisch-Meteorologisches Observatorium (I. R. Osservatorio Marittimo).

Wien.
Allgemeine Chemiker und Techniker Zeitung.
Kaiserliche Akademie der Wissenschaften.
K. K. Gartenbau Gesellschaft.
K. K. Geologische Reichsanstalt.
K. K. Naturhistorisches Hof Museum.
K. K. Universitäts Bibliothek.
K. K. Zoologische-Botanische Gesellschaft.
Section für Naturkunde des Oesterreichischen Touristen-Vereins.
Wissenschaftlicher Club.

BELGIUM.

Anvers.
*Société Royale de Géographie.
Vlaamsch Natuur- en Geneeskundig Congres.

Bruxelles.
Académie Royale des Sciences, des Lettres et des Beaux-Arts de Belgique.
Musée Royale d'Histoire Naturelle de Belgique.
Musée du Congo.
*Société Royale Belge de Géographie.
Société Belge de Géologie, de Paleontologie et d'Hydrologie.
Société Belge de Microscopie.
Société Entomologique de Belgique.
Société Royale Zoologique et Malacologique de Belgique.
Société Royale de Botanique de Belgique.

Liege.
Société Géologique de Belgique.
Société Royale des Sciences.

Louvain.
Université Catholique.

Mons.
Société des Sciences, des Arts et des Lettres du Hainaut.

Tongres.
Société Scientifique et Littéraire du Limbourg.

DENMARK.

Kjobenhavn (Copenhagen).
Botaniske Forening.
Commissionen for Ledelsen af de Geologiske og Geographiske Undersögelse i Grönland.
*Danske Geologiske Forening.
Entomologiske Forening.
Kongelige Danske Videnskabernes Selskab.

FRANCE.

Amiens.

Société Linnéenne du Nord de la France.

Angers.

Société Linnéenne de Maine-et-Loire.
Société Nationale d'Agriculture, Science et Arts.

Annecy.

Société Florimontane.

Arras.

Académie des Sciences, Lettres et Arts.

Besançon.

Académie des Sciences, Belles-Lettres et Arts.
*Société d'Émulation du Doubs.

Beziers.

Société d'Étude des Sciences Naturelles de Béziers.

Bordeaux.

Académie Nationale des Sciences, Belles-Lettres et Arts.
Société Linnéennne de Bordeaux (Société de Médécine de Bordeaux).

Bourg.

Société d'Émulation et Agriculture (Lettres, Sciences et Arts) de l'Ain.

Caen.

Académie Nationale des Sciences, Arts et Belles-Lettres.

Chalon-sur-Saone.

Société des Sciences Naturelles de Saone-et-Loire.

Chambery.

Société d'Histoire Naturelle de Savoie.

Charleville.

Société d'Histoire Naturelle des Ardennes.

Cherbourg.

Société Académique de Cherbourg.
Société Nationale des Sciences Naturelles et Mathématiques de Cherbourg.

Dijon.

Académie des Sciences, Arts et Belles-Lettres de Dijon.

Douai.

Union Géographique du Nord de la France.

Draguignan.

*Société des Études Scientifiques et Archéologiques.

Grenoble.

Académie Delphinale.

*Société de Statistique, des Sciences Naturelles, et des Arts Industriels du Departement de l'Isère.

*Laboratoire de Géologie de la Faculté des Sciences.

Gueret.

Société des Sciences Naturelles et Archéologiques de la Creuse.

La Rochelle.

Académie des Belles-Lettres, Sciences et Arts de la Rochelle.

Le Havre.

*Société Nationale Havraise d'Études Diverses.

Le Mans.

Société d'Agriculture, Sciences et Arts de la Sarthe.

Lille.

Société Géologique du Nord.

Lyon.

Académie des Sciences, Belles-Lettres et Arts de Lyon.

Société Botanique de Lyon.

Macon.

Société d'Histoire Naturelle.

Marseille.

Muséum d'Histoire Naturelle.

Société Scientifique Industrielle.

Montpellier.

Académie des Sciences et Lettres de Montpellier.

Nancy.

Académie de Stanislas.

Société des Sciences.

Nantes.

Société Académique de Loire-Inférieure.

*Société des Sciences Naturelles de l'Ouest de la France.

Nimes.

Société d'Études des Sciences Naturelles.

Paris.

Feuilles des Jeunes Naturalistes.
Observatoire Metéorologique du Mont Blanc.
Service de la Statistique Municipale.
Société Entomologique de France.
Société d'Ethnographie.
Société Française de Physique.
Société Philomathique.

Rheims.

Société d' Étude des Sciences Naturelles.

Rennes.

Bibliothéque Universitaire.

Rouen.

Société des Amis des Sciences Naturelles.
Société Normande de Géographie.

Toulon.

Société Académique du Var.

Toulouse.

Société d'Histoire Naturelle.
Université.

Tours.

Société d'Agriculture, Sciences, Arts et Belles-Lettres.

GERMANY.

Altona-Bahrenfeld.

Entomologischer Verein für Hamburg-Altona.

Annaberg.

Annaberg-Buchholzer Verein für Naturkunde.

Augsburg.

Naturwissenschaftlicher Verein für Schwaben und Neuburg.

Bamberg.

Naturforschende Gesellschaft.

Berlin.

Apotheker-Zeitung.
Berliner Entomologischer Verein.
Botanischer Verein der Provinz Brandenburg.
Deutsche Geologische Gesellschaft.
Gesellschaft für Erdkunde.
Gesellschaft Naturforschender Freunde.
Königlich Preussische Akademie der Wissenschaften.
Königlich Preussische Geologische Landesanstalt.
Zoologisches Museum.

Bonn.

*Mineralogisches Museum und Institut der Universität.
Naturhistorischer Verein der Preussischen Rheinlande, Westfalens, und des Regierungsbezirks Osnabrück.
Niederrheinische Gesellschaft für Natur- und Heilkunde.

Braunschweig.

Verein für Naturwissenschaften.

Bremen.

Naturwissenschaftlicher Verein.

Breslau.

Schlesische Gesellschaft für Vaterländische Kultur.
Verein für Schlesische Insektenkunde.

Chemnitz.

Naturwissenschaftliche Gesellschaft.

Colmar.

Naturhistorische Gesellschaft.

Danzig.

Naturforschende Gesellschaft.

Donaueschingen.

Verein für Geschichte und Naturgeschichte der Baar.

Dresden.

Gesellschaft für Natur- und Heilkunde.
Königliches Mineralogisch-Geologisch und Prähistorisches Museum.
Naturwissenschaftliche Gesellschaft "Isis."
Verein für Erdkunde.

Dürkheim a. H.

Pollichia, Naturwissenschaftlicher Verein der Rheinpfalz.

Düsseldorf.

Naturwissenschaftlicher Verein.

Elberfeld.
Naturwissenschaftlicher Verein von Elberfeld und Barmen.

Emden.
Naturforschende Gesellschaft.

Erfurt.
Akademie Gemeinnütziger Wissenschaften.

Erlangen.
Physikalisch-Medizinische Societät.

Frankfurt a. M.
Deutsche Malakozoologische Gesellschaft.
*Neue Zoologische Gesellschaft.
Physikalischer Verein.
Senkenbergische Naturforschende Gesellschaft.

Frankfurt a. O.
Naturwissenschaftlicher Verein.

Freiburg i. Br.
Badischer Botanischer Verein.
Naturforschende Gesellschaft.

Gera.
*Deutscher Verein zum Schutze der Vogelwelt.
Gesellschaft der Freunde der Naturwissenschaften.

Giessen.
Oberhessische Gesellschaft für Natur- und Heilkunde.

Görlitz.
Naturforschende Gesellschaft.

Göttingen.
Königliche Gesellschaft der Wissenschaften.

Greifswald.
Geographische Gesellschaft.
Naturwissenschaftlicher Verein von Neuvorpommern und Rügen.

Halle a. S.
*Kaiserliche Leopoldinisch-Carolinische Deutsche Akademie der Naturforscher.
Naturforschende Gesellschaft.
Naturwissenschaftlicher Verein für Sachsen und Thüringen.

Hamburg.
Naturwissenschaftlicher Verein.
Verein für Naturwissenschaftliche Unterhaltung.

Hanau.
Wetterauische Gesellschaft für die Gesammte Naturkunde.

Hannover.
Deutscher Seefischerei-Verein.
Naturhistorische Gesellschaft.

Heidelberg.
Naturhistorisch-Medizinischer Verein.

Husum.
Zeitschrift für Wissenschaftliche Insektenbiologie.

Jena.
*Geographische Gesellschaft für Thüringen.
Universitäts-Bibliothek.

Karlsruhe.
Naturwissenschaftlicher Verein.

Kassel.
Verein für Erdkunde.
Verein für Naturkunde.

Kiel.
Mineralogisches Institut der Universität.
Naturwissenschaftlicher Verein für Schleswig-Holstein.
Universitäts-Bibliothek.

Königsberg.
Botanischer Verein.
Königliche Physikalisch-Oekonomische Gesellschaft.
Universitäts-Bibliothek.

Landshut.
Naturwissenschaftlicher Verein.

Leipzig.
Insektenbörse (Entomologisches Wochenblatt.)
Königlich Sächsische Gesellschaft der Wissenschaften.
Naturforschende Gesellschaft.
Verein für Erdkunde.
*Zeitschrift für Gewässerkunde.

Lübeck.
Geographische Gesellschaft.

Lüneburg.

Naturwissenschaftlicher Verein.

Magdeburg.

*Museum für Natur- und Heimatkunde.

Naturwissenschaftlicher Verein.

Marburg.

Gesellschaft zur Beförderung der Gesammten Naturwissenschaften.

Universitäts-Bibliothek.

Metz.

Académie de Metz.

Société d'Histoire Naturelle.

München.

Königlich Bayerische Akademie der Wissenschaften.

Münster.

Provinzial-Verein für Wissenschaften und Kunst.

Nürnberg.

Naturhistorische Gesellschaft.

Offenbach.

Verein für Naturkunde.

Osnabrück.

Naturwissenschaftlicher Verein.

Regensburg.

Historischer Verein für die Oberpfalz.

Königliche Bayrische Botanische Gesellschaft.

Naturwissenschaftlicher Verein.

Rostock.

Grossherzogliche Mecklenburgische Geologische Landes-Anstalt.

Verein der Freunde der Naturgeschichte in Mecklenburg.

Stettin.

Gesellschaft für Völker- und Erdkunde.

Strassburg.

Kaiserliche Universitäts- und Landes-Bibliothek.

Kommission für die Geologische Landes-Untersuchung von Elsass-Lothringen.

Stuttgart.
Kosmos, Gesellschaft der Naturfreunde.
Mathematisch-Naturwissenschaftlicher Verein.

Thorn.
Copernicus Verein für Wissenschaft und Kunst.

Ulm.
Verein für Mathematik und Naturwissenschaften.

Weimar.
Thüringischer Botanischer Verein.

Wernigerode.
Naturwissenschaftlicher Verein.

Wiesbaden.
Verein für Naturkunde.

Würzburg.
Physikalisch-Medizinische Gesellschaft.

ENGLAND AND WALES.

Barrow-in-Furness.
Naturalists' Field Club.

Birmingham.
Birmingham Midland Institute Scientific Society.
Birmingham Natural History and Philosophical Society.

Cambridge.
Cambridge Philosophical Society.

Canterbury.
*East Kent Scientific and Natural History Society.

Cardiff.
Cardiff Naturalists' Society.

Chester.
Chester Natural Science Society.

Guernsey.
Guernsey Society of Natural Science and Local Research, Guille Allès Library.

Kew.
Royal Herbarium.

Leeds.

Leeds Geological Association.
Leeds Philosophical and Literary Society.
Yorkshire Geological and Polytechnic Society.
Yorkshire Naturalists' Union.

Liverpool.

Liverpool Biological Society.
Liverpool Geographical Society.
Liverpool Geological Association.
Liverpool Geological Society.

London.

British Museum, Natural History Division.
Geological Society of London.
*Geological Survey of the United Kingdom.
Quiekett Microscopical Club.
Royal Botanic Society.
Royal Institution of Great Britain.
Royal Society of London.
Society for the Encouragement of Art, Manufactures and Commerce.
South London Entomological and Natural History Society.

Manchester.

Literary and Philosophical Society.
Manchester Field Naturalists' and Archaeologists' Society.
Manchester Geological Society.
Manchester Geographical Society.
Manchester Microscopical Society.

Marlborough.

Marlborough College Natural History Society.

Newcastle.

Literary and Philosophical Society.
*North of England Institute of Mining and Mechanical Engineers.

Norwich.

Norfolk and Norwich Naturalists' Society.

Penzance.

Penzance Natural History and Antiquarian Society.
*Royal Geological Society of Cornwall.

Preston.

Preston Scientific Society.

Sheffield.

Literary and Philosophical Society.

Southport.
Southport Society of Natural Sciences.

Watford.
Hertfordshire Natural History Society and Field Club.

Wellington College, S. E. R.
Wellington College Natural History Society.

York.
Yorkshire Philosophical Society.

IRELAND.

Belfast.
Belfast Naturalists' Field Club.
Natural History and Philosophical Society.

Dublin.
Department of Agriculture and Technical Instruction.
Royal Dublin Society.
Royal Irish Academy.

SCOTLAND.

Dumfries.
Dumfriesshire and Galloway Natural History and Antiquarian Society.

Edinburgh.
Edinburgh Geological Society.
Royal Botanical Society.
Royal Physical Society.
Royal Society of Edinburgh.
Scottish Microscopical Society.

Glasgow.
Glasgow Geological Society.
Natural History Society of Glasgow.

Perth.
Perthshire Society of Natural Science.

ITALY.

Acireale.
Accademia di Scienze, Lettere, ed Arti degli Zelanti.

Bergamo.
Ateneo di Scienze, Lettere ed Arti.

Bologna.
Accademia delle Scienze dell' Istituto di Bologna.

Brescia.
Ateneo di Brescia.

Catania.
Accademia Gioenia di Scienze Naturali.

Firenze (Florence).
Reale Istituto di Studi Superiori.
Società Entomologica Italiana.
Reale Stazione di Entomologia Agraria.

Lucca.
Reale Accademia Lucchese di Scienze, Lettere, ed Arti.

Milano.
Fondazione Scientifica Cagnola.
Reale Istituto Lombardo di Scienze e Lettere.
Società Italiana di Esplorazioni Geografiche e Commerciali.
Società Italiana di Scienze Naturali.

Modena.
Reale Accademia di Scienze, Lettere, ed Arti.
Società di Naturalisti in Modena.

Napoli.
Museo Zoologico, Università di Napoli.
Reale Orto Botanico.
Società di Naturalisti.

Padova.
Accademia Scientifica Veneto-Trentina-Istriana.
Rivista di Mineralogia e Cristallografia Italiana.

Palermo.
Circolo Matematico di Palermo.
Il Naturalisto Siciliano.
Reale Accademia Palermitana di Scienze, Lettere, e Belle-Arti.
Società di Scienze Naturali ed Economiche.

Perugia.
Istituto Umbro di Scienze e Lettere.

Pisa.
Società Toscana di Scienze Naturali.

Roma.

British and American Archaeological Society.
Pontificia Accademia Romana dei Nuovi Lincei.
Reale Accademia dei Lincei.
Reale Comitato Geologico d'Italia.
Società Italiana della Scienze.
Società Zoologica Italiana.

Siena.

*Reale Accademia dei Fisiocritici.
Rivista Italiana di Scienze Naturali.

Torino.

Accademia Reale delle Scienze.
*Museo di Zoologia ed Anatomia Comparata della Reale Università.

Udine.

Accademia di Udine.

Verona.

Accademia d'Agricoltura, Commercio, ed Arti di Verona.

LUXEMBURG.

Luxemburg.

Fauna, Verein Luxemburger Naturfreunde.
Institut Luxembourgeois: Section des Sciences Naturelles et Mathématiques.
Société Botanique du Grand-Duché.

NETHERLANDS.

Amsterdam.

Koninklijke Akademie van Wetenschappen. (Royal Academy of Sciences.)

Delft.

Commission Géodésique Néerlandaise.

s'Gravenhage (Hague).

*K. Zoologisch-Botanische Genootschap.

Groningen.

Central Bureau voor de Kennis van de Provincie.
Natuurkundig Genootschap.

Haarlem.

Fondation de P. Teyler van der Hulst. (Teyler Stichting.)
Hollandsche Maatschappij van Wetenschappen.
Koloniaal Museum.

Helder.

Nederlandsche Dierkundige Vereeniging.

Leiden.

Rijks Geologisch en Mineralogisch Museum.

Middelburg.

Zeeuwsch Genootschap van Wetenschappen.

Rotterdam.

Bataafsch Genootschap der Proefondtervindelijke Wijsbegeerte.
(Batavian Society of Experimental Philosophy.)

Utrecht.

Provinciaal Utrechtsch Genootschap van Kunsten en Wetenschappen.

NORWAY.

Bergen.

Bergens Museum.

Christiania.

Norske Gradmaalings Commission.
Norske Meteorologiske Institut.
Universitet.
Videnskabs Selskab.
Nyt Magazin for Naturvidenskaberne.

Stavanger.

Stavanger Museum.

Trondhjem.

Kongelige Norske Videnskabernes Selskab.

Tromsö.

Tromsö Museum.

PORTUGAL.

Coimbra.

Sociedade Broteriana.

Lisboa.

Collegio S. Fiel.
Commissào dos Trabalhos Geologicos de Portugal.

Porto.

Accademia Polytechnica.

ROUMANIA.

Bukarest.

Academia Romăna.
Institutul Meteorologic al Romaniei.

RUSSIA.

Dorpat (Jurjew).

Naturforscher Gesellschaft an der Universität.

Ekaterinburg.

Uralian Society of Friends of Natural Science.

Helsingfors.

*Finlands Geologiska Undersökning.
Finska Vetenskaps Societet.
Societas pro Fauna et Flora Fennica.

Kazan.

Society of Naturalists of the Imperial University.

Kharkof.

Society of Naturalists at the Imperial University of Kharkof.
Société Impériale des Sciences Physico-Chimiques.

Kief.

Society of Naturalists.

Moskva.

Imper. Moskofskoie Obshchestvo Iestestvo-Ispytatelei. (Moscow Imperial Society of Naturalists.)

Odessa.

Club Alpin de Crimée.

Riga.

Obshchestvo Iestestvo-Ispytatelei. (Society of Naturalists.)

Sankt Peterburg.

Geologicheskii Komitet. (Geological Committee.)
Glavnaia Fizicheskaia Observatoria. (Central Physical Observatory.)
Imper. Akademia Nauk. (Imperial Academy of Sciences.)
Imper. Sankt-Peterburgskii Botanicheskii Sad. (Imperial Botanical Garden.)
Imper. Sankt-Peterburgskoie Mineralogicheskoie Obshchestvo. (Imperial Mineralogical Society.)
Institut Impérial de Médécine Expérimentale.
Sankt-Peterburgskoie Obshchestvo Iestestvo-Ispytatelei. (St. Petersburg Society of Naturalists.)
Section Géologique du Cabinet de sa Majesté.

SPAIN.

Barcelona.

Real Academia de Ciencias y Artes.
Institucio Catalana d'Historia Natural.

Madrid.

Comision de Mapa Geológica de España.
Real Academia de la Historia.
Real Academia de Ciencias Exactas, Fisicas, y Naturales.
Sociedad Española de Historia Natural.

Zaragoza.

*Sociedad Aragonesa de Ciencias Naturales.

SWEDEN.

Goeteborg.

Kongliga Vetenskaps och Vitterhets Samhället. (Royal Society of Sciences and Belles-Lettres.)

Lund.

Kongliga Universitet.

Stockholm.

Bergeanske Botaniska Trädgård (Hortus Bergianum.)
Entomologiska Förening.
Geologiska Föreningen.
Geologiska Undersökning.
Historiska Museum.
Kongliga Svenska Vetenskaps Akademien.
Kongliga Vitterhets, Historie och Antiquitets Akademien.
Universitets Biblioteket.

Upsala.

*Geological Institution of the University.
Kongliga Universitet.
Kongliga Vetenskaps Societeten.
Universitets Astronomiska Observatoriet.

SWITZERLAND.

Aarau.

Naturforschende Gesellschaft.

Basel.

Naturforschende Gesellschaft.

Bern.

*Geographische Gesellschaft.
Naturforschende Gesellschaft (Société des Sciences Naturelles.)
*Schweizerische Entomologische Gesellschaft.
Schweizerische Naturforschende Gesellschaft. (Société Helvétique des Sciences Naturelles.)

Chur.

Naturforschende Gesellschaft Graubündens.

Frauenfeld.

Thurgauische Naturforschende Gesellschaft.

Freiburg.

Société Fribourgeoise des Sciences Naturelles.

Geneva.

Conservatoire et Jardin Botanique.
Société Botanique de Genève.
Société de Géographie.
Société de Physique et d'Histoire Naturelle.

Lausanne.

Institut Agricole de Lausanne.
Société Vaudoise des Sciences Naturelles.

Neuchatel.

Société des Sciences Naturelles.

St. Gallen.

Naturhistorische Gesellschaft.
Naturwissenschaftliche Gesellschaft.

Zürich.

Naturforschende Gesellschaft.
Schweizerische Botanische Gesellschaft.

PROCEEDINGS OF THE ACADEMY.

THIRTY-FIFTH ANNUAL MEETING.

MILWAUKEE, WISCONSIN, December 28-29, 1904.

The meetings of the Academy were held in Room B3 of the State Normal School building. The following program was carried out with slight changes in the order of the papers as noted below:

WEDNESDAY, DECEMBER 28.

Morning Session, 10:30 o'clock.

Reports of officers and general business.

Reading of papers.

1. Charles Kendall Adams—His place in three universities. *James Davie Butler.*
2. The specific capacity of wells. *C. S. Slichter.* (By title.)
3. The concept of motion. *J. H. Farley.*
4. The present status of the Wisconsin Industrial School for Boys—Its mechanism and methods. *J. S. Roeseler.*
5. The determination of the value of the right of way for Wisconsin railroads. *E. B. Skinner.*

Afternoon Session, 2:00 o'clock.

6. A contribution to the chemistry of the tellurates. *E. B. Hutchins, Jr.* (By title.)
7. On the electrical conductivity of vapors. *F. L. Shinn.* (By title.)

8. On the evolution of hydrogen during the action of sodium on mercury. *Louis Kahlenberg* and *Herman Schlundt.*
9. On the measurement of osmotic pressures. *Louis Kahlenberg.*
10. On classification of carbon compounds, II. *Edward Kremers.*
11. Some examples of fault networks. *William H. Hobbs.*
12. The relations of the Andrenine bees to the entomophilous flora of Milwaukee county. *Sigmund Graenicher.*

Thursday, December 29.

Morning Session, 9:30 o'clock.

General business.

Reading of papers.

13. The *Russulas* of Madison and vicinity. *R. H. Denniston.*
14. Infection experiments with *Erysiphe graminis. George M. Reed.* (By title.)
15. The fungi of Milwaukee county and vicinity. *Valentine Fernekes* and *C. E. Brown.* (By title.)
16. Spore formation in *Cordyceps herculea* Schw. *R. A. Harper.*
17. The nature and origin of the binucleated cells in certain Basidiomycetes. *Susie P. Nichols.* (Presented by *R. A. Harper.*)
18. Observations on the wintering of the grain rusts in Wisconsin. *A. H. Christman.*
19. Soil bacteria in the vicinity of Madison. *W. D. Frost* and *E. V. McComb.*

Memorial address—John Lendrum Mitchell. *John G. Gregory.*

Afternoon Session, 2:30 o'clock.

20. The viability of *Bacterium diphtheriae*. *W. D. Frost, C. G. Davies* and *H. F. Helmholz.*
21. The Attidae of Borneo. *George W.* and *Elizabeth G. Peckham.* (By title.)
22. Experiments with caddis-fly larvae. *W. S. Marshall.*
23. Notes on the behavior of *Physa ancillaria*. *George Wagner.*
24. The psychology of linguistic development in the individual. *M. V. O'Shea.*
25. The fluted stone axes of Wisconsin. *C. E. Brown.*
26. The Greek and Persian armies at Thermopylae. *A. G. Laird.* (By title.)

During the year 1904, the Academy has suffered the loss of three valuable members. The members deceased are:

Captain Frederick Pabst, president of the Pabst Brewing company, who died January 1, 1904, at his home in Milwaukee.

John I. Jegi, professor of physiology and psychology in the State Normal school at Milwaukee and a vice-president of the Academy, who died January 7, 1904.

John Lendrum Mitchell, ex-United States senator for Wisconsin and a life member of the Academy, who died at his country home near Milwaukee, June 30, 1904.

A detailed account of the sessions is herewith given:

WEDNESDAY, DECEMBER 28.

Morning Session.

The Academy was called to order at 10:30 by President Davis. The secretary announced that the minutes of the last meeting had been published in the Transactions. The reading of these minutes was therefore dispensed with. The report of the secretary, which is published below, was then read.

The secretary reported that one serious obstacle in the way of the prompt publication of the Transactions is the fact that all the copy for a part must be in the hands of the printers before an order for the printing may be issued. The Transactions could also be made more valuable if they could be issued in series, the articles in each series having to do with a single subject or with a set of allied subjects. He therefore recommended the appointment of a committee to consider the advisability of changing the form of the Transactions and to secure, if possible, such action from the printing commissioners or from the state legislature as will enable the secretary to carry out any changes that may seem desirable.

Dr. Birge moved that a committee as recommended by the secretary be appointed. The motion was carried, and the president appointed the following members: C. R. Van Hise, G. W. Peckham, E. A. Birge. At the request of the members present, President J. J. Davis was added to the committee.

The report of the membership committee was presented by the secretary. Upon the recommendation of the committee, the following-named persons were elected to active membership:

Florence Eliza Allen, Madison.
Charles Russell Bardeen, Madison.
Charles Frederick Burgess, Madison.
Wilbur Oscar Carrier, Waukesha.
Alletta F. Dean, Madison.
Rollin Henry Denniston, Madison.
Benjamin Mack Dresden, Oshkosh.
William H. Ellsworth, Milwaukee.
Nevin Melancthon Fenneman, Madison.
Valentine Fernekes, Milwaukee.
Harry R. Fling, Oshkosh.
Arthur Dudley Samuel Gillett, Superior.
Andrew J. Hutton, Waukesha.
Frank S. Hyer, Stevens Point.
Hugo Philler, Waukesha.
James David Phillips, Madison.
Arthur Ranum, Madison.

Adolphus H. Sage, Oshkosh.

Maurice H. Small, Oshkosh.

E. Kirby Thomas, Superior.

Halsten Joseph Berford Thorkelson, Madison.

In the absence of Dr. J. D. Butler, portions of his paper on the late President Adams were read by the secretary.

Professor Farley's paper was discussed by Messrs. Birge and Skinner.

Principal Roeseler's paper was discussed by Messrs. Kre mers, Birge, Wagner and others.

The reading of paper No. 5 was postponed, owing to the lateness of the hour.

Afternoon Session.

Owing to the absence of the authors, papers 8 and 9 were read by title.

No. 11 was discussed at length by President Van Hise and No. 12 by Dean Birge.

The amendment to the first clause of Article VII of the constitution as proposed at the last meeting was then taken up and voted by the Academy. This amendment changes Clause 1 of Article VII to read as follows:

"The annual meeting of the Academy shall be held at such time and place as the council may designate."

On motion it was voted to appoint a committee of three to nominate a candidate for vice-president to fill the unexpired term of John I. Jegi, deceased, and a curator to fill the unexpired term of E. C. Perisho, who has removed from the state. The president appointed Messrs. Peckham, Hobbs and Birge as such committee.

A very pleasant feature of the meeting was the dinner at the Hotel Pfister on Wednesday evening. The attendance, though not large, was quite representative. After the dinner, an hour was spent in discussing informally the needs of the Academy. The two subjects which received most attention were the improvement of the Academy library, and desired changes in the form of the published Transactions. This discussion was of such importance that the matters were taken up in subsequent meetings and action taken which it is hoped will materially increase the efficiency of the Academy.

THURSDAY, DECEMBER 29.

Morning Session.

The committee to nominate candidates for a vice-president and curator to fill out the unexpired terms of Messrs. Jegi, deceased, and Perisho, removed from the state, reported the names of Henry E. Legler for vice-president and Charles E. Brown for curator. These gentlemen were elected to the respective offices by vote of the Academy.

The secretary announced that the treasurer's report had been received. The report, which was read by the secretary, showed total receipts of $357.72, including a balance of $121.52 from last year, and disbursements, including $32.60 cash on hand, of $357.72. There were unpaid bills amounting to $50.00. During the year, two additional bonds of $100 each were purchased, increasing the permanent fund to $1816.40.

The treasurer recommended that a safety deposit box in one of the Madison banks be rented for the use of the Academy. He also at this time tendered his resignation to the Academy and asked that a successor be appointed to fill out the unexpired term.

The report was accepted and ordered filed. Messrs. Hobbs, Wagner and Marshall were appointed a committee to audit the accounts of the treasurer. This committee was authorized to report to the council, as the treasurer did not submit vouchers with his report and it would not be possible to audit his accounts during the present meeting.

It was moved and carried that the resignation of the treasurer be accepted and that a committee to nominate a successor be appointed. The president appointed Messrs. Peckham, Hobbs and Harper.

The condition of the library was then taken up for consideration. After a lengthy discussion, it was voted to appoint a special committee on exchanges, whose chairman shall be known as director of exchanges. The chair appointed Messrs. Wagner chairman, Kremers and Hobbs.

It was further voted that the sum of $500.00, or so much thereof as may be legally appropriated from the funds of the Academy, be placed at the disposal of the committee to assist in the prosecution of its work.

The reading of papers was then resumed. No. 13 was discussed by Messrs. Harper, Brown and Sherman. Dr. Denniston indicated his desire to extend his investigations upon the *Russulas* and asked for the cooperation of other interested persons in helping him to secure specimens from other localities.

Nos. 14 and 15 were read by title.

Nos. 16 and 17 were then presented by Professor Harper, and the two papers, dealing with closely allied subjects, were discussed together. Messrs. Densmore, Pauly and Marshall took part in the discussion.

In the absence of the author, No. 18 was presented by Professor Harper. This paper touched upon certain important economic questions.

No. 19 was read by Professor Frost.

Mr. John G. Gregory then gave an address in memory of the late Senator John L. Mitchell, who had been a life member of the Academy for more than thirty years.

Paper No. 5, which was omitted from its proper place owing to lack of time, was then read. This paper was discussed by Messrs. Gregory, Marshall, Harper, Wagner, Farley and others.

Afternoon Session.

The Academy was called to order at 2:30 by President Davis with seventeen members present.

Paper No. 20 was read by Professor Frost and discussed by Messrs. Davis, Birge and others.

No. 21 was read by title.

No. 22 was illustrated by a number of specimens showing how the caddis-fly repairs its house. The paper was discussed by Dr. Birge.

No. 23 was discussed by Messrs. Harper, Farley, Birge and others, some of whom were apparently ready to take issue with the author in his view that it is possible to separate wholly matters of animal psychology from the methods of human psychology.

No. 24 was omitted, owing to the detention of the author by the snow blockade.

No. 25 was discussed by Messrs. Marshall and Wagner.

No. 26 was read by title.

The committee to nominate a candidate to fill the unexpired term of the treasurer, who had resigned, reported the nomination of Dr. R. H. Denniston of the University of Wisconsin. By vote, the secretary was authorized to cast the ballot of the Academy for Mr. Denniston. The ballot cast, Mr. Denniston was declared elected to serve until the next regular election of officers.

It was voted that the treasurer be authorized to rent a safety deposit box for the safe-keeping of the funds belonging to the Academy.

On motion of Mr. Marshall, the thanks of the Academy were voted to Mr. William F. Sell, railway manager for the State Teachers' association, for his courtesy in signing railroad certificates for the members, and to the authorities of the State Normal school for their kindness in providing a room for the meetings of the Academy.

The Academy adjourned *sine die.*

E. B. Skinner,
Secretary.

THIRTY-SIXTH ANNUAL MEETING.

MADISON, WISCONSIN, February 8-9, 1906.

The Academy met in the lecture room of the Historical Library building. The following program was carried out:

THURSDAY, FEBRUARY 8.

Morning Session, 9:30 o'clock.

Reports of officers and committees, and general business.

Reading of papers.

1. An investigation into the cause of the breaking of watch springs in greater numbers during the warm months of the year. *Richard G. Norton.*
2. The limitations of a general method of approximation in hydrodynamics. *C. S. Slichter.*
3. A fundamental existence theorem for linear homogeneous differential equations. *C. S. Slichter.*
4. The climate of Madison. (By title.) *James L. Bartlett.*
5. The influence of soil temperature on the occurrence of frost. *A. R. Whitson.*
6. The luminosity of the brightest stars. *George C. Comstock.*
7. Hybrid parts of speech. (By title.) *Edward T. Owen.*
8. The supernatural elements in the English and Scottish ballads. (By title.) *Nina M. Sheldon.*
9. English dramatic origins:—A protological study. *Arthur Beatty.*
10. A study of moral standards. *F. C. Sharp.*

Memorial Address—James Davie Butler. *Reuben G. Thwaites.*

Afternoon Session, 2:30 o'clock.

Reading of papers.

11. Wisconsin's quartzite implements. *Charles E. Brown.*
12. The period of anarchy in Illinois, 1782-90. *Arthur C. Boggess.*
13. The occupation of government land in Oklahoma territory. *Solon J. Buck.*
14. Life in the beguinages before the Reformation. (By title.) *J. F. Dilworth.*
15. A Nuremberg city ordinance of the year 1562, issued during the time of the black death. *E. K. J. H. Voss.*
16. Alexander and the Council of Worms. (By title.) *D. L. Patterson.*
17. The Children's Crusade. *D. C. Munro.*
18. Suspension of *habeas corpus* in the Civil War. (By title.) *G. C. Sellery.*
19. Problems of colonization as illustrated in the province of Georgia. *Ulrich B. Phillips.*
20. Table illustrating the progress of rotation in office. (By title.) *C. R. Fish.*
21. Causes affecting the westward movement of settlement prior to 1850. *William V. Pooley.*

Thursday Evening.

6 o'clock: The Academy dinner for members and their friends, at Keeley's Annex.

8 o'clock: Address of the retiring president, *Dr. John J. Davis*—"The Academy—Its past and its future."

FRIDAY, FEBRUARY 9.

Morning Session, 9:30 o'clock.

Election of officers and general business.
Reading of papers.

22. Note on the nature of the hydrocarbons occurring in Wisconsin oil rock. (Preliminary notice.) *W. F. Koelker.*
23. On the differences of potential between manganese and lead peroxides and various aqueous and non-aqueous solutions. *Louis Kahlenberg* and *Alonzo S. McDaniel.*
24. Nitrogen from the atmosphere and its use in the annealing of brass wire. *L. A. Youtz.*
25. Nitroselenic acid. *V. Lenher.*
26. Effect of desiccation on *Bacillus dysenteriae* Shiga. *W. D. Frost, R. Whitman* and *R. E. Miltenberger.*
27. A note on the chemotaxis of *Oxytricha aeruginosa. George Wagner.*
28. Some points in the natural history of the spoon-bill catfish. *George Wagner.*
29. Variations of the brachial and sciatic plexus of the frog. *G. A. Talbert.*
30. Cerebral localization from a clinical study. *G. A. Talbert.*
31. Comparative studies on the trophi of Scarabaeidae. (Preliminary notice.) *C. B. Hardenberg.*
32. The gases of Wisconsin lakes. *E. A. Birge* and *V. Lenher.*

Afternoon Session, 2:30 o'clock.

Reading of papers.

33. Wave-rolled snowballs. *E. C. Case.*
34. The mesothelium of the pleural cavity. *W. S. Miller.*
35. An additional driftless area in Wisconsin. *S. Weidman.*

36. Notes on a few parasitic fungi of the Pacific Northwest. *J. J. Davis.*
37. Gasteromycetes of Wisconsin. *R. H. Denniston.*
38. The life history of *Coleochaete*. *C. E. Allen.*
39. Infection experiments with the mildew on the cucurbits. *George M. Reed.*
40. The nature of the variation of the spore number in the ascus. *R. A. Harper.*
41. Polar organization in the cells of *Isoetes*. *W. Marquette.*
42. Cell and nuclear division in *Basidiobolus*. *E. W. Olive.*
43. On the permanence of the chromosomes in the calla and the elm. *J. B. Overton.*
44. Spore formation in the primary uredo. *A. H. Christman.*
45. The origin of the sex cells of *Chrysemys*. *B. M. Allen.*

Items of business were transacted as follows:—

Thursday, February 8.

Morning Session.

The meeting was called to order by President J. J. Davis.

The secretary's report, which appears below, was read.

The report of the treasurer was read by Mr. Denniston.

Messrs. Slichter, Chandler and Wagner were appointed a committee to audit the accounts of the treasurer. The reports of the treasurer and of the auditing committee appear in full in another place in this volume.

The librarian made a verbal report, with the understanding that a written report would be submitted in time for publication at the end of Volume XV of the Transactions.

The report of the committee on membership was then read. The committee recommended the following-named persons for active membership:

Bennet Mills Allen, Madison,

James D. Barnett, Norman, Oklahoma,

James L. Bartlett, Madison,
Murray Charles Beebe, Madison,
Raymond C. Benner, Madison,
Charles Preston Cary, Madison,
Arthur Henry Christman, Menomonie,
Arthur B. Clawson, Madison,
Edward Charles Elliott, Madison,
Edward Merriam Griffith, Madison,
Ewald Haase, Milwaukee,
Christian B. Hardenberg, Madison,
Samuel Jackson Holmes, Madison,
William F. Koelker, Madison,
Willard Lannerd, Racine,
Benjamin F. Lutman, Madison,
William George Marquette, Madison,
Evander Bradley McGilvary, Madison,
Charles McKenny, Milwaukee,
Susie Percival Nichols, Clinton, N. Y.,
Edgar William Olive, Madison,
James Bertram Overton, Madison,
George Matthew Reed, Madison,
Henry Douglas Robinson, Racine,
Emil Peter Sandsten, Madison,
Henry P. Severson, Winneconne,
Nina M. Sheldon, Ripon,
Hugh Allison Smith, Madison,
Charles William Stoddart, Madison,
Winifred Titus, Milwaukee,
Charles Taylor Vorhies, Madison.

The secretary was ordered to cast the ballot of the Academy for these persons, and they were declared elected, to be enrolled as members upon payment of the customary initiation fee.

The committee further recommended that the following active members be transferred to the list of corresponding members:

Ernest Robertson Buckley, state geologist and director of the Missouri Bureau of Mines and Geology, and author of many important memoirs on geological subjects.

Edward Dwight Eaton, pastor of the Congregational church at St. Johnsbury, Vermont, for many years president of Beloit college and an educator of known ability and wide reputation in this state.

Henry Nehrling, of Gotha, Orange county, Florida, formerly curator of the Milwaukee Public museum and author of "Birds of North America," an important ornithological work.

The exchange committee appointed last year presented an extended report through its chairman, George Wagner. The report appears in full on another page. The committee announced that through its efforts there had been added to the library 1,102 volumes and 518 parts of volumes. It presented several recommendations and asked that further consideration of the report be made a special order for Friday morning. It was so ordered.

The secretary presented invitations from various societies and academies to send representatives to celebrations as follows:

From the American Philosophical Society, to send delegates to the celebration of the two-hundredth anniversary of the birth of Benjamin Franklin, to be held at the University of Pennsylvania, April 17-20, 1906.

From the St. Louis Academy of Science, to send a delegate to a dinner commemorating the fiftieth anniversary of the foundation of the academy, to be given in St. Louis, March 10, 1906.

From the Royal Geographical Society of Australasia, to send a delegate to the celebration of the twenty-first anniversary of the founding of the society.

These invitations were referred to the council with power to choose delegates.

The president announced the following committee on nomination of officers: Messrs. C. R. Van Hise, E. A. Birge, George W. Peckham, Samuel Plantz and E. B. Skinner.

It was voted to put the hour of meeting for the afternoon session at four o'clock to enable the members to attend the funeral of the late Professor D. B. Frankenburger.

The papers on the program for the morning session were then read, with the exception of Nos. 4 and 5. As the authors of these two papers were both absent, the papers were read by title.

Afternoon Session.

The Academy was called to order at four o'clock, President Davis in the chair. In the absence of Mr. C. E. Brown, the paper on "Wisconsin quartzites" was read by the secretary.

Owing to the lateness of the hour, papers numbered 14, 16 and 18 were read by title.

Thursday Evening.

At six o'clock, a number of members of the Academy, with invited guests, assembled at Keeley's Annex for the dinner given by the Madison members to the visiting members. Thirty-three members, five of them from out of town, and nine guests, were present. After justice had been done to the excellent dinner furnished by Mine Host Keeley, the tables were cleared away and the audience seated to listen to the admirable address of the retiring president on "The Academy—its past and its future."

FRIDAY, FEBRUARY 9.

Morning Session.

The Academy was called to order by the president with about thirty-five members present.

The committee on the nomination of officers reported as follows:

President, Louis Kahlenberg, Madison;
Vice Presidents: Charles H. Chandler, Ripon,
Henry E. Legler, Madison,
E. C. Case, Milwaukee;
Secretary, Charles E. Allen, Madison;
Treasurer, Rollin H. Denniston, Madison;
Librarian, Walter M. Smith, Madison;
Curator, Charles E. Brown, Milwaukee.

Publication Committee: The president and secretary *ex officio,* E. B. Skinner.

Library Committee: The librarian *ex officio,* Herbert J. Farley, George W. Peckham, Hiram D. Densmore, George Wagner.

Committee on Membership: The secretary *ex officio,* R. H. Halsey, Harriet B. Merrill, D. C. Munro, L. A. Youtz.

By vote of the Academy, the secretary was directed to cast the ballot of the Academy for the persons named. The ballot cast, the persons named in the committee's report were declared elected for the ensuing term of three years.

The council recommended to the Academy that Dr. John J. Davis, retiring president, and E. B. Skinner, retiring secretary, be elected to life membership in the Academy in view of their services to the Academy. Dr. Birge was directed to cast the ballot of the Academy for these two gentlemen. The ballot cast, they were declared elected life members.

The auditing committee reported that they had examined the accounts of the treasurer and had found them correct in every respect. They recommended that the treasurer open an account with the permanent fund, and that when such account should be opened the treasurer should report to the present auditing committee. This feature of the report was sanctioned by the Academy.

The council reported the selection of Hon. John W. Hoyt and C. Dwight Marsh, both of Washington, D. C., as delegates to attend the Franklin celebration at the University of Pennsylvania, April 17–20, 1906. They also named Dr. Ernest R. Buckley of Rolla, Missouri, as delegate to the dinner commemorating the fiftieth anniversary of the founding of the St. Louis Academy of Science at St. Louis, March 10, 1906.

No delegate was named to attend the celebration of the twenty-first anniversary of the founding of the Royal Geographical Society of Australasia.

The report of the exchange committee was then taken up as a special order. The following recommendations of the committee were adopted by vote of the Academy:

A. That the exchange committee be authorized to dispose of the duplicates and separata in the Academy library, in such manner and to such an extent as may appear advantageous to the Academy, and to carry out such exchanges with the University libraries and the State Historical society as may appear similarly advantageous.

B. That there be appropriated from the funds of the Academy two hundred dollars, or such part thereof as may in the opinion of the secretary and treasurer be available, for the work of this committee and the purchase of needed volumes or parts of volumes; provided, that no part of this sum shall be taken from the principal of the invested funds of the Academy.

C. That this committee be further allowed to use any sums for this work that may be realized by the sale of duplicates in the Academy library.

The reading of papers was then resumed, the first two papers being those of Professor Case of Milwaukee on "Wave-rolled snowballs," and of Professors Birge and Lenher on "Gases of Wisconsin lakes." Professor Case made a brief report on the occurrence along the shore of Lake Michigan, after a recent storm, of great numbers of snowballs which had been rolled up by the waves.

Professors Birge and Lenher reported on the occurrence of various gases that had been found in the waters of a number of Wisconsin lakes. This work is still in progress and will be more fully reported at a later time. The paper was discussed by Messrs. Harper, Kahlenberg and Slichter.

As Professor Talbert wished to leave on a forenoon train, his two papers were next taken up.

The remainder of the program was carried out as printed.

Afternoon Session.

The Academy was called to order by President Davis at 2:30.

The secretary read a letter from Mr. Charles E. Brown of Milwaukee, secretary of the Wisconsin Archaeological Society, transmitting the greetings of that society to the Academy and asking that the Academy co-operate with the society in the work of saving to posterity the archaeological treasures of the state.

The remaining papers were read in their order. About thirty members were present.

The business of the Academy all transacted, the Academy adjourned *sine die.*

E. B. Skinner,
Secretary.

REPORTS OF THE SECRETARY.

REPORT OF THE SECRETARY, DECEMBER 28, 1904.

The proceedings of the meeting for 1903 have been published in Part 2 of Volume XIV of the Transactions of the Academy. At the end of this volume is also published a roster of members whose names were on the books of the Academy March 1, 1904. This roster contains 258 names, as follows:

Honorary members	6
Life members	12
Active members	196
Corresponding members	44

Of the 196 persons named as active members, some five or six have since been dropped for non-payment of dues, leaving the present active membership about 190. The treasurer will give a more detailed report regarding the membership of the Academy.

The publication of Part 2 of Volume XIV of the Transactions of the Academy has already been noted. This part contains thirteen articles by as many authors and is illustrated by 22 plates. Besides the thirteen articles noted, the part contains addresses in memory of the following deceased members:— Charles Kendall Adams, George McKendree Steele, John Butler Johnson, Samuel Dexter Hastings, Hamilton Greenwood Timberlake, Frederick Pabst and John I. Jegi.

It is a matter of great satisfaction to the secretary to be able to report the continuance of the liberal policy of the state printing commissioners in the matter of illustrations for papers published in the Transactions. Not only have they allowed the Academy to select the engraver to do their work, but they have allowed the printing of the plates to be done by the engraver when so desired. This policy will enable the Academy to secure the best obtainable illustrations for papers offered to it.

The most serious obstacle now in the way of making the Transactions a first-class medium of publication for papers offered to it, lies in the form in which they are issued and the ruling of the printing commissioners which requires that all the copy for a part shall be in the hands of the printer before work may be begun. This ruling, and the fact that the state printer usually takes his own time for the printing, has been the cause of the most vexatious delays and has been in some cases the cause of the loss of some excellent material which otherwise would have been given to the Academy. This delay might be obviated and the appearance of the Transactions much improved if a ruling could be secured from the printing commissioners allowing the Academy to receive a permit to have its papers printed as soon as they are presented. Separates could then be issued within a reasonable time and either the matter stereotyped for later printing or the whole two thousand copies printed and distributed as a numbered part of the volume.

In this connection, the secretary would also recommend that the form of the Transactions be so changed that one of the two parts shall be devoted to papers in science and mathematics, and the other, separately paged, to letters, the term letters to include language, history, political economy, political science and allied subjects. If this were done, it would be necessary under the present law to keep each part open for two years and to complete the two parts simultaneously. It may be that an act of the state legislature will be required to make these changes.

I recommend, therefore, that a committee of three members be appointed whose duty it shall be to try to secure such ruling from the printing commissioners and, if need be, such action from the legislature, as will enable the Academy to secure the prompt printing of papers offered for publication and to change the form of the Transactions by the establishment of one or more fairly homogeneous series or parts as may seem best. The secretary should be authorized to put into effect such changes as the committee may be able to secure in the publication of Volume XV.

Respectfully submitted,

E. B. SKINNER,

Secretary.

REPORT OF THE SECRETARY, FEBRUARY 8, 1906.

At the last meeting of the Academy, the number of active members reported was 196; of the members elected at that meeting, 13 have accepted by paying the initiation fee. During the year, 16 members have been dropped for non-payment of dues, two have resigned, and two have died, making a total of 20 names that have been taken from the roll. The present active membership is therefore 189. Of the 44 corresponding members reported last year, one has died. The present membership of the Academy is as follows:

Honorary members,	6
Life members,	12
Active members,	189
Corresponding members,	43
Total,	250

The following members have died since the last meeting:

Colonel Stephen Vaughn Shipman, who died at his home in Chicago, November 12, 1905. Colonel Shipman was an architect by profession, a soldier in the Civil war, and is known to Madison people as the architect of the government building in this city and of the dome of the present capitol. He was a charter member of the Academy and was made a corresponding member December 30, 1879.

James Davie Butler, who became a member of the Academy February 10, 1874, died at his home in Madison November 20, 1905. Fitting tribute will be paid to his memory at this session.

David Bower Frankenburger, professor of rhetoric and oratory in the University of Wisconsin and a member of the Academy since 1879 or 1880, died at his home in this city February 6, 1906.

The secretary regrets to report that plans instituted a year ago to diminish the delay in the publication of the Transactions have not been carried out. The committee appointed at that time planned to have the Transactions appear in series and arranged with the printing commissioners to publish parts of approximately 100 pages each, thinking that in this way material could be published as fast as received. As a matter of fact, however, the copy came into the hands of the secretary practically all at one time, so that it was impossible to publish part and hold back part. Most of the copy was in the printer's hands by May 1st and some separates were out shortly after August 1st, but the first part is yet in the hands of the printer. Doubtless the volume of state printing to be done during the past few months has been very great, but the secretary feels that the Transactions have been unreasonably delayed. At the same time, there seems to be little hope of improvement so long as the present state printer holds his office.

Your secretary is pleased to report the continuance of the liberal policy of the printing commissioners in the matter of furnishing first-class engravings for the Transactions. He feels warranted in saying that he believes that the commissioners will furnish suitable illustrations for any paper that may be offered, no matter what may be the cost, provided only that the paper is of sufficient value to warrant the expenditure.

At present the income of the Academy exceeds the necessary expenditures by something more than $100 annually. I dare express the hope that in the future the income may be so increased through increased membership that it will be possible to strengthen the library materially by filling gaps that now exist and which can only be filled by purchases. It is also desirable that as the work of the secretary increases the office receive a larger compensation. To this end, it would seem most desirable that for the present the interest-bearing funds of the Academy be increased as rapidly as the circumstances will permit.

In conclusion, the secretary desires in this, his last report, to thank the members of the Academy for their kindness and assistance in carrying on the work of the Academy as it has been shown in many ways.

E. B. Skinner,
Secretary.

REPORTS OF THE TREASURER.

Report of the Treasurer, December 28, 1904.

General Fund.

Receipts.

Balance on hand, December 24, 1903	$121 52
Received from dues	139 00
Received from Transactions sold	7 20
Received from interest on permanent fund	90 00
Total receipts	$357 72

Disbursements.

Vouchers Nos.		
1, 2.	Postage	$13 30
3, 7, 8, 9, 10.	Printing and paper	18 42
4.	Drafting	1 80
5.	Mailing Transactions	14 60
11.	Secretary's fund	75 00
6.	Bonds for permanent fund	202 00
	Cash on hand	32 60
	Total disbursements	$357 72

Permanent Fund.

Permanent fund, December 24, 1903	$1,614 40
Investment in Madison street improvement bonds	202 00
Total investment in permanent fund	$1,816 40

There are unpaid bills to the amount of some $50.00, but the cash on hand with dues collected at the present meeting will be enough to meet the obligations. The expenditures of the Academy are now so much less than the receipts, including the interest on the permanent fund, that it should be possible to invest in the permanent fund at least $100.00 each year. Your treasurer here suggests that he be authorized to rent a safety deposit box in one of the Madison banks for the keeping of the bonds belonging to the Academy and now kept in a safety deposit box belonging to one of its members.

Your treasurer asks for an auditing committee to examine the accounts for 1904.

He also at this time tenders his resignation from the office of treasurer, and asks that a successor be elected to fill out the unexpired term.

H. W. HILLYER,
Treasurer.

We, the auditing committee, have examined the above account with vouchers and find the same correct.

WILLIAM H. HOBBS,
WILLIAM S. MARSHALL,
GEORGE WAGNER.

REPORT OF THE TREASURER, JANUARY 1, 1906.

Receipts.

Balance in treasury, January 1, 1905	$32 60	
Received for dues and separates, January 1, 1905, to January 1, 1906	190 81	
Interest on investment to April 1, 1905	99 12	
Total receipts		$322 53

Disbursements.

Postage and supplies for treasurer	$5 52	
Printing	68 05	
Supplies for librarian	6 10	
Clerical services (mailing Transactions)	19 60	
Journals, etc. (George Wagner)	34 79	
Expenses of secretary, 1905	75 00	
Total disbursements		209 06
Balance on hand		$113 47

The Wisconsin Academy of Sciences, Arts, and Letters has a permanent fund in the form of seventeen Madison city street improvement bonds of the denomination of $100 each and bearing 6 per cent interest. The cost of these bonds, including premiums paid, was $1,816.40, but the face value is $1,700, and this latter amount is the one that should appear in the statement of the permanent fund.

R. H. DENNISTON,
Treasurer.

The committee appointed to audit the accounts of the Treasurer have examined the books and vouchers and find the statement of receipts and expenditures correct as given in attached report of the Treasurer.

The committee has not been able to determine the correct amount in the permanent fund. We recommend that the Treasurer open an account with the permanent fund and that the present committee be instructed to audit the said account when opened in the books.

CHAS. S. SLICHTER,
CHAS. H. CHANDLER,
GEORGE WAGNER.

REPORT OF THE LIBRARIAN.

FEBRUARY 8, 1906.

The larger part of the work of the library, especially as regards extension of its exchange relations, has been done the past two years by the exchange committee under the efficient chairmanship of Mr. George Wagner. For his valuable services in this work, Mr. Wagner deserves the hearty thanks of all members of the Academy.

The ordinary routine work connected with the library has been performed as heretofore. The librarian regrets, however, that great press of library work in other directions has prevented him from giving much personal attention to the library. It is hoped soon to take up the work of recataloging the library, thus rendering it more accessible to all members and other students. Volumes are of course loaned to members on demand, and are sent to members outside of Madison whenever requested.

The full amount of binding allowed by the state appropriation has been done by the state printer. In the limited amount of binding now possible, preference has of course been given to those publications in most demand. There remain, however, many hundred volumes which should be bound as soon as funds can be secured for the purpose. With the constantly increasing use of the library, the need for increased provision for binding becomes more imperative.

WALTER M. SMITH,
Librarian.

REPORT OF THE EXCHANGE COMMITTEE.

FEBRUARY 8, 1906.

At the last annual meeting of this Academy, a committee was appointed for the purpose of extending the exchange service of its library, securing such volumes as might be missing from its sets of publications and otherwise extending the usefulness of the library. This committee herewith presents the report of its labors.

1. It seemed to us that the most pressing necessity was that of completing, so far as possible, such partial sets of periodicals as we already possessed. Preliminary to this, it was necessary to determine just what we owned, and (a much more difficult task) just what we did not own. In this work, the labors bestowed on our collections by our librarian aided us immensely. Nevertheless, it was a task that required several months of leisure moments. The result was, in a crude way, a card index to our library, and this formed the basis of our remaining work. Thanks to the financial support of the Geological and Natural History Survey, we were enabled to employ a typewriter to write, from set forms, letters to the various societies, requesting such parts of their publications as we lacked. Mr. Kelly, the man employed, gave thorough satisfaction, but unfortunately was forced to quit the work at the end of the summer on account of other duties. Since then, no one has been employed, although many dozens of letters have been written.

The response to these letters was unexpectedly liberal. Through them, the Academy has added to its library:

Complete volumes	1,102
Parts of volumes	518
Maps	5

Through these acquisitions, it has been possible to complete:

Sets of publications	37
Volumes, hitherto incomplete	81

And this does not express the whole result, for there are yet thirty societies that have sent notice of volumes forwarded, where the volumes have not as yet arrived (due to method of shipment through international exchange service). The results from these must therefore be held for a future report.

Not half of the work possible along this line has been done as yet. Even with adequate help and facilities, many questions continuously arise that need long searching in bibliographic fields for their solution. We have made it a rule, but seldom broken, never to communicate with a society until we have ascertained *fully* the extent of its publications. If the Academy sees fit to continue this work, there is every reason to believe that it will be fully as fruitful this coming year as in the one just past.

2. In establishing this committee, the Academy made appropriations for its use in purchasing volumes not otherwise obtainable. Sentiment on this matter subsequently developed in such a way as to make it seem best not to spend any considerable amount of this, until the Academy would be able once more to consider the question. The purchases have therefore been restricted to a few cases where unusual opportunities were offered; the purchases were:

Rendiconti, Circolo Matematico di Palermo, 7 volumes.

1 volume, Crustacea of Norway.

6 volumes, Proceedings of the Royal Society (at less than 50 cents apiece, bound).

1 volume, Proceedings of the Royal Irish Academy.

1 part, Bulletin of the Museum of Comparative Zoology.

It is to be hoped that the Academy may see fit to provide for the completion of one or two of our most important sets, such as the Proceedings of the Royal Society and the publications of the Leipzig Academy, as well as for the acquiring of smaller lots where such are offered at very advantageous prices.

3. The work of filling gaps has left so far but little time for the soliciting of new exchanges. We have, however, incidentally, chiefly at the request of individual members of the Academy, made arrangements with seventeen organizations, not previously on our list, for an exchange, and from all of these we have received publications. Thirteen others, who have accepted exchange but have so far sent nothing, are reserved for a future report. There remains much to be done in this line, but in order to prevent placing ourselves under obligations to societies whose publications are absolutely worthless, a cautious progress is necessary.

4. In all our work, we have constantly been impressed with the desirability of a different kind of exchange between our library and the other two libraries that share this palace with it. There is much in our library in the way of odd volumes and partial sets, which would find better place on our neighbors' shelves. University dissertations, for example, we can never hope to possess in such numbers as to make our collection useful; what we own of them will, however, greatly enhance the value of the university collection. The University, on the other hand, owns many rare volumes and partial sets of society publications which would in many cases complete or nearly complete our sets. The same holds true of our relations to the Historical society. Both of these libraries have already repeatedly turned over to us valuable works, more appropriate to our collection than to theirs. They have also aided us most liberally in allowing us to offer their publications together with our own to such larger societies whose publishing activities made such a course advisable. In that way we have several times been able to get more complete returns than would otherwise have been possible. It may be mentioned here that the Geological and Natural History survey has also, and per-

haps more than the others, aided us here. The astronomical observatory also has offered us its aid, though hitherto we have not needed to take advantage of the liberality of its director.

5. We have looked upon it as part of our work, with the permission and hearty cooperation of the superintendent of the state survey, to correlate the exchange lists of the two organizations, and thus prevent the sending out of needless material and the receipt of equally needless duplicates. In the course of this work, we have incorporated the material received by the survey into the Academy library, where the law says it shall go. This has made a most valuable addition. Our records concerning this are complete, but at present not in such shape as to allow us to state the number of volumes so acquired. There must be several hundred, however, beside many which are duplicates of what we previously possessed.

6. During our work, we have also been forced to scan pretty carefully the duplicates owned by the Academy, the separata and the small collection of individual works. These contain much that is of no further use to the Academy, but which could probably be disposed of with some return in cash. Doing this would enable us to make useful additions to our collection, and at the same time to release from encumbrance valued shelf-room needed badly for expansion.

In view of the facts recited, we beg to close our report with the following recommendations:

A. That the exchange committee be authorized to dispose of the duplicates and separata in the Academy library, in such manner and to such an extent as may appear advantageous to the Academy, and to carry out such exchanges with the University libraries and the State Historical society as may appear similarly advantageous.

B. That there be appropriated from the funds of the Academy $200, or such part thereof as may in the opinion of the secretary and treasurer be available, for the work of this committee and the purchase of needed volumes or parts of volumes; provided, that no part of this sum shall be taken from the principal of the invested funds of the Academy.

C. That this committee be further allowed to use sums for this work that may be realized by the sale of duplicates in the Academy library.

D. That these recommendations be made a special order for the business session tomorrow morning.

Professor Hobbs' absence in Europe prevents his signing this report. The chairman feels confident that he would concur with all the above recommendations.

GEORGE WAGNER,
EDWARD KREMERS.

EXTRACTS FROM THE CHARTER.

An Act to incorporate the Wisconsin Academy of Sciences, Arts, and Letters.

The people of the state of Wisconsin, represented in senate and assembly, do enact as follows:

Section 1. Lucius Fairchild, Nelson Dewey, John W. Hoyt, Increase A. Lapham, * * *[1] at present being members and officers of an association known as "The Wisconsin Academy of Sciences, Arts, and Letters," located at the city of Madison, together with their future associates and successors forever, are hereby created a body corporate by the name and style of the "Wisconsin Academy of Sciences, Arts, and Letters," and by that name shall have perpetual succession; shall be capable in law of contracting and being contracted with, of suing and being sued, of pleading and being impleaded in all courts of competent jurisdiction; and may do and perform such acts as are usually performed by like corporate bodies.

Section 2. The general objects of the Academy shall be to encourage investigation and disseminate correct views in the various departments of science, literature, and the arts. Among the specific objects of the Academy shall be embraced the following:

1. Researches and investigations in the various departments of the material, metaphysical, ethical, ethnological, and social sciences.
2. A progressive and thorough scientific survey of the state with a view of determining its mineral, agricultural, and other resources.
3. The advancement of the useful arts, through the applications of science, and by the encouragement of original invention.
4. The encouragement of the fine arts, by means of honors and prizes awarded to artists for original works of superior merit.
5. The formation of scientific, economic, and art museums.
6. The encouragement of philological and historical research, the collection and preservation of historic records, and the formation of a general library.

---

[1] Here follow the names of forty others. Sections 5, 6, 8 and 9 are omitted here as of no present interest. For the charter in full see *Transactions*, vol. viii, p. xi, or earlier volumes.

7. The diffusion of knowledge by the publication of original contributions to science, literature, and the arts.

SECTION 3. Said Academy may have a common seal and alter the same at pleasure; may ordain and enforce such constitution, regulations, and by-laws as may be necessary, and alter the same at pleasure; may receive and hold real and personal property, and may use and dispose of the same at pleasure; *provided*, that it shall not divert any donation or bequest from the uses and objects proposed by the donor, and that none of the property acquired by it shall, in any manner, be alienated other than in the way of exchange of duplicate specimens, books, and other effects, with similar institutions and in the manner specified in the next section of this act, without the consent of the legislature.

SECTION 4. It shall be the duty of the said Academy, so far as the same may be done without detriment to its own collections, to furnish, at the discretion of its officers, duplicate typical specimens of objects in natural history to the University of Wisconsin, and to the other schools and colleges of the state.

SECTION 7. Any existing society or institution having like objects embraced by said Academy, may be constituted a department thereof, or be otherwise connected therewith, on terms mutually satisfactory to the governing bodies of the said Academy and such other society or institution.

Approved March 16, 1870.

EXTRACTS FROM THE WISCONSIN STATUTES.

STATUTES OF 1898.

TRANSACTIONS OF THE ACADEMY.

SECTION 341. There shall be printed by the state printer biennially in pamphlet form two thousand copies of the transactions of the Wisconsin Academy of Sciences, Arts, and Letters, uniform in style with the volumes heretofore printed for said society.

Note.—Under a ruling of the printing commissioners of the state of Wisconsin, made in response to a presentation by a committee of the Academy appointed December 29, 1897, each volume of the Transactions may be issued in two consecutive parts; so that a publication may thus be issued each year covering the papers accepted after the previous annual meeting. The Academy allows each author one hundred separate reprints of his paper from the Transactions without expense, except a small charge for printed covers when desired. Additional copies are charged for at the actual cost of printing and binding.

OF THE DISTRIBUTION OF PUBLIC DOCUMENTS.

SECTION 365. The transactions of the Wisconsin Academy of Sciences, Arts, and Letters shall be distributed as follows: One copy to each member of the legislature, one copy to the librarian of each state institution; one hundred copies to the State Agricultural Society; one hundred copies to the State Historical Society; one hundred copies to the State University, and the remainder to said Academy.

SECTION 366. In the distribution of books or other packages, if such packages are too large or would cost too much to be sent by mail, they shall be sent by express or freight, and the accounts for such express or freight charges, properly certified to, shall be paid out of the state treasury.

STATUTES OF 1901.

CHAPTER 447.

BINDING OF EXCHANGES.

SECTION 1. Section 341 of the revised statutes of 1898 is hereby amended by adding thereto the following: The secretary of state may authorize the state printer to bind in suitable binding all periodicals and other exchanges which the Society shall hereafter receive, at a cost not exceeding one hundred and fifty dollars per annum. The secretary of state shall audit the accounts for such binding.

CONSTITUTION

OF THE WISCONSIN ACADEMY OF SCIENCES, ARTS, AND LETTERS.

[As amended at various regular meetings.]

Article I.—*Name and Location.*

This association shall be known as the Wisconsin Academy of Sciences, Arts, and Letters, and shall be located at the city of Madison.

Article II.—*Object.*

The object of the Academy shall be the promotion of sciences, arts, and letters in the state of Wisconsin. Among the special objects shall be the publication of the results of investigation and the formation of a library.

Article III.—*Membership.*

The Academy shall include four classes of members, viz.: life members, honorary members, corresponding members, and active members, to be elected by ballot.

1. Life members shall be elected on account of special services rendered the Academy. Life membership in the Academy may also be obtained by the payment of one hundred dollars and election by the Academy. Life members shall be allowed to vote and to hold office.

2. Honorary members shall be elected by the Academy and shall be men who have rendered conspicuous services to science, arts, or letters.

3. Corresponding members shall be elected from those who have been active members of the Academy, but have removed from the state. By special vote of the Academy men of attainments in science or letters may be elected corresponding members. They shall have no vote in the meetings of the Academy.

4. Active members shall be elected by the Academy or the council and shall enter upon membership on the payment of an initiation fee of two dollars which shall include the first annual assessment of one dollar. The annual assessment shall be omitted for the president, secretary, treasurer, and librarian during their term of office.

ARTICLE IV.—*Officers.*

The officers of the Academy shall be a president, a vice-president for each of the three departments, sciences, arts, and letters, a secretary, a librarian, a treasurer, and a custodian. These officers shall be chosen by ballot, on recommendation of the committee on nomination of officers, by the Academy at an annual meeting and shall hold office for three years. Their duties shall be those usually performed by officers thus named in scientific societies. It shall be one of the duties of the president to prepare an address which shall be delivered before the Academy at the annual meeting at which his term of office expires.

ARTICLE V.—*Council.*

The council of the Academy shall be entrusted with the management of its affairs during the intervals between regular meetings, and shall consist of the president, the three vice-presidents, the secretary, the treasurer, the librarian, and the past presidents who retain their residence in Wisconsin. Three members of the council shall constitute a quorum for the transaction of business, provided the secretary and one of the presiding officers be included in the number.

ARTICLE VI.—*Committees.*

The standing committees of the Academy shall be a committee on publication, a library committee, and a committee on the nomination of members. These committees shall be elected at the annual meeting of the Academy in the same manner as the other officers of the Academy, and shall hold office for the same term.

1. The committee on publication shall consist of the president and secretary and a third member elected by the Academy. They shall determine the matter which shall be printed in the publications of the Academy. They may at their discretion refer papers of a doubtful character to specialists for their opinion as to scientific value and relevancy.

2. The library committee shall consist of five members, of which the librarian shall be *ex officio* chairman, and of which a majority shall not be from the same city.

3. The committee on nomination of members shall consist of five members, one of whom shall be the secretary of the Academy.

ARTICLE VII.—*Meetings.*

The annual meeting of the Academy shall be held at such time and place as the council may designate; but all regular meetings for the election of the board of officers shall be held at Madison. Summer field meetings shall be held at such times and places as the Academy or the council may decide. Special meetings may be called by the council.

ARTICLE VIII.—*Publications.*

The regular publication of the Academy shall be known as its Transactions, and shall include suitable papers, a record of its proceedings, and any other matter pertaining to the Academy. This shall be printed by the state as provided in the statutes of Wisconsin. All members of the Academy shall receive gratis the current issues of its Transactions.

ARTICLE IX.—*Amendments.*

Amendments to this constitution may be made at any annual meeting by a vote of three-fourths of all the members present; *provided*, that the amendment has been proposed by five members, and that notice has been sent to all the members at least one month before the meeting.

RESOLUTIONS

REGULATIVE OF THE PROCEEDINGS OF THE ACADEMY.

THE TRANSACTIONS OF THE ACADEMY.

[*By the Academy, December* 28, 1882.]

2. The secretary of the Academy shall be charged with the special duty of overseeing and editing the publication of future volumes of the Transactions.

3. The Transactions of the Academy hereafter published shall contain: (a) a list of officers and members of the Academy; (b) the charter, by-laws and constitution of the Academy as amended to date; (c) the proceedings of the meetings; and (d) such papers as are duly certified in writing to the secretary as accepted for publication in accordance with the following regulations, and no other.

6. In deciding as to the papers to be selected for publication, the committee shall have special regard to their value as genuine, original contributions to the knowledge of the subject discussed.

9. The sub-committee on publication shall be charged with insisting upon the correction of errors in grammar, phraseology, etc., on the part of authors, and shall call the attention of authors to any other points in their papers which in their judgment appear to need revision.

[*By the Academy, June* 2, 1892.]

The secretary was given authority to allow as much as ten dollars for the illustrations of a paper when the contribution was of sufficient value to warrant it. A larger amount than this might be allowed by the committee on publication.

[*By the Academy, December* 29, 1896.]

The secretary was directed to add to the date of publication as printed on the outside of author's separates the words, "Issued in advance of general publication."

FEES OF LIFE MEMBERS.

[*By the Academy, July* 19, 1870.]

Resolved, That the fees from members for life be set apart as a permanent endowment fund to be invested in Wisconsin state bonds, or other equally safe securities, and that the proceeds of said fund, only, be used for the general purposes of the Academy.

ANNUAL DUES.

[*By the Academy, December* 29, 1892.]

Resolved, That the secretary and treasurer be instructed to strike from the list of active members of the Academy the names of all who are in arrears in the payment of annual dues, except in those cases where, in their judgment, it is desirable to retain such members for a longer time.

ARREARS OF ANNUAL DUES.

[*By the Council, December* 29, 1897.]

Resolved, That the treasurer be requested to send out the notices of annual dues as soon as possible after each annual meeting and to extend the notice to the second or third time within a period of four months where required.

SECRETARY'S EXPENSES.

[*By the Academy, December 27, 1902.*]

Resolved, That the Academy hereby appropriates the sum of seventy-five dollars per annum as an allowance for secretary's expenses, for which a single voucher shall be required.

ERRATA.

P. 382, line 8, for "Minnesota" read "Indiana."

P. 402, note 1, line 6 from bottom, for "arm" read "armed"; for "attendate for" read "appendix or."

P. 404, line 2 (below the heading), for "district" read "distinct."

P. 463, line 8, for "regment" read "segment."

P. 539, line 1 (below the heading) should read: "The common fall and winter squashes, as the Hubbard,"

INDEX.

Index.

Index.