Transactions of the Wisconsin Academy of Sciences, Arts and Letters. volume XVII, Part II, No. 1 1914

Madison, Wis.: Wisconsin Academy of Sciences, Arts and Letters, 1914

TRANSACTIONS

OF THE

WISCONSIN ACADEMY

OF

SCIENCES, ARTS, AND LETTERS

VOL. XVII, PART II, NO. 1

MADISON, WISCONSIN
1914

CONTENTS

The annual half-volume of the Transactions of the Wisconsin Academy of Sciences, Arts, and Letters is issued in six numbers, under the editorial supervision of the Secretary.

The price of this number is 25c.

ON THE ANATOMY OF THE DRAGONFLY, LIBELLULA QUADRIMACULATA, LINNE.

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From time to time the Odonata have been the subject of special morphological, anatomical and embryological papers; some of these have dealt with the insect during its nymphal life, others have been restricted to the imago. Among the earlier entomologists there have been several, Dufour (8), Burmeister (4), Ramdohr (20), Rathke (21) whose work has been of a general nature—later the work has been more along the line of investigating some special problem or working on a single organ.

The following paper does not include all the organs or parts of the body of *Libellula quadrimaculata;* some of these have been investigated both anatomically and histologically and the results, while not giving as much of interest as anticipated, are presented as the result of the work, however incomplete.

HEAD.

The vertex (fig. 1, Vt.), frontal vesicle, is, as seen anteriorly (2mm x 1. 5mm), very prominent; it appears as a small conical cap placed on the head between the antennae. Viewed from above the vertex is seen to be a little broader than long, it has an oval base, each end of which is drawn out to a blunt point; at each of these ends is situated a lateral ocellus. The curve of the base, anterior, passes to the median ocellus; posteriorly the margin runs nearly parallel to the compound eyes. The anterior surface of the vertex is slightly concave.

Scattered over its surface are a number of slightly curved setae.

The frons (fig. 1, Fr.), 1. 5mm in length and 4. 5mm at its greatest width, occupies a large, somewhat rectangular region, extending across the front of the head.; at either side are the eyes above is the vertex and below it the clypeus. The two upper corners are rounded, the lower ones acutely angled with rounded apex. Dorsally there is a deep median depression, in the center of this is a narrow longitudinal stripe of a lighter color which divides the entire frons into right and left halves. This dorsal depression gives to the frons, at either side, an inflated appearance. Slightly curved setae are also scattered over this region.

The clypeus (fig. 1, Cly.) is very distinctly divided into anterior and posterior parts; the combined length (height) is 1. 5mm, the width of the posterior part is 4.5mm, of the anterior portion 3.75mm. Except in the median region there is a distinct boundary between the two parts. Each part is divided into a median and a lateral portion, the division being most plainly seen in the posterior region where the lateral lobes extend to the margin of the eyes. Setae, similar to those on the other parts, are also found on the clypeus.

The occiput (fig. 4, Op.) has both a dorsal and a posterior surface; these are not separated in any way from each other but are formed by the bending of the occiput at the posterior margin of the head: there is thus exposed a nearly equal surface from each of the two views. From a dorsal view the occiput has a triangular outline; the base is posterior and rounded, the apex is anterior, and, wedging in between the eyes, makes the sides of the triangle slightly concave. Posteriorly the occiput shows a surface about equal in area to that seen from above; it is also in this view somewhat triangular in outline, all but the dorsal surface is convex, the base more so than the sides. The narrow space which marks the median boundary of the eyes connects the apex of the occiput with the posterior margin of the vertex. The setae borne on the occiput are not so stiff as those on the other parts already mentioned.

The genae (fig. 1, G), including that part of the epicranium in front of the eyes, are small and barely seen from an anterior view. Each is but a small piece at either side of the clypeus and is in part hidden by the posterior clypeus and the mouth parts.

The epicranium, besides the parts already described, extends back of the eyes and over the posterior surface of the head. The largest part of the surface at the back of the head is covered with dark brown chitin; this area lies between the occiput above and the occipital foramen below and is divided into right and left parts which are connected by a wide bridge. In a lateral view of the head a small piece of this part of the epicranium is seen to lie along the posterior margin of each eye (fig. 2, Ep.). Just where, at each side, this piece turns inward to cover the posterior surface of the head there is, extending from dorsal to ventral margin, a band of setae (seen in fig. 2); these, for about one quarter of the distance from the dorsal boundary, are longer than at any other place. A lateral view of the head shows two light areas (drawn without stippling in figure 2), one near the middle, the other ventral.

The gula (fig. 3, Gu.) consists of two portions; the basal piece 2mm wide, 1.25mm high, is somewhat rectangular in shape; from the upper corners of this piece arise two slightly curved arms which extend up to the occipital foramen.

The labrum (fig. 1, Lb.) is 2.75mm x 1.20mm; it is slightly convex on the outer and concave on the inner surface, the greatest convexity is medium near the upper margin. On the outer surface, along the free margin, runs a strip, darker in color than the rest and having the cuticula thicker. At the upper corners this strip turns inward and extends nearly halfway to the median part of the labrum (this part is stippled in fig. 1, Lb.). Along and near the free margin are a number of setae; all of these are slightly curved and, in most of them, the concavity faces the median axis of the labrum. Along the upper surface are other curved setae, these are not so long as the marginal ones. The labrum moves very freely on the lower edge of the clypeus, there being at this place two hinges formed in part by the labrum and in part by the clypeus. Along that edge of the clypeus which is opposed to the labrum are two heavy, curved rods (shown between labrum and clypeus in fig. 1) and, not far from the anterior end of each of these, there is a heavy blunt projection (fig. 5, t). Just opposite this projection there is on the edge of the labrum a depression, the wall of which is strengthened by a thickening of chitin along the upper surface (fig. 5, r).

The elevation or raising of the labrum is due to two slender pairs of muscles which can easily be seen by cutting away the central part of the frons and clypeus; this exposes a larger frontal and a smaller clypeal cavity. Such a preparation (fig. 6), shows the frontal cavity to have a chitinous roof which is prolonged into two processes, the prefrontal-antennal apodemes of Berlese (1), from the ends of which the two pairs of muscles arise. The larger, median, pair of these muscles converge in their course towards the base of the labrum, finally coming together to be inserted on a small median chitinous plate at the upper margin of the labrum (fig. 1, median, between clypeus and labrum). From the same apodemes arise another pair of muscles, thinner and more laterally situated than the first pair; they diverge slightly and, before their insertion, become narrow tendons. Before they reach the labrum both pairs of muscles pass back of a slightly curved chitionous prop (figs. 4 and 6, Ap. 2), the clypeo-prefrontal apodeme of Berlese. This is the enlarged inner margin of a thin plate which separates the frontal from the clypeal cavity (fig. 4). These two pairs of muscles are called by Berlese "M. adductore primo et secondo del labbro superiore". The median pair from their insertion on a plate which is part of the external wall of the labrum, would raise it. The lateral muscles do not, from their insertion, show so clearly just what their use is; the tendons in which they end run for a short distance along the wall of the buccal cavity and are finally inserted so near the outer ends of this upper margin of the labrum that it is hard to distinguish the difference between the two walls, external and internal, at their point of insertion. They probably help to elevate the upper lip.

Buccal cavity. A view of the inner surface of the labrum shows, along and near its free outer margin, a number of long, slightly curved setae. Around the entire free margin there is a wide band, darker than the rest of the surface but which shows in section, no perceptible difference in the thickness of the cuticula. In the central region, where the sense pits are situated, the chitin is both darker and thicker; where the epipharyngeal muscle is attached it is darker but not thicker. There are also on the inner surface four groups of setae; two of theses are more centrally located, the other two groups are near the lateral margins (fig. 7). The setae comprising the more centrally located groups are longer than the others. In the central region there are a number of sensory plates; these are small, dark areas of the cuticula, of varying size and perforated with small circular openings. The number of openings in each plate varies from one to thirteen; the greater number of openings in the larger plates give to them a sive-like appearance.

Near the center of the roof of the mouth, close to the upper, attached margin of the labrum, are two heavy, dark projections of the chitin; these are covered with many stiff setae which gives to them a brush-like appearance (figs. 7, c and 8,c). From near the base of each brush there is a stiff, slightly curved chitinous rod which forms in part the inner margin of the labrum. These rods act as supports for the labrum and, near their outer ends, are found the hinges upon which it articulates. A little to the side from the apex of each brush there is a group of sensory pits. The layer of hypodermis which lies next to the cuticula shows but a slight variation in thickness; in the more central part the cells contain a great many black pigment granules.

The hypopharynx is very large and leaves but little space underneath between it and the labium. Along its margin there are many setae, these are longer on the lower than on the lateral margins. Over the upper surface are a number of slightly curved setae which exceed in length those on corresponding parts of the epipharynx. The entire basal part of the hypopharynx is borne on a chitinous prop which arches up over the reservoirs of the salivary glands. At the inner margin of the hypopharynx, just at the opening into the pharynx, there is a transverse plate of thickened chitin (fig. 7, Ph. pl.) which, in a sagittal section shows as a tooth (fig. 8, Ph. pl.); this is used to hold open the entrance into the alimentary canal, there being at this region a dorso-ventral compression. Directly in front of this opening the cuticular layer is, on both roof and floor, slightly thicker than over the rest of the surface; the cuticula here is transparent and slightly rugose. Excepting those parts mentioned the cuticular lining of the mouth shows but slight variations in thickness although over the floor it is a little thinner than on the roof.

Alimentery Canal.

General (fig. 9). At its commencement the oesophagus is a narrow tube which changes but little in diameter through the head and cervical region. It at first passes upwards and forwards (the latter direction is but slight and assumes the head to be in a deflexed position), the slight forward direction soon changes and the oesophagus gradually turns backward to pass under the supra-oesophageal ganglion. Just before passing out of the head through the occipital foramen it assumes a position which is parallel to the longitudinal axis of the insect's body; this position relative to the body it retains to the anal opening. The anterior portion of the oesophagus is the thinnest part of the alimentary canal. Just after leaving the cervical region the oesophagus commences to increase in diameter, this increase continues through the prothorax and becomes greater at the anterior end of the mesothorax. At the beginning of the mesothorax this increase in diameter appears, from a dorsal view, to be very gradual; from a lateral view the change is seen to be an abrupt one. In this region the dorsal wall of the oesophagus remains nearly level, the ventral wall however falls suddenly away from the dorsal causing the abrupt enlargement.

The crop, beginning in the middle of the metathorax, extends through the first, second and the anterior half of the third abdominal segments; at its posterior end it decreases slightly in diameter. The thickest part of the crop is in the first and second abdominal segments and exceeds in diameter any other portion of the alimentary canal. At its posterior end the fore-intestine decreases in diameter and, when seen externally, passes over into the mid-intestine as the end of one tube pushed into another and slightly larger one. The boundaries between the different regions of the fore-intestine must be more or less assumed as there are no external markings or changes which separate one part from another. The same is true from a study of the structure of the wall.

The mid-intestine starts near the middle of the third abdominal segment; its diameter does not change within the fourth and fifth segments except, that, at the posterior end of the latter segment, there is a gradual decrease in size. In defining the position of the boundary between the fore- and mid-intestines one must bear in mind that the presence of the oesophageal valve which is pushed into this region of the alimentary canal, makes this boundary a little different in external view to what it is really found to be in longitudinal section. We take here, however, the anterior end of the mid-intestine as seen in external view and find that this boundary lies within the third abdominal segment. In some specimens it is well toward the boundary between the third and second segment, in others near or at the boundary between the third and fourth. In the fourth and fifth segments and also in a small part of the third, the mid-intestine is covered with transverse folds, each fold appearing as a ridge passing around the intestine. The folds have sinuous boundaries and are fairly regular. From a surface view many of these folds can be traced from side to side across the intestine; when closely studied and any one fold is carefully followed it is found that in nearly every instance each fold ends or branches before the circumference of the intestine is completed. For a distance of 1mm from its anterior end the mid-intestine is smooth; near the middle of the seventh abdominal segment the plicated appearance ceases, leaving the posterior 2mm with a smooth external surface. The Malpighian tubules are inserted just behind the middle of the seventh segment. The posterior end of the mid-intestine is generally in the seventh segment, a few specimens were found in which it was in the extreme anterior part of the eighth segment.

The ileum, the first division of the hind-intestine, extends through most of the posterior half of the seventh segment, all of the eighth segment and a little into the ninth. On the posterior portion there is the appearance of longitudinal folding. In the anterior part of the ninth segment the ileum passes into the rectum, this latter section of the alimentary canal does not vary in thickness throughout its length.

The alimentary tract of Libellula 4-maculata passes straight through its body excepting a small part of the head; the length of the body in a number of speciments will show slight variations and a difference in the length of the intestine is also noticed. In measuring some alcoholic specimens it was found that the average length of the males was greater than the females; ten specimens of each sex were then measured, exclusive of the genital claspers, etc, with the result that the average length of the males was 41.65mm, of the females 39.90mm. The different divisions of the alimentary canal averaged as follows: fore-intestine, male 20.5mm, female 17.5mm, mid-intestine; male 12.5mm, female 14mm; hind-intestine; male 7.7mm, female 6.5mm. The males have the longer fore-and hind-intestine, the females the longer mid-intestine. The total of the parts of the alimentary tract is a little less than the length of the body. The curved portion of the oesophagus is slightly less than the distance to the front of the head and it is also impossible to accurately measure in rough dissections the length of this same curved part.

Pharynx. The pharynx is somewhat flattened dorso-ventrally. Its cuticular lining is thick and varies in different specimens from an entirely colorless layer to one in which the outer part is brown; in all specimens the pharyngeal plate is darkly colored. This plate (fig. 10, Ph. pl.) extends transversely across the floor of the pharynx near its posterior boundary; in a longitudinal section of the pharynx it has the appearance of a forwardly directed tooth (figs. 8 and 11, Ph. pl.). Forming the ventral wall there are besides the cuticular and hypodermal layers, a few circular muscles. Dorsally the cells of the hypodermis are longer than those of the opposite surface and there is, above the hypodermis, some glandular tissue; this is followed by longitudinal and oblique muscles and above these a circular layer. In the posterior part of the pharynx there are small muscles arising on its dorsal wall and passing to the clypeus. Just posterior to the pharyngeal plate there is a depression in the ventral wall, a little back of this the circular muscles increase in thickness and the lumen of the alimentary canal decreases in size: at this point might be placed the boundary between the pharynx and the oesophagus. The cuticular lining of the pharynx is covered with numerous small, blunt projections.

The glands lying at the roof of the pharynx (fig. 11, Gl.) show a fairly continuous layer just above the hypodermis. In a longitudinal section through the pharynx a number of pieces of different sizes are seen; the largest of these lie parallel to the roof of the pahrynx and are seldom more than two or three cells in thickness (fig. 12). Each gland-cell contains a rounded nucleus and often shows one or more vacuoles in the cytoplasm.

Oesophagus. The oesophagus is narrower at its beginning than the pharynx; it changes but little in diameter until, at the beginning of the mesothorax, the sudden enlargement takes place which was mentioned in the general account of the alimentary tract. A study of transverse sections shows that in its most anterior part it is similar in structure to the pharynx; the five large folds found in the latter region change to six or eight, the medium dorsal fold is still larger than any of the others. Between these large folds there are still many small irregular ones. At the middle of the cervical region a change takes place; the large median dorsal fold persists and at either side of this there are two or three narrow ones ventrally directed. On the ventral wall are a number of small folds (fig. 13). Further back in the cervical region the folding again changes and one could not, in this region, determine in a transverse section, which part was dorsal: the median dorsal fold is still present but no larger than the others. Throughout this and other parts of the fore-intestine the cuticular layer is covered wih small blunt processes (fig. 14); similar ones were noted as present in the pharynx.

In the middle of the prothorax the oesophagus enlarges; the walls remain of the same thickness but, owing to the increase in diameter, the folds do not come so close together. Towards the posterior end of the prothorax the large folds disappear and their place is taken by a number of small ones. As the oesophagus enters the mesothorax there is, 4.25mm from its commencement, the sudden increase in its diameter, due to the abrupt fall in its ventral wall. At the beginning of this enlarged part the folds are smaller and most of them are restricted to the dorsal wall. At this region the wall of tthe oesophagus becomes thinner, due to a decrease in the layer of circular muscles (fig. 15) which are not so thick here as in the most anterior region. From this place to the gizzard the muscular layers are scarcely noticeable.

Gizzard. If a specimen of *Libellula* with an empty crop be examined the plates of the gizzard can be seen through the thin wall protruding, apparently, from the anterior end of the mid-intestine forward into the crop. One is unable to notice any boundary between the crop and the gizzard. If the intestine at this region be cut longitudinally into halves a view of the interior will show the true position of the plates and it will then be seen that they have no connection with the mid-intestine (fig. 16). Taking for the limits of the gizzard a point slightly anterior to the plates and, posteriorly, where the fore-and mid-intestines join, it can be seen that the wall of the fore-intestine shows no external difference between the crop and the gizzard; the presence of the plates alone indicating the latter. The thin transparent wall of both crop and gizzard has, in the latter, a thicker muscular layer; this cannot be noticed in an external view.

Calvert (6) found a variation in the position of the gizzard in individuals of the same species. In *Hetaerina americana* the gizzard was in the fourth, fifth or sixth abdominal segments and in *Archilestes grandis* it varied in position from the fourth to the sixth segment. In *Libellula 4-maculata* there is a slight variation but the gizzard is always in the second, third and fourth segments. It cannot be described as situated exclusively in the third segment as, in many examples, it extends forward into the second or back into the fourth. If there be any sexual difference it is that in male specimens the gizzard more frequently extends forward into the second segment while there are some females, in which it extends back into the fourth. Calvert (6) found in *Hetaerina americana* four folds in the gizzard, each covered with minute teeth; there were no large teeth present and no intermediate tooth-bearing folds. Ris (22) mentions that in *Libellula* the teeth are much reduced and, while he does not figure any species of the genus, his drawing of the gizzard of *Cordula aenea* is very similar to what is found in *Libellula 4-maculata*.

In this latter dragonfly there are four large folds and along each of these there is a long, narrow, longitudinal plate (fig. 17). From a surface view these plates appear of a dark brown color and, in transverse section, it is seen that the chitin forming the plates is not only much darker but also thicker than the chitin lining any other part of the gizzard. Each plate is shaped a little like the head of a spear with the point directed backward; the anterior end does not have a distinct boundary but gradually becomes lost in the surrounding light colored cuticula. The edges of the plates, especially the posterior half, are very irregular. The small cuticular projections present over the surface of the pharynx and oesophagus are not so abundant in the gizzard although a few can be seen scattered over the entire surface. An exception to this is the posterior half of each plate and a little to each side where the projections are very numerous and form a rectangular area (fig. 18) and the spaces between are almost free from the projections.

Examining a series of transverse sections through the gizzard, and restricting what we have to say to that portion bearing the plates, a great difference is noted in the folding of the wall in different parts. In the anterior end those portions of the wall bearing the plates extend but a little, if any, into the lumen of the intestine and are hardly noticeable as folds (fig. 19). Passing back the four plate-bearing folds are seen to extend further and further towards the center of the section until, near the posterior end, the plates nearly touch (fig. 20). During this change in the four primary folds the smaller ones between them have also increased in size.

The microscopical structure of the wall of the gizzard is very similar throughout. Sections through the plates show the cuticular layer to be dark and thick, between the plates it is thinner and colorless. In the posterior region, where the four folds are well developed, there is generally a space between the layer of circular muscles and the hypodermis (fig. 21) but this may be due to the separation of the layers in the preserving fluid.

Mid-intestine. This region of the alimentary canal extends from the third to the seventh abdominal segment. In external view there is a very noticeable annulated appearance, due to the alternating ridges and depressions which from any one view, extend across the intestine. Such an appearance occurs over the entire section of the alimentary canal except for a short distance at either end. For 2mm from the posterior end the surface is smooth; at the anterior end about 1mm of the intestine appears smooth externally, but longitudinal sections show even this part to be slightly annulated (fig. 22) These folds do not all show a regularity in making a complete circumference of the intestine or in the distance separating them from each other. When, under a strong dissecting lens, the folds are followed around the intestine it is seen that, before making the entire circumference, nearly all of them either come to a sudden end or branch. At the anterior end the folds are smallest and are continued over that portion of the mid-intestine which takes part in the formation of the oesophageal valve (fig. 22). Over most of the mid-intestine, except at either end, there is often a smaller secondary fold on the apex of the primary ones (fig. 23).

Throughout the entire extent of this region of the alimentary tract there are, except in the nidi, no great histological differences; the size and form of the cells change on account of the folding of the wall. There is but a slight development of the circular and longitudinal muscular layers. The epithelial cells are long and narrow (fig. 24), becoming shortest at the regions of the secondary folds. The striated layer, rhabdorium, is present; at some places it contained a number of vacuoles but, as the dragonflies were taken at a period of inactivity, but few of the peculiar appearances due to secretory activity were seen.

Over the entire mid-intestine nests of cells, nidi, are very noticeable (fig. 25) and are remarkable for their great abundance. The structure here is very similar to what has been described in the dragonfly nypmph, Sadones (24), Needham (14). All the dragonflies studied were caught during a day or two of unusually cold weather and had all been without food for some time; this tended to retard the secretory activities of the digestive tract. Specimens dissected showed the entire fore-intestine empty and in a large majority the same condition prevailed in the anterior part of the mid--intestine. Needham (14) found that within about an hour after feeding the discharge of the cells in the anterior part of the mid-intestine commenced, to be followed a little later by the more posteriorly situated cells. The adult dragonfly, as well as the nymph, is a great feeder and the conditions relative to this discharge would be as apt to occur in the former as in the latter stage.

Hind-intestine. A dorsal view of the ileum shows an irregular longitudinal folding of the wall, extending from end to end; at its anterior end each fold has a narrow beginning and is fairly straight for a distance of 1mm, it then widens, becomes irregular and shows a great many indentations and transverse folds. The ileum at its posterior end becomes narrow and here the folds end. An examination of the entire surface shows that there are six of these apparent folds.

A study of transverse sections through this region shows that these apparent folds are in reality due to an equal number of internal folds. Where each internal fold sinks in from the wall it makes, on the external surface, a distinct, irregular furrow; these furrows appear dark from an external view and give the appearance of external folding to the regions between them. The relation of the apparent external and real internal folding is best understood by a comparison of the surface view of the ileum (fig. 26) with a section through the same region (fig. 28).

Faussek (10) found in the nymph of *Aeschna* that in the hind-intestine there were two different kinds of cells. He says: "Die ganze oberfläche des Dünndarmes nämlich ist mit einem Epithel bedeckt, das nicht, wie gewöhnlich, gleichartig ist, sondern zwei, der Grösse und dem Charakter seiner Zellen nach, scharf sich unterscheidende Formen zeigt. In der Vertheilung derselben is gar keine Regelmässigkeit zu bemerken; sie sind Stellenweise auf der Wand des Dünndarmes zerstreut, und wechseln mit einander ab". He then speaks of the large cells with the large nuclei in contrast to the smaller ones. While this description from Faussek is in part true here there are some difference between the *Aeschna* nymph and the imago of *Libellula 4-maculata*. In the latter the large cells are entirely restricted to the ileum and confined there to three places. When one examines the ileum after it has been cut open, stained and mounted with the inner surface uppermost, the three areas to which the large cells are confined can be distinguished by the size of the cells and of their nuclei. It is seen that there is a large area of these cells near the anterior end of the ileum and two small areas lying near the posterior end.

A study of a series of transverse sections through the ileum shows that very near the anterior end these large cells, as already stated, first appear in a large area which is ventral in position. In most parts of the ileum the epithelial layer is thrown into six longitudinal folds which, in a few sections, are quite large; this area of large cells does not show any such folding but lies parallel to the layer of circular muscles (fig. 27, stippled part) and occupies the place of one of the folds, there being, as shown in the figure, this area and five folds. This arrangement continues for some distance, then the area of large cells ceases and its place is taken by a fold, the sixth, corresponding to the other five. Posterior to this come the other two areas of large cells, lateral, but a little ventral in position; these do not occupy so definite a region as the single large area but each one is in reality a part of the regular folds (fig. 28, stippled part). This arrangement continues until the ileum decreases in diameter near its posterior end.

At the anterior end of the ileum the longitudinal folds begin very abruptly and there is, but for a short distance however, a greater number of circular muscles than at other parts. The folds are at first not very large; they then increase in size and, in the last third or half of the ileum, become still larger and so remain until, near its posterior end, the ileum decreases in diameter. In this last region the folds nearly touch, making the lumen small and very irregular in transverse section. Near its posterior end the ileum becomes narrow and at the beginning of this narrow region the longitudinal folds end. This narrow portion forms only a small part of the entire length of the ileum but in appearance is quite disdistinct; viewed from the surface this region appears like a collar around the hind-intestine; it has a peculiar, somewhat inflated, appearance or, often there are several small, rather irregular swellings. In this same region there were often found other swellings of various sizes, irregular in position except that they were always located in the same part; these were due to abnormal, parasitic, growths.

Sections through this narrow part of the ileum show the wall to be folded and that the folds may nearly close the lumen. A longitudinal section (fig. 29) shows the folds to be more numerous in the posterior part. At two different places there is a larger number of circular muscles than usual (fig. 29, cm). The more anterior of these two groups of muscles is the larger and would, in contraction, close the opening between the ileum and the rectum; the more posteriorly situated group would have the same action.

The large cells mentioned as occupying three areas in the ileum are not sharply marked off from the regular epithelium but the one kind passes gradually into the other. The smaller regular epithelial cells (fig. 30) show no peculiarities; the cytoplasm is slightly vacuolated and longitudinal striae were noticeable in the cells. In the large cells (fig. 31) this striation, (Sadones, 24), was more apparent; in them the nucleus was large and irregular and it generally showed a massing of the contents in that half nearest the lumen of the ileum. As Faussek (10) says, so great a difference in the structure of the cells must signify some physiological difference and a cytological study of the ileum during different periods of nutritive and other activities would no doubt lead to interesting results. The presence of these large cells in the ileum has been observed in other insects.

The rectum, 2mm in length, extends through the posterior half of the ninth and the tenth segment. Except for a short distance at either end, where it is slightly narrower, it is straight and of equal diameter throughout. In external view the rectal glands are seen to occupy nearly all the surface, they appear as six wide longitudinal areas with narrow, darker spaces between. The difference between the two parts, rectal glands and intermediate space, does not show as plainly as in most insects, as here the latter spaces are nearly covered by the rectal muscles and thus in part hidden. The six rectal glands begin near the anterior end of the rectum and continue to within a short distance of the anal opening (fig. 26, Rt.).

A transverse section of the rectum shows that the glands are well marked off from the spaces between them. The glands themselves are composed of long columnar cells, varying in length in different parts. Those along and near the margins of the glands are shorter than the more centrally located ones. The nuclei of these cells are elongated with rounded ends and each lies near the center of the cell to which it belongs. Near the base of these cells and just within the basal membrane there is an irregular row of the nuclei; these are large and more spherical than the regular ones. The cuticular layer covering the rectum is rather thick and the regular muscular layers are not well developed. In transverse section that part of the wall situated between the glands is folded and the epithelial cells, as contrasted to those of the glands, are very much reduced in size. Just anterior to the anus the rectal glands cease and the entire wall of the hind-intestine becomes very thin.

There are a number of small muscles found on the rectum; these are easily seen in a dissected specimen to pass in part from the rectum to the wall of the body. A transverse section through the posterior half of the rectum shows that these muscles are attached to the narrow spaces between the rectal glands (Sadones, 24). From each of these spaces there is, in the posterior part of the ninth segment, a group of from two to four muscles which pass to the wall of the body at the anterior part of the tenth segment; the two most dorsal groups are larger than the others. Ventral and also somewhat lateral there are at either side two or three small muscles which, leaving the rectum, also between the rectal glands, pass forward to the body wall at the side of and on the anterior end of the ninth segment; here they have a common point of insertion.

Salivary Glands.

The salivary glands of the Odonata received but little attention until the appearance of the paper by Bordas (3), in this work these glands were described for a number of different species of dragon flies. The first special work on the subject to which any reference can be found is by Poletajew (19) who describes the salivary glands as paired, oval, acinose glands situated in the prothorax near the first thoracic ganglion. Small ducts in each gland lead into the larger ones until there is finally a large duct which empties into a reservoir. "Ein jeder Speichelgang erweitert sich am vorderen Ende zu einem Speichelsack oder Reservoir". There is a short duct from each reservoir, the two joining to open by a single outlet near the base of the hypopharynx on its under surface.

In *Libellula 4-maculata* the salivary glands are situated, as in other dragonflies, in the prothorax; there is but a single pair, and these lie at either side of and generally a little ventral to the oesophagus. In some specimens the glands extend back a short distance into the mesothorax. Each gland has a slightly bilobed appearance and is, in part, divided into an anterior and a posterior portion (fig. 32). A duct leaves the anterior margin of each gland; it runs forward through the cervical region and, upon entering the head, turns ventrad and takes a slightly posterior direction until it reaches the reservoir, which lies at the base of the hypopharynx, one end of which it enters. From the other end of each reservoir a short duct passes towards the floor of the buccal cavity; these two short ducts, each .28mm long, unite before emptying into the buccal cavity. The duct, both upon entering and leaving the reservoir, is of the same structure, it is in each instance covered for a short distance by a prolongation of the wall of the reservoir; this covering gradually decreases in thickness (fig. 33).

Each salivary gland of *Libellula 4-maculata* is flattened and irregular in shape, broad distally but pointed at the anterior end from which the duct leaves. Each gland is composed of a number of small lobes which are in turn made up of many smaller acini. Within and near the center of each acinus is a small collecting duct which runs between the cells. These ducts unite with others in the small lobes; the ducts from the lobes unite with or empty into those from other lobes until all finally assemble in the large duct which leaves the anterior end of each gland. Each acinus is composed of a number of uninuclear cells, the boundaries of which are difficult to distinguish (fig. 34).

Many of the acini look as if they were hollow, the central part containing a secretion. This appearance is due to the difference in structure in different parts of the cells. In the basal half or two-thirds of each cell (the nucleus is always within this part) the cytoplasm stains readily; in contrast to this the outer half or one-third of each cell did not stain very dark with haematoxylin. In the acini this darker-staining basal portion appeared as the wall and the lighter part as the central cavity. Upon closer examination one can see both these parts belong to the cells and that the portion in which the stain was not so effective was due to the accumulation of secretion in the outer half or third of the cell.

Both Poletaew (19) and Bordas (3) speak of the swollen parts of the ducts situated on the base of the hypopharynx as the reservoirs. Bordas (2) in his first paper does not use this word but calls them "glandes buccales". Poletaiew (19) in the quotation we have already given at the beginning of the account of the salivary glands, used the word reservoir; he describes the peculiar external appearance of the reservoirs as due to the cuticular layer and says: "die an ein netzförmiges Zellengeflecht aus dem Gewebe einiger Blätter erinnert." In plate 1, figure 5, he shows the reservoirs of a species of *Lestes,* the markings on which, as he gives it, resemble the shingles on a house, the shingles having rounded, exposed ends. Bordas (3) figures the reservoirs in three species of dragonflies; *Agrion minium, Cordulegaster annulatus* and *Cordulina aenea.* All of these appear very similar to what has been found in *Libellula 4-maculata.* Bordas gives enlarged views of a part of a reservoir of *Anax formosa,* both from the surface and in section. In his surface view the cells are shown with a polygonal outline, in section the wall is shown to be equally thick throughout and without the large protrusions so noticeable in the species here described. Berlese (1) in his text-book figures three cells, in section, from the reservoir of a species of *Diplax* and labels the figure as a portion of the wall of the salivary gland near the mouth.

The two reservoirs of the salivary glands of *Libellula 4-maculata* are found on the basal part of the hypopharynax (fig. 32). Each receives a duct from one of the salivary glands, each duct where it enters the reservoir is much thicker than at other parts; this thickness is due to the wall of the reservoir extending for a short distance out over the duct and forming a second wall much thicker than the real one (fig. 33). From the more rounded basal part of each reservoir a short duct leads off, these two ducts soon unite to form a common one (fig. 35) which opens at the base of the hypopharynx.

The wall of the reservoir is peculiar in structure and, at first view, one is apt to consider it as composed of two layers of cells; one, the inner, protruding beyond the other. A surface view of the inner surface (fig. 36) shows a number of separated cells having no connection with each other until the focus is dropped and then the outer portion of the wall comes into view. In many of the specimens examined these cells, from this inner surface view, showed an irregular or scalloped margin; whether this is due to shrinkage I am unable to say as all the specimens studied were from preserved material. A section of the wall (fig. 37) shows that the outer half or third is entirely continuous and regular and that the inner part is composed of wide prolongations which give to the wall a papillate appearance. These protruded parts make up the larger part of the wall. No cell boundaries can be seen at any part but one would expect to find them dividing the protruded parts from each other or where the wall is thinnest; this is the way they have been figured by Berlese (1, Fig. 584, B, II). Over the inner surface of the reservoir the cuticula is quite thick but lacks the taenidial structure that is present in the ducts.

A study of the reservoirs, both in surface view and in sections, fails to convince me as to the true nature of the nuclei of the cells. In both these views very many cells are found that have all the appearance of being binucleate. In nearly every instance where this appearance was noted the adjacent walls of the apparent nuclei touched. Often in surface view a supposedly binucleate cell could be seen by careful focussing to give a view in which these two apparent nuclei were connected. In many sections nuclei were seen of a greatly bent horse-shoe shape, the two prongs of the shoe being short and projecting towards the outer wall of the reservoir. The nuclei always lie in the large projections but may extend out into the other part of the wall. It appears that each cell really has but a single nucleus but that it is generally very much bent.

While these two enlargements at the end of the ducts have been called the reservoirs of the salivary glands, and, from their position and connection, would appear to act as such, their structure would seem to give to them more than a passive function. In most of the specimens examined the cells showed, between the nucleus and the outer wall of the reservoir, a distinct striation in the cytoplasm giving to them the appearance of active secretory cells. From the whole structure one would suppose that the secretion was expelled from the outer wall or that, if it found an exit into the reservoir there were special ducts to pass the secretion through the thick cuticula lining the inner wall. No such ducts were observed, the only structures that could in any way be taken for a collecting tube or passageway were small dark spots; these were rather regular in their appearance just where the inner comes nearest the outer wall (fig. 37, s). These were also seen as dark strands running from one cell to another parallel to the outer surface of the reservoir but could never be followed for any great distance. A study of this so called reservoir of different species of dragonflies during periods of rest and activity might solve this problem.

From the more rounded end of each reservoir a small duct leads out, the two shortly uniting (fig. 35). The wall of this common duct has for some distance the peculiar covering of cells from the reservoir that was observed on the long ducts just before their end. Before opening externally the structure of the wall changes to a regular hypodermal layer with a thick cuticular lining (fig. 38). Muscles are inserted on either side at the opening of the duct on the hypopharynx.

Malpighian Tubules.

In a general dissection of *Libellula 4-maculata* the Malpighian tubules are seen to arise from the intestine near the posterior end of the seventh segment; from here they all extend backward and lie principally in the eighth and ninth abdominal segments, seldom extending back into the tenth. In the ninth segment some of the tubules bend and run forward again but not beyond their point of union with the intestine. The ileum is covered with the tubules and they are in general more numerous here than over the rectum.

An examination of the union of the tubules with the intestine shows that they do not open into it singly but that several tubules unite to form a common vestibule which opens at the boundary of mid-and hind-intestines. The number of these openings varied in the specimens in which they were counted, there being from eighteen to twenty-two; the number of Malpighian tubules uniting for a common opening varies from two to twelve, the average was 8.25.

The minute structures of the tubules is similar to what has been found in other insects. The different tubules are similar as to size and structure or, if variations do occur, they are only what might be expected from an examination of a great number of sections and surface views. In the vestibule and in the tubules just before opening into it, the epithelial cells are smaller than in other parts. A few of the tubules showed an abnormality in that they were very short with swollen ends, in which part the wall was somewhat thinner than usual and the lumen much larger.

The lumen of the tubules is very irregular and, examining a number of specimens, one often sees in a single tubule that the lumen changes in diameter. An examination of transverse sections also showed this variation in size of the lumen and that it was always irregular and angular. Griffith (12) noticed this same irregularity and said: "the internal cavity of one of these tubules is very irregular".

Male Reproductive Organs.

The two testes (fig. 39, T) are long and cylindrical. Each arises in the posterior part of the third abdominal segment to one side of and slightly dorsal to the mid-intestine. Each, in passing backward, shows at first a slight outward curve, this soon ceases and the testes run parallel to and along side of the alimentary canal to the posterior margin of the seventh segment. From each testis there arises, in the anterior end of the eigth segment, a vas deferens which, continuing in the direction of the testis, extends to near the middle of the ninth segment. At this region each vas deferens suddenly turns inward and forward; after a short distance (less than the length of the segment) in this direction each suddenly bends once more, and, passing backward again the two approach and unite just over the common external opening which lies ventral and median on the ninth segment (fig. 40). This last portion, that part from the final bend to the union of the vasa defferentia, is larger than at any other part and forms here, at the proximal end of each vas deferens, a seminal vesicle.

A longitudinal section through a testis shows it to be made up of many cysts arranged in from one to three layers around a central tube which has a distinct wall of epithelial cells. This central duct starts back of the terminal cysts and runs longitudinally through the testis its continuation outside of which is the vas deferens (fig. 41). Leading into this main central tube are many small efferent ducts which carry the spermatozoa from the cysts.

The vas deferens shows in transverse sections that it is not completely filled with sperms there being a central rod-like mass of cells which passes through it. The cells composing this central core are similar in structure to the epithelium. An examination of serial sections shows that at or near the place where the vas deferens leaves the testis there are prolongations of the epithelium which give to the lumen very odd shapes, these outgrowths finally take the form of a solid central core. This mass of cells passes entirely through the vas deferens and finally fuses again with the regular epithelial layer of the wall. A transverse section through any part of either vas deferens (fig. 42) will show this central core of cells and also that the sperms occupy entirely or in part the space between it and the epithelium of the true wall. Longitudinal sections of the vas deferens show that the central core is now and then supported by strands of cells which connect it to the epithelium.

In transverse section the wall of the vas deferens is seen to be composed of two layers. The inner of these, the epithelium, is a single layer of columnar cells each cell containing an irregularly ovoid nucleus (fig. 43). The outer layer of the wall is not so thick as the epithelium; it is composed of from one to three layers of cells, these are generally flattened but where there is a single layer this is not the case. If two or more layers of the cells are present the inner layer is much more flattened than the others. The nuclei of these cells are small and their form varies with the shape of the cell. At the place where the vas deferens leaves the testis there is more or less fat present; some of these small fat masses can be traced down over the vas deferens into this outer layer. Where the tracheae in any way touch the vas deferens the fat which may surround them can be seen to connect with these fat cells which surround the latter. This layer surrounding the vasa defferentia is a continuation of these fat cells.

Following in serial sections the vas deferens it is seen that where it widens to form the seminal vesicle the structure of the wall changes. In the vesicle (fig. 44) the epithelial layer has changed only in the cells being shorter and that the cell boundaries are very difficult to find. The fat cells as a layer have disappeared and in their place we find a wider layer of muscle fibres running in various directions. Along the free surface of the epithelium a cuticular layer is present.

The common opening of the testes is ventral on the ninth segment between two valves (fig. 45). It is in the form of a longitudinal slit situated on the apex of an elongated papilla and can be seen after the valves have been raised. The rather thick chitinous covering over the surrounding region of the body is interrupted in two places by thinner areas (fig. 45, at ends of bracket x), these act as the hinges on which the valves move. In many of the specimens examined the seminal vesicles were filled with sperms.

Accessory glands were not found in connection with the male reproductive organs. The view that the wall of the seminal vesicle has a glandular function, Fenard (11), does not seem so probable as to give to the epithelium of the vasa defferentia this function. A comparison of the structure of the wall of these two will show that in the former part (fig. 44) the epithelial cells are much smaller than in the latter (fig. 43). In the vas deferens the cytoplasm may not have the same appearance in different parts of the cell, near the outer surface there was noticed in some specimens a darker zone which contrasted very clearly with the rest of the cell contents.

There has been some doubt about the presence, in connection with the vasa defferentia of one or more seminal vesicles. In our specimens there has not only been noted the presence of masses of sperms in the vesicles (fig. 45) but the great enlargement in the proximal ends of the vasa and the change in the histological structure of the wall would point to the formation at this place of seminal vesicles. Palmén (16) noted this in the dragonflies and, amongst others, in species of *Libellula;* he says: "Die beiden Vasa deferentia fand Ich vesiculaartig ausgedehnt, wie bei den Ephmeriden; sie legen sich im hinteren Körperende in S-förmige Biegungen und laufen zuletzt, einender median berührend, eine kurze Strecke nach vorne; hier vereinigen sie sich, und der mittlere Theil dringt conisch abwärts gegen die am neunten Sternite belegene Geschlechtsöffnung."

Female Reproductive Organs.

The female reproductive organs of the dragonflies have already received considerable attention. The earliest real anatomical account to which any reference can be found is that by Rathke (21). Calvert (5) calls attention to the fact that he was unable to examine this paper and knows of it only through the references of others. Requests to the libraries of several of our largest Universities failed to obtain this work. Rathke was followed in his work by Siebold (26), Palmén (16) and Fenard (11).

Siebold (26) has shown the presence of copulatory pouch and seminal recepticle and, in fact, describes the latter in the species of dragonfly which is the subject of this paper. He says: "*Libellula 4 maculata* bietet eine Abweichung dar, in den ihre beiden Samen kapseln nur zwei kleine Blindsächen vorstellen".

The two ovaries occupy relatively the same position in the female that the testes do in the male. They begin in the first abdominal segment—the terminal filaments extend forward into the thorax—and end in the middle of the sixth segment; at this point the oviducts, which have for some distance been along the outer margin of the ovaries (fig. 51, Odt.), continue alone to join finally near the anterior margin of the eighth segment, to form a common oviduct. This passes into the vagina which continues to the outlet.

The opening of the vagina is ventral on the posterior margin of the eighth segment. From a posterior view the opening (vulva) is shaped like a capital T, the upright of the T instead of having a short horizontal bar for its base has an oval shaped opening (fig. 50). In the vagina, when empty, are numerous large and small longitudinal folds in the wall the two ventral ones of which are much larger than the others (fig. 54). These folds make the vagina appear very irregular in all transverse sections. Lining the vagina is a thick cuticular layer.

Each ovary consists of a great many ovarian tubules which lie side by side closely packed together. The ovaries are changed very greatly in size by the growth of the oöcytes; in some specimens they are but little larger than the testes while in others the entire abdominal cavity is nearly filled with them. The terminal filaments of the ovarioles lie nearly parallel to the longitudinal axis of the oviduct and along its inner and in part ventral surface.

Each ovarian tubule (fig. 46) has, distally, a long and thin terminal filament. This is followed by a small terminal chamber in which the youngest oöcytes are found and these, passing backward in the tubule, increase in size, very soon to become arranged in a single row, this linear arrangement persists until the end. Proximally there is a short basal stalk through which the oöcytes pass before entering the oviduct. In *Libellula 4-maculata* there are no terminal or other food chambers. The follicular epithelium is rather thin over all parts of the tubule; it, as usual in insect ovaries, consists of a single layer of cells except between the egg chambers.

The two oviducts, passing back and converging towards a common median line, finally join to form a short oviductus communis. This lies ventral to the seminal vesicles, continues but for a short distance, and then passes into the vagina (fig. 49, Vg). In section the common oviduct shows the presence of a thin layer of longitudinal muscles which is absent in the vagina. Besides this layer of muscles both the common oviduct and the vagina have at either side a considerable mass of muscles (fig. 55).

The vagina, as already mentioned, is very irregular in shape, the wall is longitudinally folded and two of these folds are much larger than any of the others. The two larger folds can be seen in a dissection in which the vagina is cut open longitudinally (fig. 47) or in transverse sections. In this latter case the folds may come from near the ventral wall of the vagina or may have their origin at some place on the lateral walls (fig. 54). The wall shows a thick cuticular layer with a noticeable lamellate structure. This layer varies greatly in thickness in different parts. The hypodermal layer contains small ovoid nuclei, in it the cell boundaries are difficult to distinguish (fig. 56).

The seminal vesicles lie dorsal to the union of the two oviducts. These (fig. 47, Rp. Sem.) are irregular in outline and each somewhat kidney shaped; the two are joined together and form a body somewhat the shape of a dumb-bell. The union of the right and left recepticles is more clearly seen in a transverse section through the region of their union (fig. 55). In all the specimens examined the seminal recepticles were entirely or nearly empty and what their appearance would be when filled with sperm is not known. From the wrinkling of the inner wall one would judge that the cavity would be very much enlarged if stretched by being filled.

Median and just posterior to the union of the receptacles lies a peculiar chitinous piece, the collar (fig. 47, Cu. Co.). This at first appears to be a ring encircling in this place some part of the reproductive organs but a more carful examination shows that the ring is not a complete circle but is ventrally imperfect. Posterior to the ring and dorsal in position there is a chitinous piece, not so thick as the collar, extending back and prolonged laterally into two blunt projections (this is shown in figure 47). The chitin forming this piece varies in thickness, being thicker near the ring than along any of the free margins. A sagittal section shows several muscles that arise from the posterior end of this piece (fig. 48, M), the action of these would give to the ring a backward and forward motion. In this same view the collar has more the shape of a wine glass, with these muscles coming from the tip of the stem and the cup of the glass being occupied by a prolongation of the cavity which lies just back of the junction of the receptacles. From this same view the chitinous piece is seen to be free on all sides and not connected with any other tissue; this makes possible what ever movement it may have.

What this chitinous collar is for is not known and it would be necessary to examine a number of specimens during and after copulation to determine its real use. It is very possible that the muscles attached to it pull it back from the seminal receptacles and, having the other and larger anterior end in part concave, one would suppose that it would have to do with pumping the sperm out of the receptacle.

Where the openings of the two seminal receptacles join there is a large cavity with a very much wrinkled and folded wall. This passes backward into a narrow passageway which extends posteriorly into the vagina. From a dorsal view this outlet appears to pass directly through the center of the chitinous collar but it in reality passes ventral to his part (figs. 48 and 54). A little posterior to the collar the passageway shows a slight enlargement (seen in figure 47, just posterior to). Both from an examination of traverse sections and from entire mounts of this part of the reproductive system the lateral walls of this passageway are seen to have a number of cuticular setae which extend inward from the wall on which they originate (figs. 47 and 54).

A section through this wall (fig. 52) shows very thick epithelial and cuticular layers. The epithelium consists of long narrow cells with ovoid nuclei. The inner two-thirds of the cuticular layer has a very marked lamellate structure, this is followed by a much thinner layer (stippled in figure) which was blue in the slides stained with haematoxylin; and, last of all, an inner transparent layer from which the setae arise.

The use of these setae is not at all clear, and, as only one of my specimens contained sperm in these parts of the reproductive organs, it was impossible, if they had a special function, to arrive at any conclusion as to what this function was. The one specimen in which sperm was found showed that in this passageway they were arranged in regular rows running in two directions (fig. 48). An examination of this surface with a high power showed that these strings of sperms corresponded fairly regularly to the spaces between the setae; this is shown in figure 53 where the small circular areas represent the setae cut transversely. Such an arrangement of the sperm would naturally follow its being forced between the setae but if this in any way persists and has anything to do with some special final arrangement of the sperm it was impossible to determine from the single specimen in which this was shown.

At the anterior end of the vagina there is a dorsal outgrowth with two somewhat lateral prolongations, all of which forms the bursa copulatrix (figs. 47 and 48, Br. C). In *Libellula* the copulatory pouch does not form as distinct a body as in many other insects.

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April, 1912.

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REFERENCE LETTERS.

A. Anterior.
Ant. Antenna.
Ap. Apodeme.
Br. Brain.
Br. C. Bursa copulatrix.
Bm. Basement membrane.
C. Brush.
Cly. Clypeus.
Cm. Circular muscles.
Cu. Cuticula.
Cu. Co. Cuticular collar.
D. Dorsal.
E. Eye.
Ep. Epicranium.
Epth. Epithelium.
FI. Fore-intestine.
Fr. Frons.
Ft. Fat bodies.
G. Gena.
Gu. Gula.
H I. Hind-intestine.
Hp. Hypodermis.
Hyp. Hypopharynx.
Il. Ileum.
L. Labium.
Lb. Labrum.
Lm. Longitudinal muscles.
M. Muscles.
Md. Mandible.
Mes. th. Mesothorax.
Met. th. Metathorax.
MI. Mid-intestine.
Mx. Maxilla.
Mxp. Maxillary palp.
Oc. Ocellus.
Oes. Oesophagus.
Op. Occiput.
Odt. Oviduct.
Odt. Cm. Oviductus communis.
Pg. Pigment.
Ph. Pharynx.
Ph. Pl. Pharyngeal plate.
Pro. th. Prothorax.
Rp. Sem. Receptaculum seminis.
R. sgl. Reservoir of salivary gland.
Rt. Rectum.
S. gl. Salivary gland.
T. Testis.
Tr. Trachea.
Vc. Sem. Vescicula seminalis.
Vd. Vas deferens.
Vg. Vagina.
Vt. Vertex.

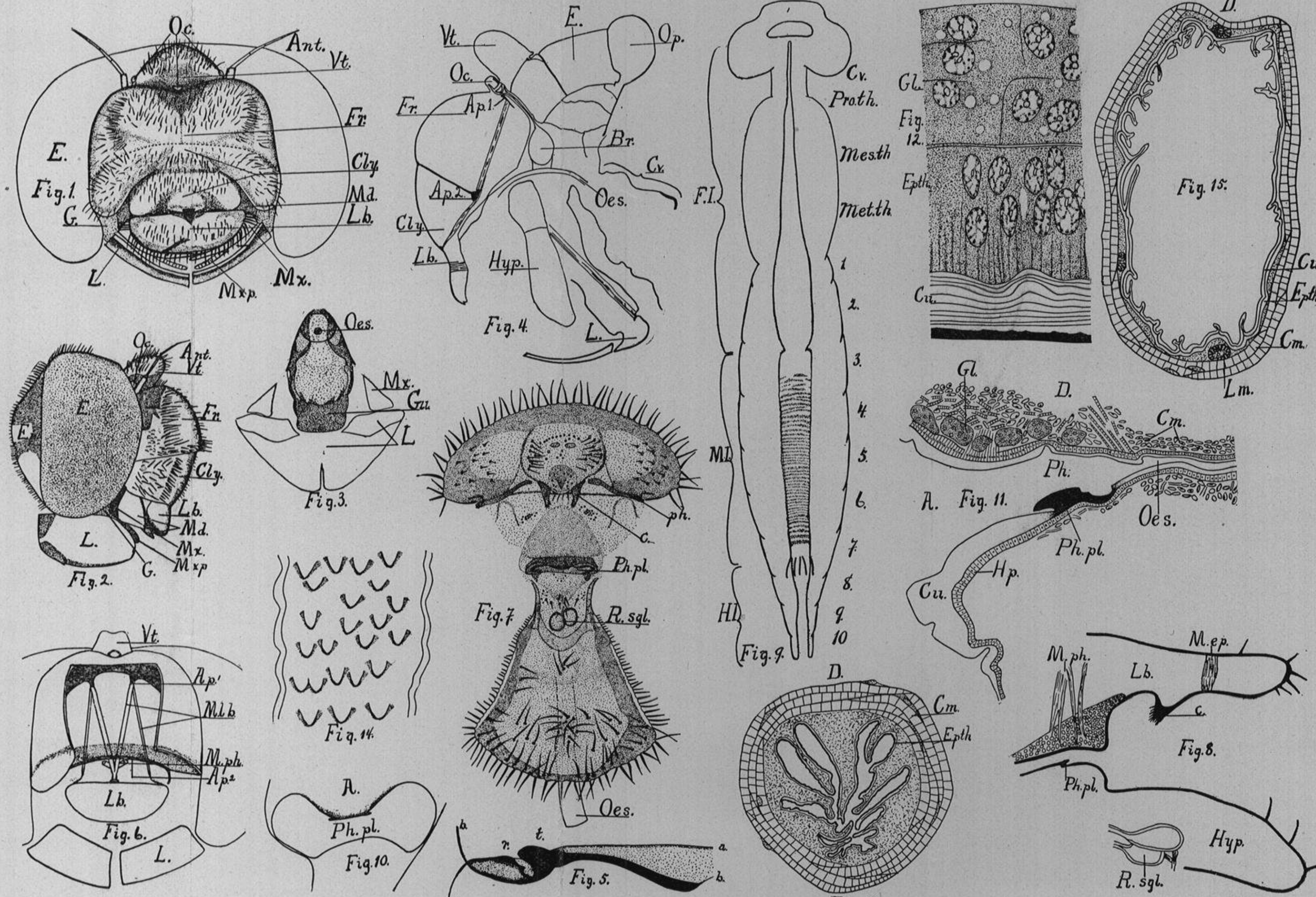


Fig. 1.
Oc.
Ant.
Vt.
Fr.
Cly.
Md.
Lb.
E.
G.
L.
Mx.
Mxp.
Fig. 2.
Fig. 3.
Oes.
Gu.
Fig. 4.
Op.
Ap. 1.
Ap. 2.
Br.
Cv.
Hyp.
Fig. 5.
Fig. 6.
Mlb.
M. ph.
Lb.
Fig. 7.
ph.
c.
Ph. pl.
R. sgl.
Fig. 8.
M. ep.
Fig. 9.
Proth.
Mesth.
Metth.
F. I.
M I.
H I.
Fig. 10.
Fig. 11.
Gl.
D.
Cm.
Ph.
Hp.
Cu.
Fig. 12.
Epth.
Fig. 13.
Fig. 14.
Fig. 15.
Lm.

PLATE LXVIII.

Fig. 1. Front view of head. × 8.
Fig. 2. Side view of head. × 6.
Fig. 3. Posterior view of part of the head showing gula, Gu. × 6.
Fig. 4. A partly diagrammatic median sagittal section through the head and cervical region. × 10. Ap. 1 and Ap. 2 apodemes. Cv. cervical region.
Fig. 5. View of a part of the opposed margins of clypeus and labrum, showing one of the two hinges, the right hand one. × 105. a — a, edge of labrum. b — b, edge of clypeus showing part of the curved chitinous rod on this side. t, tooth on edge of clypeus. r, thickened chitin along outer edge of the cavity in labrum into which t fits.
Fig. 6. Anterior view of the head with portions of the frons and of the clypeus removed; part of each eye cut away. The stippled part shows the partition separating the frontal from the clypeal cavity. × 8. Ap. 1 and Ap. 2 apodemes. M. lb. Elevator muscles of the labrum. M. ph. Muscle of pharynx.
Fig. 7. Inner surface view of labrum, above, and of hypopharynx, below. Each part drawn and then joined in their natural position. × 40. Oes. Oesophagus, drawn only in part, not continued to its outlet. Ph. Position of teeth upon which labrum articulates (Fig. 5, t). C. Brush, (Fig. 8, c). Ph. pl. Pharyngeal plate (Figs. 8 and 10, Ph. pl.).
Fig. 8. Median sagittal section of labrum, Lb. and hypopharynx, Hyp. × 20. The buccal cavity, the pharynx and the beginning of the oesophagus are shown. M. ph. Pharyngeal muscle. M. ep. Epipharyngeal muscle. Ph. pl. Section of the pharyngeal plate across the entrance to the pharynx (Fig. 7, Ph. pl.). C. One of the brushes on the labrum (Fig. 7, c).
Fig. 9. Dorsal view of the alimentary tract. × 3. Cv. Cervical region. Between MI and HI the dark lines represent the position of the Malpighian tubules, these are not drawn in full but only their position of attachment to the intestine represented by these lines.
Fig. 10. View of the pharyngeal plate. × 40.
Fig. 11. Sagittal section showing portions of the buccal cavity, the oesophagus and the pharynx. × 150. Gl. Glandular tissue on dorsal wall of pharynx.
Fig. 12. Section through the dorsal wall of the pharynx. × 1100. Gl. Glandular tissue.
Fig. 13. Transverse section of the oesophagus in the cervical region. × 280.
Fig. 14. View of inner surface of cuticular layer of the oesophagus showing the small blunt projections which occur on this and other parts of the fore-intestine. × 1100.
Fig. 15. Transverse section of the oesophagus cut through the mesothorax. × 280.

PLATE LXIX.

Fig. 16. Inner view of one half of the oesophageal valve, two plates of the gizzard shown. a, where fore-and mid-intestines join.

Fig. 17. The gizzard opened longitudinally to show the four plates. × 15.

Fig. 18. Surface view of one of the plates of the gizzard. The posterior half shows the rectangular area covered by the small chitinous projections (Fig. 14). × 52.

Fig. 19. Transverse section through the gizzard, cut near the anterior end of the plates. × 70. In this and the following figure, 20, the inner irregular line represents the cuticular layer and the four plates are shown thicker, as they are, than the rest of it.

Fig. 20. Transverse section through the gizzard near the posterior end of the plates. × 110.

Fig. 21. Transverse section through wall of gizzard in position of one of the plates. × 875. Cu. Cuticula (plate).

Fig. 22. Longitudinal section through the oesophageal valve showing at x the place where fore-and mid-intestines join. (a of Fig. 16.)

Fig. 23. Longitudinal section through a portion of the wall of the mid-intestine showing three of the primary folds and the secondary ones between them. × 110. x, outer surface.

Fig. 24. A small piece of the wall of the mid-intestine, from a longitudinal section. × 740. Stl. Striated layer.

Fig. 25. Part of wall of mid-intestine very near the posterior end—from a transverse section. × 1100. Stl. Striated layer. Bm. Basement membrane. Nd. Nidus.

Fig. 26. External view of hind-intestine.

Fig. 27. Outline view of a transverse section through the anterior part of the ileum. The region occupied by the large cells is strippled. × 105.

Fig. 28. Outline view of a transverse section through a region at about the middle of the ileum. At this place there are two areas of large cells, these are strippled. × 105.

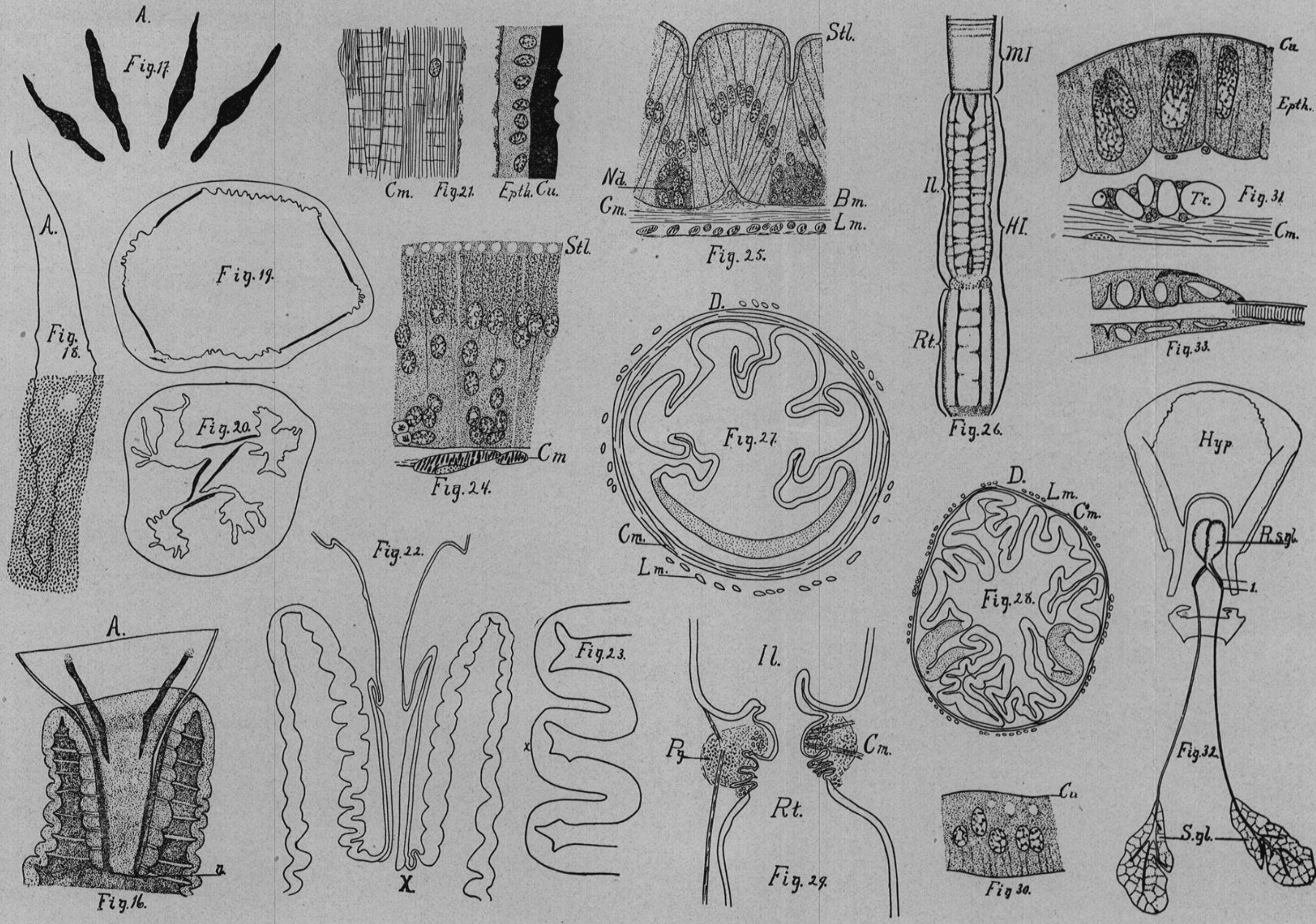
Fig. 29. Partially diagrammatic longitudinal section through the alimentary canal at union of ileum, Il. with rectum, Rt. × 40. Pg. Pigment.

Fig. 30. Part of transverse section of ileum showing the regular epithelial cells, Epth. and the cuticula, Cu. Nothing else drawn. × 550.

Fig. 31. Part of a transverse section of the ileum showing the large cells. × 435.

Fig. 32. Salivary glands, S. gl. and under surface of hypopharynx, Hyp. × 18. 1. Portion of the duct that is shown enlarged in figure 33.

Fig. 33. Optical section of that portion of duct from salivary gland that is covered for a short distance by an extension of the cells of the reservoir. The same structure is found on the ducts just after leaving the reservoir. Position of the piece here figured is shown at 1 in figure 32. × 280.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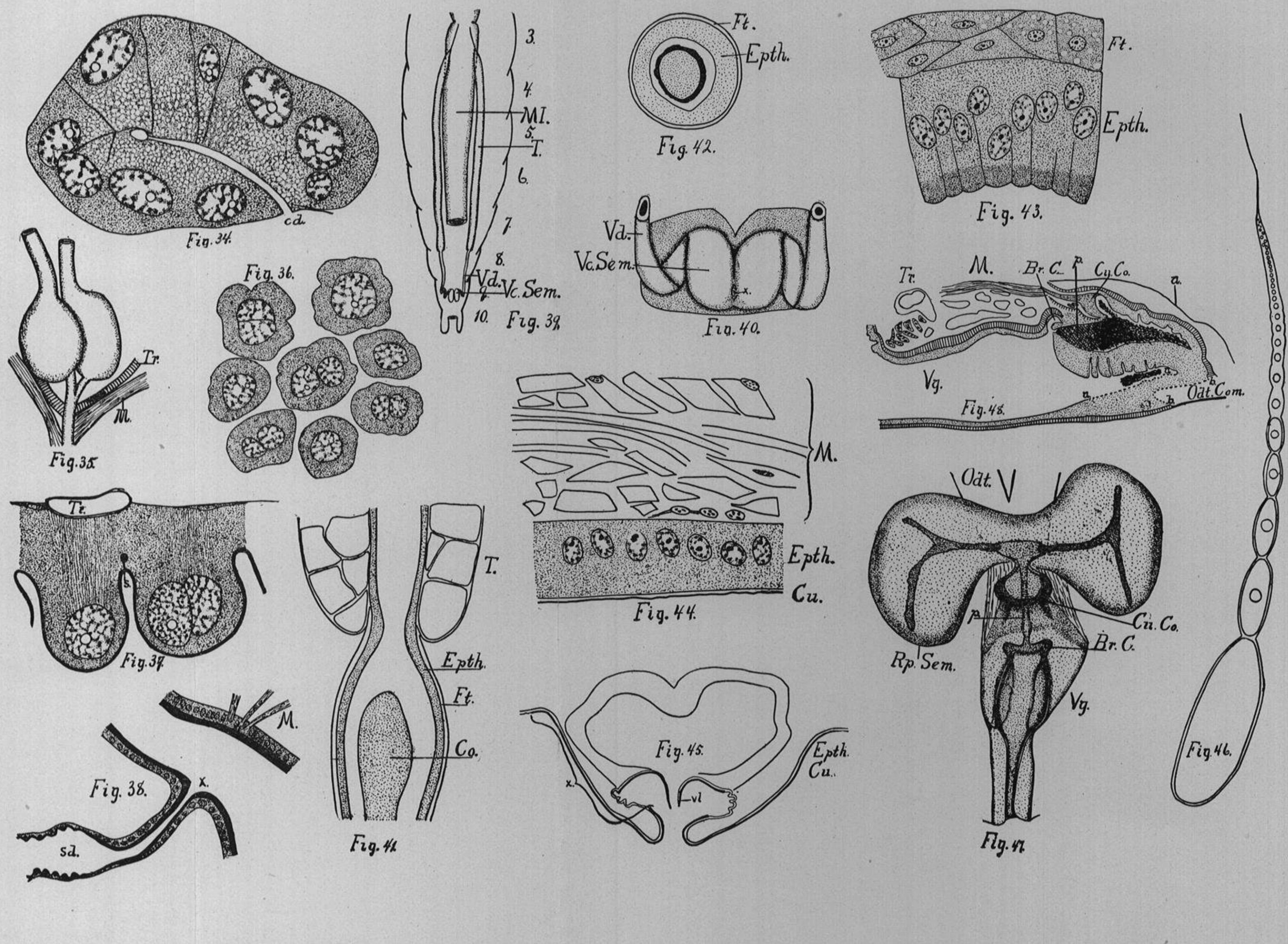
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Fig. 38.
sd.
Fig. 45.
Epth.
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PLATE LXX.

Fig. 34. Section through an acinus of the salivary gland. × 1700. cd. collecting duct.

Fig. 35. Reservoirs of salivary glands—above a part of the large ducts leading from the glands, below the two short ducts and the common one into which they unite. × 50.

Fig. 36. Surface view showing a few cells, inner surface, of the salivary gland reservoir. × 875. This view shows the free ends only of the protruding portions of the cells. Compare figure 37.

Fig. 37. Section showing two cells of the wall of the reservoir. × 1100. The heavy cuticula lines the inner surface. s, position of small dark objects which might have to do with outlet of secretion.

Fig. 38. Opening of common duct, sd, from reservoir of salivary glands on surface of the hypopharynx at x. Combined from two sections. × 280.

Fig. 39. Dissection to show the male reproductive organs. Part of the alimentary canal removed. T, testis; Vd. vas deferens; Vc. Sem. vesicula seminalis.

Fig. 40. Dorsal view showing proximal part of vasa defferentia, Vd., and the seminal vesicle, Vc. Sem. × 30. The common opening ventral, is shown by dotted lines near the posterior part of the vesicles, at X.

Fig. 41. Longitudinal section of a small proximal part of a testis, T, and the vas deferens which passes out of it. × 105. The two layers of the wall of the vas deferens, the epithelial, Epth. and the fat, Ft. both shown. The central core or mass of cells inside the vas deferens is shown at Co. None of the strands of connecting epithelial cells were shown in this section.

Fig. 42. Transverse section of the vas deferens. The epithelial layer of the wall, Epth., and the central core of epithelial cells are stippled. The thick irregular black part shows a mass of sperms. Ft., layer of fat cells.

Fig. 43. Transverse section of the wall of the vas deferens showing the epithelial layer, Epth. and the outer layer of fat cells, Ft. × 1100.

Fig. 44. Section of the wall of the seminal vesicle. × 1100.

Fig. 45. Transverse section through the wall of the seminal vesicle showing its outlet to exterior between the valves, vl. × 105. At × the bracket limits the moveable chitinous flap which, with the one on the other side, close over the opening of the male reproductive organs.

Fig. 46. Single ovarian tubule—part of terminal filament omitted. × 50.

Fig. 47. Partly diagrammatic dorsal view of the female reproductive organs—ovaries and most of oviducts not drawn. × 50. The proximal ends of the oviducts, Odt., are shown. The passageway leading from the bursa copulatrix, Br. C., to the seminal recepticle, Rp. Sem., is shown and part, p, of it is seen to have on its walls the cuticular processes shown in figure 52. This passageway, P, passes under the cuticular collar appearing in the drawing to pass through it. The vagina has been in part cut open to show the large folds in its wall. The cuticular collar is shown at Cu. Co.

Fig. 48. Median sagittal section through the proximal portion of the female reproductive organs. × 50. At p is the passage between the vagina, Vg., and the seminal recepticle (not drawn in this figure). Two dotted lines a—a and b—b where the connection between oviductus communis, Odt. Com., and vagina, Vg., is found two sections from the one here figured. Dark mass, sperms. Cuticular layers stippled. Epithelial layer shaded. At p and at a positions from which sections 54 and 55 were cut.

PLATE LXXI.

Fig. 49. View of last portion of oviducts, Odt., the oviductus communis, Odt. Com. and the vagina, Vg. × 30. Cu. Cuticular lining of the vagina.

Fig. 50. View of the posterior end of the eighth abdominal segment showing the T—shaped opening, vulva, into the vagina. v., the free posterior end of the vulvar lamina.

Fig. 51. Transverse section through the ovaries showing the many ovarian tubules sectioned and the oviduct, Odt., along each side. In the center of the figure is the heart, with stippled wall. × 50.

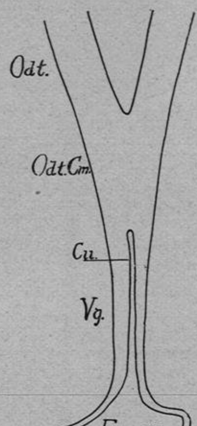
Fig. 52. Transverse section through wall of the passage leading from the vagina to the receptaculum seminis (Figs. 47 and 48, p). The long hollow setae are on the inner free surface. × 875.

Fig. 53. Surface view of portion of lateral wall of passage between vagina and seminal recepticle (Fig. 48, p). In this view the hollow setae have been cut transversely and are shown at s as little circles; the dark lines between these represent the strings of spermatozoa. × 740.

Fig. 54. Transverse section through the reproductive organs, the cuticular layer only drawn and stippled. Cu. Co. section of cuticular collar. p., passage between vagina and seminal recepticle (Figs. 47 and 48, p). The two large folds of the wall of the vagina, V, are shown. Cut in about position represented in figure 48 at p. × 105.

Fig. 55. Transverse section cut at about position a in figure 48. e, egg; ch, chorion of same; m, muscles of common oviduct and of vagina. × 105.

Fig. 56. Longitudinal section through dorsal wall of vagina. × 875.



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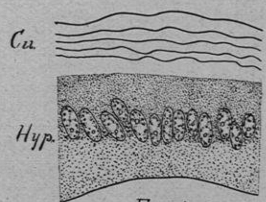

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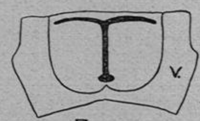

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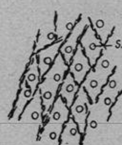

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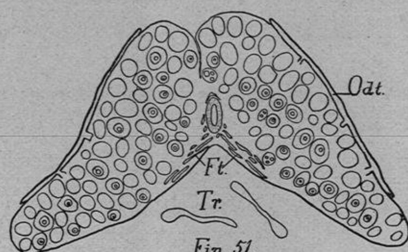

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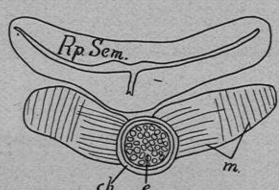

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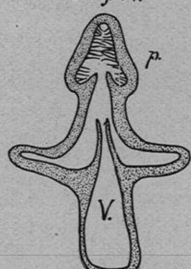

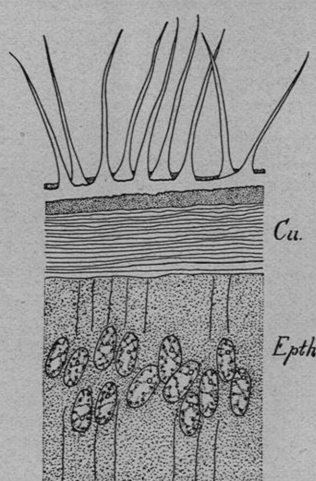

Fig. 52.

ON THE HABITS OF UCA PUGNAX (SMITH) AND U. PUGILATOR (BOSC).

By A. S. Pearse.

Zoology Department, University of Wisconsin.

Fiddler-crabs are remarkable chiefly for the great size of one of the chelipeds on the males. The enlarged claw may occur on either the right or left side. The females have two small chelipeds similar to the lesser one of the males. The use of the monstrous claw has been a matter of much speculation; it has been variously supposed to serve as a stopper for the burrow, a spade for digging, a weapon for combat, a "nuptial couch" used during copulation, and to attract the admiration of the females. Smith and Weldon ('09), though they review the opinions of other writers, do not commit themselves as to the use of this peculiar structure. Alcock ('02) believes that it is used as a sort of flag, which is waved to attract the females. Calman ('11) in his recent "Life of Crustacea" says (p. 106), "What the precise use of this enormous claw may be does not seem to be quite certainly known. It is said to be used as a weapon by the males in fighting with one another, but it seems too clumsy to be very efficient for this purpose. It is often brilliantly colored, and has been supposed to be a sexual adornment."

The writer ('12) has shown elsewhere that fiddlers use their great claw with marked agility in combats with each other; indeed, one crab may throw his adversary three or four feet, and, as many such contests have been observed (fig. 1), there seems to be no reason to doubt the claw's efficiency as a weapon.

Once during the past summer a male was seen to grasp an adversary by the wrist and hold him at "arm's length" above his head.

From June 28 to August 13, 1912, the writer occupied a room in the Marine Biological Laboratory at Woods Hole, Massachusetts, and had opportunity to extend his observations on fiddler-crabs. Fortunately this period came during the height of the breeding season. It is a pleasure to acknowledge the courtesy of those in charge of the laboratory, particularly Mr. George Gray.

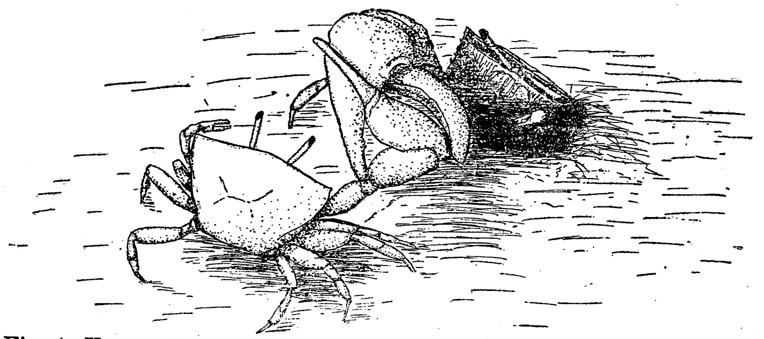

Fig 1. *Uca pugilator.* Two males fighting. The right hand one is partly in his burrow. Drawn from a photograph taken at West Falmouth, Massachusetts.

Two species of fiddlers are common in suitable localities in the Woods Hole region. Both occur along the sheltered shores of estuaries and inlets, where they are usually found among the marsh grass (Spartina). The roots of this plant serve to support the soil so that the crabs' burrows do not cave in so readily when covered by water. *Uca pugnax* is most often found where the soil is of mud or clay; and *U. pugilator* is more common on sandy beaches; but the burrows of both species are often intermingled and mixed colonies are not infrequent. Aside from these differences in habitat and the fact that *U. pugnax* bred earlier in the season than *U. pugilator,* no difference was noticed in the behavior of the two species.

The maximum number of burrows was found about two feet (vertical) below high tide mark, and some crabs even had holes above the tide limit. Where the tide had covered the beach with eel grass or other debris many of the burrows had mud towers around their openings. These towers were sometimes an inch in height. In the Philippines the writer had observed that the fiddler-crabs usually carried the mud excavated from their burrow eight or ten inches away, and it was noticeable that the Massachusetts fiddlers usually piled such mud close to their door-ways (fig. 2), contrary to the observations of Smith (Stebbing, '93, p. 90). The crabs dug most actively when the tide was falling. Then burrows which had caved in or been partially filled were repaired. In digging,

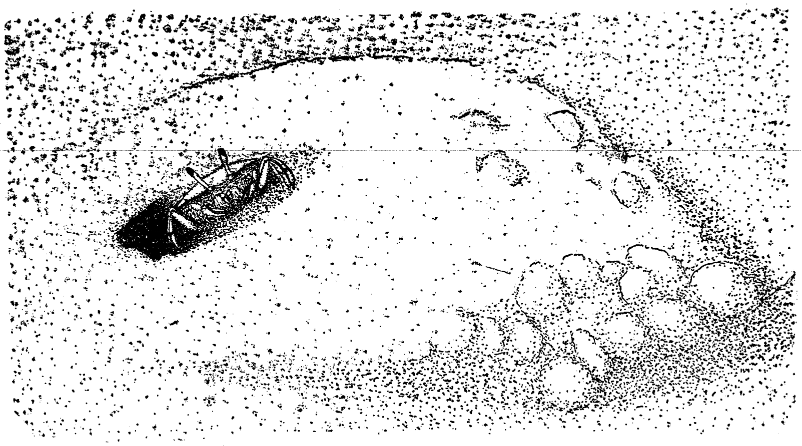

Fig. 2. *Uca pugilator.*. **A female at the mouth of her burrow. Drawn from a photograph taken at Falmouth, Massachusetts.**

dirt was scooped up with the walking legs of one side and carried behind the body (fig. 3). A detailed description of methods of excavating and carrying dirt has been given in a former paper (Pearse, '12), and Stebbing ('93) reviews Smith's earlier observations. Only once was a crab seen to use his great chela in digging. This was when a piece of shell blocked his way; he turned around, reached down the hole, and removed the obstacle with his chela.

Sometimes, when the tide had washed the dirt away at the mouth of the burrow so that the opening was too large to suit the owner, mud or other material was carried to it and smoothly plastered down with the walking legs until the size was proper. Each hole was usually plugged just before the rising tide reached it and remained closed while it was covered with water. Where the soil was fairly firm a crab would gouge a plug out of the beach and pull it down into the mouth of his burrow as he descended in such a way as to completely close the opening. On a softer beach a crab carried two or three pellets of mud which were placed about the opening of his hole so as to partly close it; then he sidled through the narrowed space and pulled the mud down with the walking legs of one side (fig. 4) so as to nearly close the hole. The legs were then withdrawn and dirt was pushed up on the inside so that no aperture was

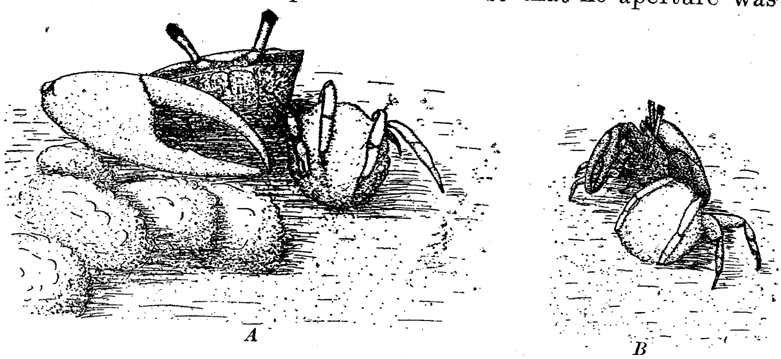

Fig. 3. *Uca. pugilator.* Males carrying loads from their burrows. In *A* the fiddler is facing the observer and walking toward the left. He carries his load with the first three legs of the left side. B shows a male carrying a load away from the observer.

left. Fiddlers seemed to feel that the necessity for having their burrows closed when the tide came in was very urgent. Once I pulled up all the grass on a thickly populated area about six feet square and chased all the crabs into their holes; then I sat in front of this open space while the tide came in and covered the mouths of the burrows. Though the crabs were timid, and apparently feared me, several of them rushed out when the water came near, and, after hastily grabbing one or more pellets of mud, plugged their holes. Other animals that were observed to be active when the tide came in, and which might have harmed the fiddlers, were ribbon-fish, minnows, green crabs, and prawns.

Fiddler-crabs usually fed on the wet beach above the water, and the position of their burrows nearer high than low tide mark, gave them the maximum amount of time for such activity. Many emerged from their burrows and moved down with the edge of the falling tide until the beach dried off; then they descended into their holes again and waited until it was time to plug them. They usually did not go far from home, but the females wandered about much more than the males. At North Falmouth the beach at low tide was alive with armies of fiddlers that were twenty or thirty feet from their holes. Where the crabs were most abundant (optimum habitat) the burrows were about five inches deep; but above high tide mark many of them went down over two feet and there was water in the bottom.

As has been stated, *Uca pugnax* bred earlier than *U. pugilator*. Egg bearing females of the first species were observed

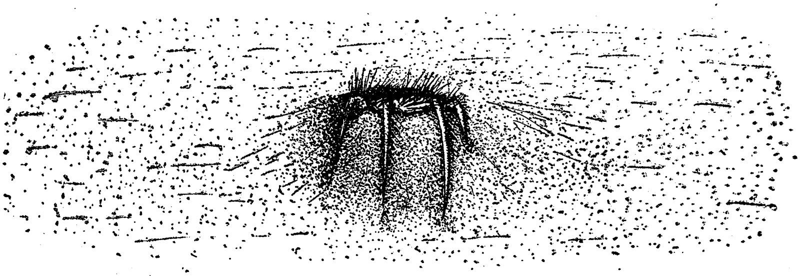

Fig. 4. *Uca pugilator*, closing his burrow by pulling down mud with his walking legs.

from July 4 to July 15. They wandered boldly about over the sand and could be picked out at once by the dark mass of eggs which caused the abdomen to hang down below the body. No females of *Uca pugilator* were observed to be carrying eggs until the first part of August; the exact date was not noted. These two species of fiddlers present another case like that of Fowler's toad and the American toad, which have different breeding seasons, though they commonly occur in the same locality and in the same habitats. The fact that *Uca pugnax* is darker colored than *U. pugilator* and usually lives in mud (which would absorb more heat than sand on account of its darker color, and would contain more organic material which would generate heat in decaying) may account for its earlier breeding period. It would be interesting to know whether other animals which live along ocean beaches in both mud and sand breed sooner in the former.

Male fiddlers were fighting each other throughout the summer (fig. 1), but the chief point of interest in the inter-relations of the crabs was the behavior of the two sexes toward each other. The writer had never before observed fiddlers during the breeding season and was interested to see whether the males would wave their claws to attract the females, as Alcock ('02) asserts they do. Such waving was observed throughout the summer. None of the males were seen to dance about the females as they do in the Philippines (Pearse, '12) and in India (Alcock, '92, '02), though they often lowered themselves on their legs and gave a sort of curtesy when a female approached. Each male stood at the mouth of his own hole when he waved, and, if a female approached when he was elsewhere, he went to it, waving on the way. Waving consisted in flourishing the chelipeds up and down (sometimes only the great chela), and the motion was increased by alternately flexing the legs and standing on tiptoe when the chelipeds were down or up. Sometimes a male or two waved when no females were about, but if a female walked through a well populated region every male, great and small, stood at the mouth of his burrow and honored her by gesticulating frantically with his claws (fig. 5). If she approached a particular hole the owner either entered with the evident intention of inducing her to follow or he attempted to push her down ahead of him. No male was seen to grasp a female with his great chela or to attempt to use it in any way in his scuffles with her. Alcock ('92, '02) maintains that the bright colors on the great claw of the male fiddlers in India "have been acquired in order to attract and please the female." The claws of both the species observed in Massachusetts are dirty white, which makes them conspicuous objects. Yet we must be cautious in assuming that colors which appear bright to out eyes are also bright when seen by a fiddler. Furthermore, I have noted that the waving of claws is commonly a sign of excitement in crabs in which they are neither remarkably large nor brightly colored (Sesarma, Macrophthalmus). The male fiddler waves his chelipeds to attract the attention of the female, but I am not convinced that she is pleased or that he has any cognisance that his claw is brightly colored.

Females were observed to enter the burrows of males on several occasions, and once a female was watched who coquetted with a male for three quarters of an hour. The last case oc-

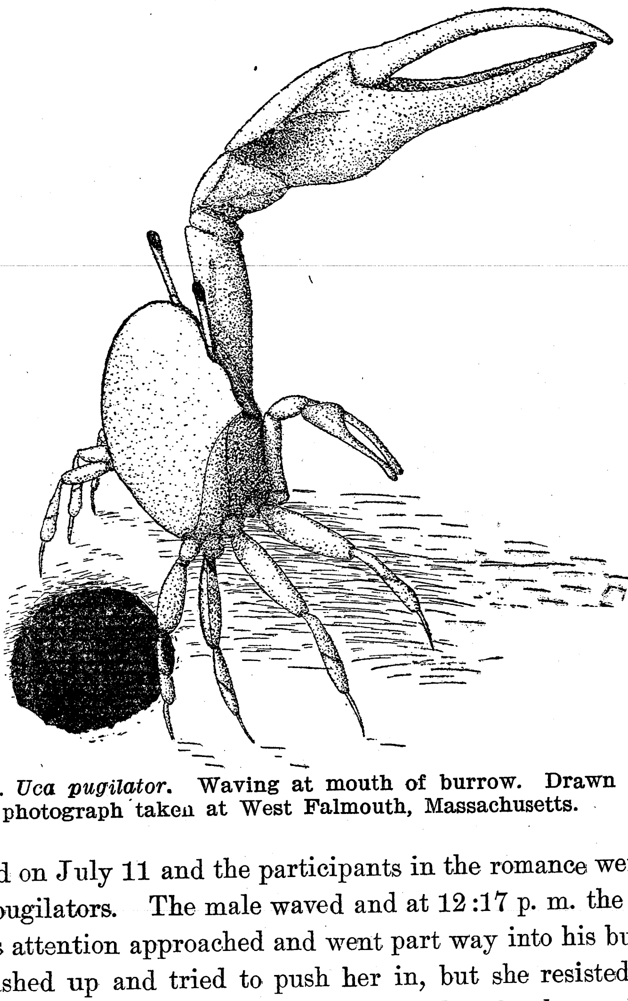

Fig. 5. ***Uca pugilator*****. Waving at mouth of burrow. Drawn from a photograph taken at West Falmouth, Massachusetts.**

curred on July 11 and the participants in the romance were two Uca pugilators. The male waved and at 12:17 p. m. the object of his attention approached and went part way into his burrow; he rushed up and tried to push her in, but she resisted. He then retired three inches and stood motionless for three minutes, with his claws outstretched in front, then sneaked up and again tried to push the female down into his burrow. She again resisted, he retired, and both were quiet for two minutes. The male then cautiously approached and stood motionless close to the female with upraised chela for three and a half minutes, and again attempted to push her down but without success. He then raised his claw and standing high on his legs assumed a statuesque pose which he held for ten minutes (I took his picture, fig. 6). The female meanwhile fed a little and moved away a couple of inches, then went part way down the hole. When the male again approached she dodged, but came back again, went into the hole and the male stood over her for more than a minute. She dodged away, again came back, and the male stood over her again. At 12:42 he went to one side of

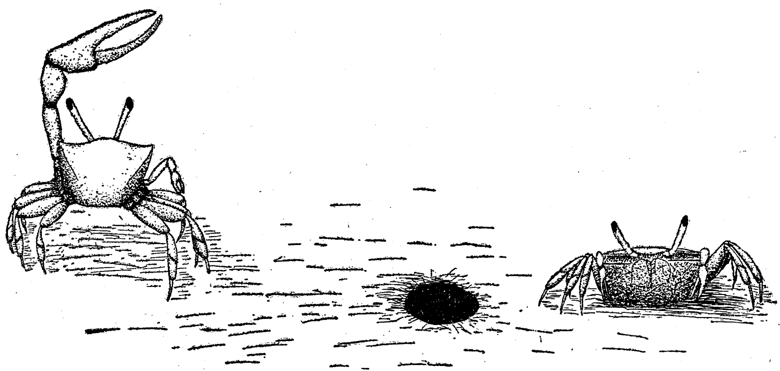

Fig. 6. ***Uca pugilator.*** **Male in courting attitude before a female. Drawn from a photograph taken at West Falmouth, July 11, 1912.**

the burrow, she to the other, and they stood thus for four minutes. At 12:46 the female moved away an inch at 12:52 the male dodged quickly into his burrow, and the female hastened up to him,—but a minute later she moved away several feet and went elsewhere. The male, however, was soon consoled, for at 1:02 he was standing at the mouth of his hole waving frantically at a new suitor. At 1:07 he carried a plug to his doorway and shut himself in.

I believe the activities just described were a courtship. The male made no attempt to use his great chela in an offensive way, as he would have done if a male or an unwelcome female had entered his hole. After his first rush he had every appearance of proceeding with great caution—as if he feared a too arduous wooing might cause his prospective mate to leave. After every repulse he retired a little way and displayed his charms for a time before making another advance. Apparently he was attempting, as Chidester ('12) says, "to demonstrate his maleness."

A little later in the same afternoon a small male *Uca pugnax* was seen to precede a female into his burrow just before the rising tide covered it. Whether copulation takes place in the burrows or on the surface of the beach I cannot say, for no crabs were seen mating under natural conditions. I dug out a number of burrows, but never found more than one crab at a time. High up on the beach there were many males (including the largest in the colony) and very few females; many of the females were carrying eggs. Lower down where the population was densest the two sexes occurred in about equal numbers. On July 12 and 17 I counted the fiddlers on a certain area. On a high, rather open place there were 146 males and 10 females (5 with eggs); two feet below (vertical) this there were 62 males and 58 females. When a well populated area was carefully dug over, attempting to get a crab from every hole, 66 males and 61 females (6 with eggs) were turned up on the lower beach; 10 males and 2 females above the high tide mark. From these results it would appear that there were more males than females, as Alcock ('92) believed to be the case in India, but there is a chance for error in the fact that the females are very easy to overlook, whereas a male can not well escape being seen.

Despairing of observing the actual mating in the field, I carried over 125 Uca pugilators into the laboratory at different times and put them in glass tumblers, a male and a female in each. Only about half to three quarters of an inch of sea water was put in each tumbler, for it was found that many of the crabs died when they were completely covered. Under such circumstances I was able to observe five pairs copulating. Two males were also observed while they were attempting to mate. Neither of them used the great chela, but attempted to climb upon the female and turn her over with the other legs. The position assumed during copulation is shown in figure 7.

Though there was some variation in the position of the appendages, the male's second legs (those next the chelipeds) were always hugged again the female's back, his third pair were between the bases of her last two pairs of legs, and his abdomen was inside hers. Two males grasped the eyestalk of their mate with the small cheliped, the other three pressed that appendage on her back as shown in the figure. The great chela was never pressed against the female, but was supported on the male's second leg. The time of the different copulations was as follows:

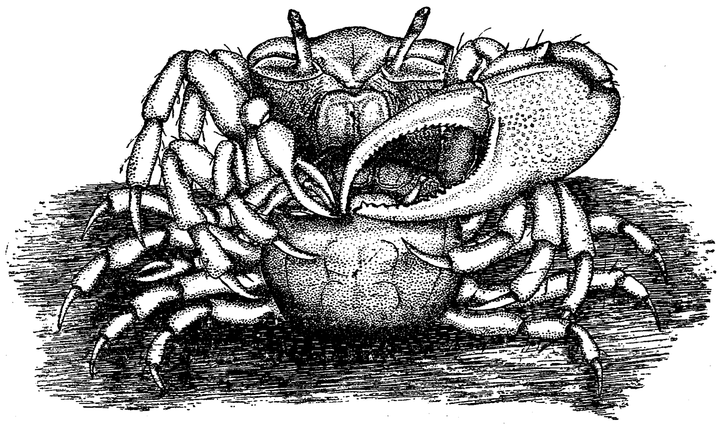

Fig. 7. *Uca pugilator*. A pair copulating. Drawn from life by Miss Barbara Bradley.

July 15, 7:00–7:10 p. m.; July 23, 6:35–7:27 p. m.; July 24, 4:40–4:53 p. m.; July 29, 8:35–9:10 p. m.; July 30, 8:38–9:10 p. m. In no case was the entire process observed; either the pair were already clasped when discovered or they were interrupted before they had finished. It will be observed that copulation took place in the afternoon or evening, but this may have been due simply to the quiet in the laboratory building at such time. All the females observed in copulation were "hard shells," hence mating in fiddlers does not follow ecdysis as in some crabs.

Summary.

1. *Uca pugnax* usually occurs on mud or clay bottoms; *U. pugilator* is commonly found where the beach is sandy.

2. The females of *U. pugnax* were carrying eggs during the

early part of July; *U. pugilator* was copulating during the latter part of July.

3. High up on the beach the fiddler population is mostly males; lower down the sexes occur in approximately equal numbers.

4. Fiddlers usually close their burrows when the tide comes in and use two methods. On a hard bottom they pull a round piece of earth down over themselves; on a soft bottom they plaster up the opening somewhat, then enter the burrow, and, after pulling the mud down with the legs, push up material from below.

5. Male fiddlers try to induce females to come to them by waving their chelipeds, and then try to make them enter their burrows.

6. Male fiddlers use the great chela as a weapon for combat and defense, and as a signal to attract the females. They do not use it as a stopper to their burrows, nor to dig, nor as a "nuptial couch" during copulation.

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A NEW SPECIES OF DIAPTOMUS.

By Chancey Juday.

On January 30 and February 1, 1910, some plankton material was collected from pools in the vicinity of Puerto Barrios and Los Amates, Guatemala. Among the copepods found in the collections is a species of *Diaptomus* which has not been described hitherto. The species is named in honor of Doctor C. Dwight Marsh in recognition of his valuable work on the North American forms of this genus.

Diaptomus marshi n. sp.

Male. The cephalothorax is bluntly cone-shaped anteriorly; it is widest in the middle. The first segment is about as long as the three following ones; the last thoracic segment does not have any lateral lobes but has a small spine on either side about the middle of the posterior margin.

The abdomen is elongated and slender, consisting of five segments besides the furcae. The first segment is short and broader than the others; the second is the longest of the five. The fourth is asymmetrical, the left side being a little shorter than the right; the fifth likewise is asymmetrical, the left side being a little longer than the right. The furcal joints are about two-thirds as long as the second segment.

The antennae scarcely reach the anterior ends of the furcal rami. The right one is modified for a grasping organ. The antepenultimate segment of the right antenna of one specimen bears a prominent curved process, but no trace of such a structure appears on any others (about twenty in all).

The spines on the first basal segments of the fifth feet (fig. 1) are moderately long and slender. The second segment of the right foot is a little longer than wide; the lateral hair is of moderate length and situated on the distal third; there is a blunt, tooth-like process on the anterior surface near the inner margin. The first segment of the right exopodite is short and broad and ends in a blunt process at the outer distal angle; there are two tooth-like processes on the posterior surface near the inner distal angle, the proximal one being the larger. The

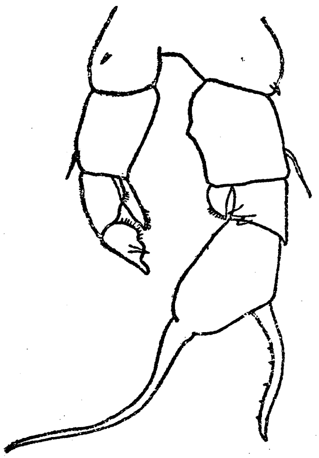

Fig. 1.
Fifth foot of male. X 190.

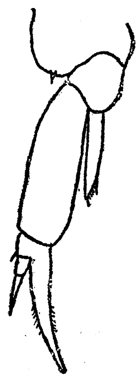

Fig. 2.
Fifth foot of female.

second segment is elongated, with an obtuse angle near the middle of the outer margin; the lateral spine originates just beyond the angle and it is long, curved, and bears from three to six teeth on its inner margin; the terminal hook is long, slender, and curved. The right endopodite is roughly triangular in outline, about as long as the inner margin of the first joint of the exopodite; it is ciliated on the inner margin toward the apex. The second basal segment of the left foot is about one and a third times as long as wide; the lateral hair on the outer margin is about a quarter of the distance from the distal end. The first joint of the left exopodite is a little longer than wide and is setose on the inner margin. The second joint has a ciliated pad on its inner margin and is terminated with a finger-like process; it bears a rather long, slender spine on the posterior surface toward the distal end. The left endopodite is elongated, reaching beyond the first segment of the exopodite; the outer end is pointed; there is a conspicuous cilium beyond the middle of the inner margin and small cilia thence toward the end.

Length of cephalothorax 0.78 to 0.81 mm.; width of cephalothorax 0.28 to 0.30 mm.; total length 1.1 to 1.15 mm.

Female. The cephalothorax is widest about one-third the distance from the anterior end; the anterior third gradually tapers forward, being cone-shaped in outline. The first segment is about as long as the three following. The last thoracic segment has a lobe on either side, each of which bears a small lateral and a small dorsal spine.

The first segment of the abdomen equals in length the three following ones; it is slightly expanded about one-third the distance from the anterior end and bears a small spine on either side at this point; the narrowest diameter is situated about the middle. The second segment is very short; the third is slightly longer than the furcal joints.

The antennae reach a little beyond the middle of the furcal setae.

The first basal segment of the fifth feet (fig. 2) bears a rather long spine on the dorsal side. The exopodite consists of three segments, the first being nearly three times as long as wide. The hook of the second segment is long and slender and only slightly curved; toward the outer end it is finely ciliate both on the inner and outer surfaces. The outer margin of this joint bears a small spine. The third segment is small and bears a rather long spine. The endopodite is one-jointed and about two-thirds as long as the first joint of the exopodite; it bears a spine-like cilium on the inner margin toward the distal end and another at the end; between these are small cilia.

Length of cephalothorax 1.03 to 1.05 mm.; width of cephalothorax 0.38 to 0.41 mm.; total length 1.40 to 1.44 mm.

A LIST OF FUNGI, CHIEFLY SAPROPHYTES, FROM THE REGION OF KEWAUNEE COUNTY, WISCONSIN.

Bernard O. Dodge.

The following list of fungi collected mainly in Kewaunee County, Wisconsin, is based on specimens collected from 1904 to 1908. The mycological flora of this region has not been hitherto investigated, and this list forms a contribution to the fungus flora of the state.

Kewaunee County, lying as it does in the glaciated area along the shore of Lake Michigan in the northeastern part of the state, has a somewhat different flora from that prevailing in Juneau County where several of the collections noted here were made. The glacial moraines rise perhaps a hundred feet above the lake level and, where wooded, are well covered with groves of maple and beech. The low or swampy areas between the moraines are especially characterized by their dense growths of white cedar, black ash, and alder. "Blahnik's woods" is one of the many places in this vicinity where one passes quickly from the pastured hardwood groves down through the tamarack, hemlock, and cedar into the alders and finally out into the heath swamps. Oak, which is so common in Juneau County, is no longer found in the vicinity of Algoma, although it is fairly common at Red River, Little Sturgeon, and beyond Kohlberg. The wild hay marshes along the Ahnapee river are especially favorable for collecting Boleti in October and November. Even in the driest seasons, species of Discomycetes are plentiful in "Perry's swamp" or in the "black ash swamp" when few fungi are to be found elsewhere. Following the cow paths or "wood roads," one can take for example a trip of about five miles around Krohns' Lake and pass through a region rich in species of fungi and other plants. Near McDonald's boat-house the growth of cedar which elsewhere borders the lake is replaced by a strip of "bottom lands" with rich, black soil and here and there a clump of alder or birch. As the ground rises abruptly, the usual fringe of hard woods is found.

In this undisturbed region the old trunks of hemlock and cedar lie strewn all about and are in just the state of decay for the growth of fleshy fungi. At the head of the lake one comes to the more open swamp lands with *Chara, Drosera, Sarracenia, Conocephalus* and species of heath. Beyond this is found a stand of tamarack, and finally the large woods, the "Otto's woods" frequently mentioned in these notes.

To aid in further critical study of the fungi of Wisconsin, to indicate variations, and to assist in the identification of the species, I have included certain field notes made at the time of collection, and references to descriptions and figures which represent especially well the forms as found here, or which differ characteristically from these forms. Specimens of the species listed have been placed in the herbaria of the University of Wisconsin and the New York Botanical Garden.

The work of listing the Wisconsin fungi was begun by Bundy (Geology of Wisconsin, 1876). This list is widely quoted but cannot be regarded as reliable, and the author left neither descriptions nor specimens. Trelease (Trans. Wis. Acad. Sci., 6: 106–144) in 1886 published a list of 286 parasitic fungi of Wisconsin. The first work of describing the species of fleshy fungi of the state was done by Trelease in 1889 in a bulletin on the morels and puff-balls of Madison (Trans. Wis. Acad. Sci., 7: 105–120). Davis (Trans. Wis. Acad. Sci., 9: 154–188; 11: 165–178; 14:83–106; 16: 739–772) has continued the work of listing the parasitic fungi, so that we have now over 600 species authentically reported for the state. Another list of the higher fungi was prepared for Milwaukee County by Brown and Fernekes (Trans. Wis. Nat. Hist. Soc., 1902). Denniston has published descriptions of about twenty species of the genus

Russula occurring in the vicinity of Madison (Trans. Wis. Acad. Sci., 15: 71–88, 1905). The species of the Tremellineae of the state have been carefully worked out by Gilbert (Trans. Wis. Acad. Sci. 16: 1138–1911) and about twenty species have been described and illustrated. His monograph includes descriptions of several new species and varieties, with keys to the genera and species, and a list of the synonyms of the species.

If to the species mentioned in the above cited lists we add about 100 species reported for various collectors by Lloyd, Peck, and Rehm, we shall have about 1200 species reported from Wisconsin.

The following list includes 440 species of fungi from Kewaunee County and 40 additional species from Juneau and Dane Counties. These 40 species were not found in Kewaunee County and are included here either because of their rarity in America, or because of their wide distribution throughout the country and their rarity in Kewaunee County. *Clitocybe illudens* and *Lepiota americana*, which seem to be widely distributed and commonly occurring species, were not found in Kewaunee County. Although the people in the vicinity of Algoma are familiar with many species of fungi which they use for food, I was unable to learn of any case of poisoning by mushrooms. This may be due in part to the fact that very few species of *Amanita* grow in this region. During the most favorable seasons for the growth of mushrooms only one or two specimens of *Amanita phalloides* and *A. muscaria* were found.

About ninety species of Discomycetes were found in this region and will be listed in another paper together with the species from other parts of the state.

The writer wishes to acknowledge the services of Prof. R. A, Harper in the preparation of this list.

HYMENOMYCETES.

AGARICINEAE.

Amanita Frostiana Pk. These specimens differ from the typical forms only in being fully as large as *A. Caesarea.* Under maple and hemlock, Schmeiling's grove, August, Algoma.

Amanita muscaria Linn. Figures of this species are generally too highly colored to represent our specimens. Coville, U. S. Dept. of Agric., Div. Cir. 13, says, "The brilliant red ones are rarely found here, but the white ones are not infrequent." June, Foscora; Mile bluff, August, Mauston.

Amanita pantherina D. C. Richon, Atlas Champ., *Pl. 5, fig. 5–8,* figures this form with the annulus distant from the pileus, generally below the middle of the stipe. In dry sandy soil under oak, Mile bluff, and in low woodland pastures, July, Mauston.

Amanita phalloides Fr. Forms with a greenish pileus with patches of the volva on the surface, as illustrated by Berkeley, Out., *Pl. 3, fig. 1,* occur at Fish Creek. Rolland, Atlas Champ., *Pl. 3, fig. 3,* figures the dull gray forms such as are found in Shaw's woods, September, Foscora.

Amanita recutita Fr. The dark drab color, the tough, tightly stretched skin of the pileus, and the inrolled margin of the volva are well shown in these specimens. Berk. Out., *Pl. 3, fig. 3,* illustrates such forms with no patches of the volva on the pileus. On decayed remains of coniferous log, edge of woods, Swaty's, August, Algoma.

Amanita rubescens Fr. The red color of the flesh was not very prominent. In open woods, in dry sod, Van Wie's park, July, Mauston; Krohn's Lake, August, Algoma.

Amanita verna Bull. The pure white forms said to be a variety of *A. phalloides* are abundant in the Mile Bluff woods. Winnebago Indians who camp here do not eat mushrooms and avoid even touching this species. June to August, Mauston. Rare at Algoma.

Amanitopsis fulva Schaeff. This species seems to have perfectly constant characters, although it may often grow in the same locality with *A. vaginata.* The pileus is tawny or golden-buff, usually with a few large, thick warts which fall off as the pileus opens. The stem is richly colored like the pileus and becomes rough from splitting. A distinct trace of a fuzzy annulus appears in the youngest forms. Specimens collected in this stage will grow several centimeters before drying and are very sensitive to geotropic stimuli. Schaeff., Icones, *Pl. 95,* and E. Michael, Fuehr. Pilz., *Pl. 96,* represent these forms very well. Van Wie's park, July, Mauston; Krohn's Lake, August, Algoma.

Amanitopsis vaginata Bull. Common in open woods, Mile Bluff, June, Mauston; rare in Blahnik's grove, August, Algoma.

Lepiota asperata Berk. On the ground, Otto's woods, September, Algoma.

Lepiota asperula Atk. This species seems to be similar to the preceding except that the brown pointed scales do not form concentric rings on the pileus, and the stem is white. Schmeiling's grove, August, Algoma.

Lepiota clypeolaria Bull. Richon, Atlas Champ., *Pl. 21, figs. 1–3.* illustrates these forms well. On low ground, Melchior's woods, October, Algoma.

Lepiota cristata A. & S. On the ground in rich open woods, Shaw's, August, Algoma.

Lepiota Friesii Lasch. These specimens have rough brown warts on the lower side of the annulus which is clothed above with a mass of cottony fibres. The chlorine odor is strong in young plants. On the ground among moss and leaves, Blahnik's grove, July, Algoma.

Lepiota meleagris Sow. On the ground under maple, Belgian settlement, September, Rosiere.

Lepiota naucina Fr. On lawns and along margins of woods, August and September, Algoma.

Lepiota procera Scop. Very common along roadsides and in maple woods, September, Rosiere.

Armillaria mellea Vahl. This is one of the most common autumn mushrooms at Algoma, the species most relied on as a source of winter food supply among the Bohemians. The species is variable as to size, color, character of the annulus and edible qualities. Aborted forms are common. On stumps and fallen timber, Decker's, September, Casco; Nelson's woods, July, Mauston.

Tricholoma album (Schaeff.) Fr. On wood-strewn earth, Hale's hill, June, Mauston; Otto's woods, July, Algoma.

Tricholoma equestre L. Specimens differ from *T. sejunctum* only in having yellow gills. Richon, Atlas Champ., *Pl. 32, figs. 1–4*, represents these forms. Rolland, Atlas Champ., *Pl. 15, fig. 24*, figures a form with a yellow stipe, while ours have a white stipe. On the ground, Danek's woods, September, Algoma.

Tricholoma grammopodium Bull. Bulliard, Hist. Champ., *Pl. 585*, and Hussey, Illust., *Pl. 41*, illustrate the large specimens. Common, Fluno's bluff under oak, June, Mauston; along roadsides, June, Foscora.

Tricholoma personatum Fr. Commonly gathered for food at Algoma as it is easily recognized by the lilac color and bulbous stipe. Schmeiling's grove, Algoma; Awe's, September, Foscora.

Tricholoma rutilans Schaeff. Clusters gathered from pine stumps had yellow gills and stipes, as figured by Rolland, Atlas Champ., *Pl. 18,* *fig. 22.* Solitary specimens from hemlock logs had whitish gills and the stipes were spotted purple, as figured by Cooke, Illust., *Pl. 8*, and Lucand, Champ. Fr., *Pl. 54.* Mile Bluff, June, Mauston; Krohn's Lake, August, Algoma.

Clitocybe amethystina Bolt. The whole plant is deep purplish amethyst in the young forms. When old, the caps generally fade to gray but the gills retain their color. This species is quite distinct from *C. laccata.* On the ground in open woods, Stewart's pasture, June, Mauston; Perry's woods, July, Algoma.

Clitocybe cerussata Fr. On leaves, Otto's woods, August, Algoma.

Clitocybe clavipes (Pers.) Fr. On the ground, Runke's woods, Kodan, October.

Clitocybe compressipes Pk. In this species the pileus is 2–5 cm. broad, yellowish to light brown, plane or depressed, with or without zones. The plants usually grow in twos or threes; occasionally clusters of about twenty plants were found in pastures. Lone Rock, June, Mauston.

Clitocybe connexa Pk. The pale sky-blue colors are not visible except at close range. On the ground in low woods under maple and beech, August, Algoma.

Clitocybe cyathiformis Fr. These forms are well illustrated by Cooke, Illust., *Pl. 113;* Sow., Eng. Fung. *Pl. 363;* Bull., Herb. Franc., Pl. *375.* Krohn's Lake, August, Algoma.

Clitocybe eccentrica Pk. The stipe is only slightly eccentric in our specimens. The base is coarsely strigose. On pieces of decayed wood and among leaves, Krohn's lake, August, Algoma. Peck *vid.*

Clitocybe ectypoides Pk. The pileus is plainly marked by blackish lines of closely appressed hairs branching dichotomously five or six times from the center to the margin. The gills are narrow and distant, not close, as described by Peck, Bull. Torrey Club, 25:821, 1898. Abundant on the ground, Krohn's Lake, August, Algoma. Peck *vid.*

Clitocybe gigantea Sow. This species differs from *C. maxima* in having a much shorter and thicker stipe. The differences are figured by Cooke, Illust., *Pls. 106, 135.* On the ground, Blahnik's grove, July, Algoma.

Clitocybe gilva Pers. The specimens dry well, retaining the characteristic yellow colors. The odor is strong, not unpleasant. October, Foscora.

Clitocybe illudens Schw. Very common in dense clusters on fallen timber and in clover fields, on roots and stumps in newly tilled ground, C. Remington farm, July, Mauston. Rare at Algoma.

Clitocybe infundibuliformis Schaeff. On the ground among leaves, Awe's, August, Foscora.

Clitocybe inversus Scop. This species closely resembles the last, from which it is here distinguished by the reddish color of the gills and the smaller, more globose spores. Lanzi, Funghi Roma, *Pl. 95, fig. 3,* gives a good figure of these forms. On the ground, Tornado, August, Kohlberg.

Clitocybe laccata Scop. Common on the ground in woods, early and late. Mile Bluff, June, Mauston; Melchior's, November, Algoma.

Clitocybe maxima Gaert. & Meyer. The pileus grows to be 25 cm. broad and the stipe 20 cm. high. Such forms are figured by Cooke, Illust., *Pl. 135.* Under dense growth of young oak and pine, Dodge's, Crossville, near Mauston.

Clitocybe multiceps Pk. Clusters growing in the woods are more slender than those found along street curbing. Insects do not seem to infect the plants and they remain several days in a fresh condition after being gathered. August, Fish Creek.

Clitocybe socialis Fr. In Sphagnum swamps with *Boletinus paluster*, Blahnik's, November, Algoma.

Collybia acervata Fr. The shining stems are dark brown, four or five being bound together at the base by a mass of felt-like hairs. On decayed wood, Warner''s grove, September, Algoma. Peck *vid.*

Collybia confluens Pers. Among leaves, Krohn's lake, August, Algoma. Peck *vid.*

Collybia dryophila (Bull.) Fr. The species is variable as to form and color. The commonest form is figured by Rolland, Atlas Champ., *Pl. 48, fig. 102,* Some specimens have white gills and greasy, hygrophanous caps. These might be called *C. butyracea.* Cf. Cooke, Illust., *Pl. 143.* On the ground among leaves, and cespitose near old logs, August, Foscora; Krohn's Lake, Algoma.

Collybia fusipes Fr. The most characteristic features of the species are the ventricose stipe and the manner in which the gills pull away from the stem in groups attached to a collar. This is well shown by Bulliard, Hist. Champ., *Pls. 36 and 106,* p. 612; Paul., Icon. Champ., *Pl. 50 figs. 1, 2;* Bolt., Hist. Fung., *Pl. 129.* Most other figures show much longer stems which taper downward several inches. Timble's woods, October, Algoma.

Collybia lacunosa Pk. Specimens 0.5–2 cm. broad, 2–4 cm. high, golden yellow throughout with the exception of the whitish gills, were found frequently on coniferous logs. The plants dry with little loss of color or form. The species is rather tough for one of this genus. Specimens at the New York Botanical Garden, very similar to ours, having the same scabrous stipe, have been called *Omphalia scabriuscula* Pk. Krohn's Lake, August, Algoma. Peck *vid.*

Collybia laxipes Fr. This is a slender, symmetrical little plant with a velvet-coated stipe and flesh-colored pileus which is viscid in moist weather. Very similar forms are figured by Cooke, Illust., *Pl. 191 B;* Gillet, Champ. Fr. Common in wet weather, July, Perry's woods, Algoma.

Collybia myriadophylla Pk. The gills are very close together, of fine texture and of delicate lilac color which turns brown in drying. Hard, Mushrooms, p. 115, *fig. 85*, gives a good figure. On old logs, Schmeiling's, July, Algoma.

Collybia platyphylla Fr. Common in all woods. Krohn's Lake, June, Algoma; Lone Rock, Mauston.

Collybia radicata Rehl. Common in woods near stumps, Heuer's, August, Algoma; in a cistern, November, Algoma.

Collybia radicata furfuracea Pk. On account of the furfuraceous coat of the pileus and stipe, some of these specimens, 10–14 cm. broad and 44–55 cm. high, might be referred to this variety. The outer layer of the stipe is much checked and cracked. Krohn's Lake, August, Algoma.

Collybia velutipes Curt. On logs and stumps all seasons of the year, March to January, Algoma.

Collybia zonata Pk. On hemlock logs, Krohn's Lake, Algoma, August.

Mycena acicula Schaeff. Fries, Icones, *Pl. 85, fig. 3*, gives a good illustration of this brilliantly colored little fungus. Otto's woods, August, Algoma.

Mycena alcalina Fr. Otto's woods, August, Algoma.

Mycena capillaris Schum. This form is pure white throughout, 1–2 mm. broad, with a thread-like stem. On old bark among leaves, Perry's Swamp, July, Algoma; campus woods, June, Madison.

Mycena corticola Fr. On old stub in pasture lands, Detjen's, April, Algoma.

Mycena cyanothrix Atk. Nelson's woods, July, Mauston.

Mycena epipterygia Scop. In these forms the pileus is pinkish at the apex and grayish at the margin. On leaf mould, Schmeiling's, August, Algoma.

Mycena galericulata Scop. Common on old stumps, Detjen's, May, Algoma.

Mycena haematopa Pers. On old logs, Fluno's bluff, July, Mauston; Devine's woods, August, Algoma.

Mycena Leaiana Berk. The whole plant is deep salmon color. Cespitose on stumps and logs, Otto's woods, June, Algoma.

Mycena polygramma Bull. Schmeiling's grove, July, Algoma; Fluno's woods, July, Mauston; cemetery woods, June, Madison.

Mycena pura Pers. A number of cespitose specimens growing in dense shade had perfectly white stems and gills, with the typical pinkish, purple, or lilac caps. The more common forms are lilac colored throughout, the gills becoming ochraceous with age. Such plants are figured by Rolland, Atlas Champ., *Pl. 52, fig. 113.* Perry's woods, August, Algoma.

Mycena rugosa Fr. On decayed logs, Melchior's woods, November, Algoma.

Mycena succosa Pk. On coniferous logs, Krohn's Lake, September, Algoma.

Omphalia campanella Batsch. On logs, May to September, Mauston, Kilbourn and Algoma.

Omphalia epichysium Pers. The pileus is funnel shaped, smoky gray, 2–3 cm. broad. Krohn's lake, Dvorak's, August, Algoma.

Pleurotus applicatus Batsch. On wood, Schmeiling's woods, August, Algoma.

Pleurotus angustatus Berk. On decayed logs and stumps, Schmeiling's swamp, June, Algoma.

Pleurotus cornucopioides Fr. The gills form ridges running down the stem, which is roughly strigose at the base. The spores are lilac-colored in mass as are those of *P. sapidus*. Figures by Paulet, Icon. Champ., *Pl. 28*, and Boudier, Icones Mycol., *no. 374*, resemble our forms. On stumps and logs, Otto's woods, August and September, Algoma.

Pleurotus dryinus Fr. On logs, Devine's woods, September, Algoma.

Pleurotus ostreatus (Jacq.) Fr. The spores are pure white in mass. Hussey, Illust., *Pl., 19*, may be considered typical for our forms. On maple logs, September, Casco.

Pleurotus petaloides Bull. On decayed wood among moss, Otto's woods, May, Algoma.

Pleurotus porrigens Pers. This species may become 2–3 cm. broad without having any indication of gills. At this stage they resemble white discomycetes. On decayed logs, Devine's woods, August, Algoma. Peck *vid.*

Pleurotus sapidus Kalch. Common on logs, Fish Creek; Heuer's woods, September, Algoma.

Pleurotus serotinus Schaeff. On limbs and logs, September, Foscora.

Hygrophorus Bresadolae Quel. In all of the young specimens there is a distinct veil which forms an annulus which disappears as the plant becomes fully expanded. Peck's description and figure of *H. speciosus* Pk., Rep. Mus. 53, *Pl. 51*, well represent this form except as to the annulus. Bresadola, Fung. Mang., *Pl. 9*, shows a rather permanent ring, but his figures seem to be of only partially expanded plants. Under tamarack along the Ahnapee river, October, Algoma. Bresadola *vid.*

Hygrophorus cantharellus Schw. Among decayed leaves and wood, Krohn's Lake, August, Algoma.

Hygrophorus chlorophanus Fr. On ground in damp places, Blahnik's swamp, July, Algoma; June, Blue Mounds.

Hygrophorus coccineus (Schaeff.) Fr. In grass under maple, Schmeiling's woods, August, Algoma.

Hygrophorus conicus (Scop.) Fr. The viscid conical caps are often greenish black when growing. On the ground, Fish Creek; Schmeiling's woods, August, Algoma.

Hygrophorus eburneus (Bull.) Fr. The pileus is shining white from the slimy substance that covers it in wet weather. The gills, which are at first pure white, become cinnamon brown in drying. September, Foscora; Schmeiling's woods, Algoma.

Hygrophorus hypothejus Fr. Gillet, Champ. France, figures a plant which represents this form. The pileus is olivaceous and is covered with a bluish sticky slime. The flesh becomes rose-colored in drying or decaying. Boudier, Icones Mycol., *Pl. 33, no. 240*, shows the characteristic crooked stipe. Under leaves, Blahnik's grove, August, Algoma.

Hygrophorus psittacinus Fr. The flesh is thin, so that the gills show through the pileus. Boudier, Icones Mycol., *Pl. 42*, represents the forms considerably larger. Under tamarack, Danek's woods, September, Algoma.

Hygrophorus pratensis Fr. Common on grassy knolls near Blahnik's woods, October and November, Algoma.

Hygrophorus puniceus Fr. Some forms of the plant resemble *H. conicus* except that the reddish-yellow to scarlet colors are well retained in drying. Schmeiling's grove, August, Algoma.

Lactarius deliciosus Fr. The large forms are not as highly colored as usually figured for the species. Common in Otto's woods, August, Algoma. At Fish Creek the typical forms are occasionally found.

Lactarius griseus Pk. Devine's swamp and Perry's woods, September, Algoma.

Lactarius hygrophoroides B. & C. On the ground, Blahnik's woods, September, Algoma.

Lactarius indigo Schw. This is a rare species at Algoma, only one well characterized specimen having been found. September, Shaw's woods, Foscora.

Lactarius pergamenus Fr. In open woods, August, Algoma.

Lactarius piperatus Fr. Abundant in pastured woods, Schmeiling's, August, Algoma; Fluno's Bluff, July, Mauston.

Lactarius scrobiculatus Scop. This is a very large and coarse *Lactarius*. The cap is covered with coarse, glutinous hairs, especially at the margin. In wet weather the pileus has two or three watery zones. The milk is white, soon changing to greenish yellow, and is not strongly acrid. The pittied stipe and coarse hairs are well shown by Krombh., Schwam. *Pl. 58, figs. 1-6.* Specimens found in open places are nearly white, those in deep woods are yellowish. Schmeiling's woods, August, Algoma.

Lactarius subdulcis Fr. Cooke, Illust., *Pl. 1002,* figures the forms which grow abundantly in Riverside swamp, October, Algoma.

Lactarius torminosus Schaeff. Fresh plants are nearly white; the reddish zones of the pileus are seen only when the flesh is broken or the plants are dry. Rolland, Atlas Champ., *Pl. 33, fig. 63,* illustrates characteristic specimens. Frequently found to be parasitized by *Hypomyces.* Common in Blahnik's woods, September, Algoma.

Lactarius trivialis Fr. The quantity of milk in the species is variable. During dry weather large specimens growing in sandy soil contained only slight amounts. Mile bluff, June, Mauston.

Lactarius vellereus Fr. This species grows in dense clusters in old roads. Most plants have a stipe only 4–5 cm. long, with pileus 10–14 cm. broad. Boudier, Icones Mycol., *Pl. 49, no. 47,* figures such forms, except that there are no red spots on the gills and the pileus is more tomentose. Blahnik's woods, August, Algoma.

Lactarius volemus Fr. On the ground in wet places, Krohn's lake and Blahnik's woods, September, Algoma.

Lactarius zonarius (Bull.) Fr. Specimens of this species grow to be 20 cm. across and when dry show 5–15 distinct zones, which in fresh plants are watery rings in the flesh. The milk is white, slightly acrid, with no change of color. The spores are white. The flesh is firm and free from larvæ. Quantities were cooked and found tough and of a strong flavor but not poisonous. There is just such a tendency for the plants to grow in pairs as is figured by Bulliard, Herb. Fr., *Pl. 104.* Abundant under white cedar in extremely dry weather when other gilled mushrooms were scarce. Dewey's spring, August, Algoma. Peck *vid.*

Russula adusta Fr. Mile Bluff, June, Mauston; Otto's woods, August, Algoma.

Russula alutacea Fr. Ihlenfeld's woods, August, Algoma.

Russula atropurpurea Pk. Schmeiling's grove, August, Algoma; Mile Bluff, June, Mauston.

Russula citrina Fr. On decayed logs and on wood strewn earth, Blahnik's swamp, August, Algoma.

Russula decolorans Fr. On decayed logs, August, Algoma. Peck *vid.*

Russula delica Fr. Shaw's woods, August, Algoma; Mile Bluff, August, Mauston.

Russula emetica Fr. Our forms are exceedingly large for the species, 10 cm. broad and 12 cm. high. The plants are fragile and the flesh very peppery, but they are edible when cooked. Shaw's swamp, September, Foscora; Stewart's pasture swamp, July, Mauston.

Russula foetens Pers. Chadwick's woods, July, Mauston; common in Blahnik's woods in August, Algoma.

Russula fragilis Pers. This species seems to be similar in color and taste to *R. emetica*, but the flesh is white under the pellicle and the plants are much smaller. Roadsides near Little Sturgeon, August.

Russula integra Fr. Mile Bluff, August, Mauston; Tornado, September, Rosiere.

Russula nigricans Fr. Fluno's woods, August, Mauston.

Russula olivacea Fr. Van Wie's Park, August, Mauston.

Russula roseipes (Secr.) Bres. Mile Bluff, July, Mauston.

Russula sordida Pk. Under coniferous trees, July, Fluno's Bluff, Mauston.

Russula virescens (Schaeff.) Fr. Ihlenfeld's woods, September; Mile Bluff, June, Mauston.

Cantharellus aurantiacus Fr. The color varies from bright orange, when growing on the ground in open places, to brown, when growing on hemlock logs. Abundant in Danek's woods, August, and at Krohn's Lake, September, Algoma.

Cantharellus brevipes Pk. Under oak, Tornado, September, Kohlberg.

Cantharellus cibarius Fr. The apricot odor is present in the Algoma specimens. Common at Mile Bluff, August, Mauston.

Cantharellus cinnabarinus Schw. The cinnabar color of the exterior is in striking contrast to the pure white flesh. Devine's woods, August, Algoma.

Cantharellus infundibuliformis Scop. Mile Bluff, June, Mauston.

Cantharellus minor Pk. The plants are scarcely 2 cm. high and 1 cm. broad. They are yellowish-orange, turning brown in drying. Detjen's pasture in open grove, September, Algoma.

Nyctalis asterophora Fr. On *Russula nigricans*, Fluno's Bluff, August, Mauston.

Marasmius minutus Pk. The pilei were densely covered with rough spherical spores of some parasitic fungus. Each pileus has about four or five gills. On decayed leaves in damp places in Perry's alder swamp, August, Algoma. Peck *vid.*

Marasmius coherens (Fr.) Bres. Growing in dense cluster under alder, Algoma swamp.

Marasmius oreades Fr. This species is rare at Algoma. In grassy spots along roadsides, September.

Marasmius perforans Fr. On hemlock leaves, Blahnik's woods, September, Algoma.

Marasmius rotula Scop. Common on bark and decayed wood, Warner's grove, September, Algoma.

Marasmius siccus Schw. Among decayed leaves, Devine's woods, August, Algoma.

Marasmius urens Fr. Fluno's woods, July, Mauston.

Lentinus cochleatus Fr. This species grows in dense clusters at the bases of stumps. Schmeiling's woods and Krohn's Lake, September, Algoma.

Lentinus Lecomtei Fr. *(Panus rudis* Fr.) On logs and stumps Fluno's woods, June, Mauston; Blahnik's grove, September, Algoma.

Lentinus lepideus Fr. On docks and ties, and on roofs of houses, July, Algoma.

Lentinus spretus Pk. These specimens were well dried when found. They are 6–14 cm. broad. The surface of the pileus is cracked, forming brownish scales. The center is entire, depressed or raised. The gills are 1 cm. broad and decurrent. The stipe is very slender in proportion to the size of the pileus, tapers downward, is solid, tough and covered with brownish scales. Three of four plants were joined together at the base of the stipe. On old saw-mill timbers, July, Crossville, near Mauston.

Lentinus vulpinus Fr. On maple stumps, Belgian settlement, August, Rosiere.

Panus conchatus Fr. Sessile forms with the twisted, shell-shaped pileus are figured by Bulliard, Hist. Champ., *Pl. 298.* We also have such forms as are shown by Cooke, Illust., *Pl. 1149,* Schaeff., Icones Fung., *Pl. 43, 44.* Krombh., Schwam. *Pl. 42, figs. 1 2,* best represent the forms that seem to run over to *P. torulosus.* On stumps, Blahnik's grove, September, Algoma.

Panus stipticus (Bull.) Fr. On stumps and fallen timber, October, Casco.

Panus torulosus Fr. This plant has a violet colored pileus and stipe as figured by Bolton, Hist. Fung., *Pl. 146.* The gills are amethyst colored in all young specimens, the flesh is white and thick. On stumps, Otto's woods, July to September, Algoma.

Trogia crispa (Pers.) Fr. The specimens collected from tamarack in December showed a reddish color at the point of attachment when bruised, but this change of color does not seem to be present in plants in the growing season. Perry's swamp, Algoma.

Schizophyllum commune Fr. Common on old limbs, Devine's woods, June to August, Algoma.

Lenzites betulina Fr. Common on birch and poplar, Devine's woods, September, Algoma.

Lenzites sepiaria Fr. Resupinate forms sometimes have thick gills. On tamarack stumps, Detjen's woods, May to October, Algoma.

Lenzites variegata Fr. This species seems to be very closely allied to *L. betulina* and may be only a variety. The pileus is sulcate and beautifully zoned. The gills are thick and have a tendency to form pores. Some forms are resupinate. Abundant on stumps of frondose trees, October, Casco.

Lenzites vialis Pk. Pores of young specimens are whitish-lilac and pruinose. On old rails near Catholic church, April, Algoma.

Volvaria bombycina (Pers.) Fr. On maple log, Krohn's Lake, August, Algoma.

Volvaria pusilla Pers. A typical specimen of this species was found among leaves in damp woods, although it is usually reported as growing among weeds in gardens. Krohn's Lake, August, Algoma.

Volvaria speciosa Fr. A large number of fine plants appeared in potato fields in June, 1905, none was found during the four succeeding years. The species was found however in Sept. 1912, Algoma.

Pluteus cervinus Schaeff. The forms growing in saw-dust are frequently 20 cm. broad. Several varieties of this species have been found on logs and stumps. It is difficult to distinguish any constant characteristics for them. Common, June to September, Algoma and Mauston.

Pluteus granularis Pk. On logs, Schmeiling's, July, Algoma.

Entoloma clypeatum L. On the ground, Detjen's woods, May, Algoma.

Entoloma jubatum Fr. Common in open woods, Blahnik's, July, Algoma.

Entoloma rhodopolium Fr. The gills are not adnate to the stem. They barely reach the stem in large specimens and seldom show marks of breaking away from it. One fairly constant character is the abrupt bend at the base of the stem. Abundant in Otto's woods, June, Algoma; in mulching under hedges, June, Madison.

Entoloma strictius Pk. The pileus has a sharp umbo in all of these plants. The stipe is tall, straight and slender. Peck and others have reported the species as growing in autumn and we find what appears to be the same species in May and June, Schmeiling's woods, Algoma.

Clitopilus abortivus B. & C. Dried plants have retained a very strong, pleasant, mealy odor. No aborted forms have been seen. Shaw's sphagnum swamp, August, Foscora.

Clitopilus popinalis Fr. Bresadola considers *C. noveboracensis* Pk. a synonym for this species. Young plants have oblong hygrophanous spots arranged somewhat concentrically on the pileus. The whole pileus becomes greasy hygrophanous in old age. Although a large number of specimens were set for spore prints, we were unable to obtain spores enough to determine the color in mass. Even when thoroughly cooked, the plants are strong and unpalatable. Devine's woods, August, Algoma. Bresadola *vid.*

Clitopilus prunulus Scop. Well illustrated by E. Michael, Fuehr. Pilz., *No. 52;* Richon, Atlas Champ., *Pl. 36, figs. 1-4.* On the ground, Danek's woods, September, Algoma.

Leptonia asprella Fr. Among needles and moss under tamarack, Riverside swamp, August, Algoma.

Leptonia serrulata (Pers.) Fr. The gills are whitish, tinged with azure-blue, serrate. The stipe is characteristically marked by rings formed by the cracking of the outer coat. A very delicate species whose distinctive points are destroyed in drying. Perry's swamp, under tamarack and white cedar, September, Algoma.

Claudopus nidulans Pers. On decayed logs, cemetery woods, June, Madison; Trumble's woods, July, Mauston; Krohn's Lake, August, Algoma.

Pholiota adiposa Fr. Well figured by Berkeley, Out., *Pl. 8, fig. 2,* Grows on sides of logs and from decayed spots on living trees. Fellow's woods, August to October, Foscora.

Pholiota aegerita Brigant. The pileus cracks into areas showing the yellow flesh. The spores are brick-red. Solitary, on maple logs, Decker's saw-mill, September, Casco.

Pholiota dura Bolt. The caps are 7–10 cm. broad, deeply cracked. The stipe is solid and elastic. In gardens under rose bushes, June, Algoma.

Pholiota marginata Pers. The common forms which grow in woods are figured by Lanzi, Funghi Mang., *Pl. 76, fig. 2.* In lawns and frondose woods, June to August, Algoma.

Pholiota squarrosa (Muell.) Fr. The foul, heavy odor ascribed to this species by Stevenson, Brit. Fungi, p. 230, was noticed in a single cluster of about twenty plants growing at the base of a maple tree. In these the stipes were 10–20 cm. high and 1 cm. thick, not as roughly scabrous as usually figured. The more common forms are such as are figured by Hussey, Illust., *Pl. 8;* Diet., Deutsch. Crypt., *Pl. 140;* Rolland, Atlas Champ., *Pl. 52.* Belgian settlement, September, Kohlberg.

Pholiota squarrosoides Pk. The pileus is covered with rough, erect scales. The stipe is rough and shaggy below the ring, smooth above. A species much confused with the preceding. Those growing in dry weather are not viscid and when dry are whitish with no change of color. On logs, Otto's woods, August, Algoma.

Inocybe asterophora Quel. The stipe has a separable pellicle and a bulb which gives it the appearance of *Agaricus acetabulosa* Sow., Eng., Fung., *Pl. 303.* The spores are nodular, 10–11.5 microns in diameter. Cooke, Illust., *Pl. 385*, figures the forms which we found under *Osmunda*, Nelson's woods, Crossville, July, Mauston.

Inocybe geophylla violacea Pat. The sharp umbo and bright violet color of the pileus are well preserved in the dried specimens. Blahnik's grove, September, Algoma.

Inocybe subochracea Pk. Common in thick woods, Algoma, August.

Hebeloma crustuliniforme Bull. A species with clay-colored spores which appeared in great numbers in all the groves about Madison in June and was found throughout the following July and August at Mauston and Algoma.

Flammula flavida Schaeff. On decayed logs, Schmeiling's woods, July, Algoma.

Flammula polychroa Berk. The margin of the pileus is decorated with triangular scales. Those on the surface of the cap are purple or purple-brown. The stem is curved when plants grow from sides of logs or timbers, etc. Common. Krohn's Lake, August, Algoma.

Flammula sapinea Fr. Grows in clusters on coniferous logs, Krohn's lake, September, Algoma.

Naucoria horizontalis Bull. Well illustrated by Sicard, Hist. Champ., *Pl. 23, fig. 117*. On sides of decayed stumps, Detjen's woods, June, Algoma.

Naucoria vernalis Pk. Common on logs, August, Otto's woods, Algoma.

Galera tenera Schaeff. Forms fairy rings on lawns or grows on rubbish heaps in groves. Schaeff., Icones, *Pl. 70*, and Diet., Deutsch. Crypt., *Pl. 157*, give good figures. Common. Blahnik's grove, August, Algoma; July, Mauston.

Crepidotus croceophyllus Berk. The gills are bright salmon to orange-colored, comparatively broad. The tawny-olive pileus and ferruginous spores together with the bright gills make it a species easily recognized. On logs with *C. malachius*, June, cemetery woods, Madison.

Crepidotus fulvo-tomentosus Pk. Common on dead limbs, Krohn's Lake, June to August, Algoma.

Crepidotus malachius B. & C. The striations on the margin are not always apparent. The soft, whitish skin is usually covered with brown spores. Common on decayed logs, Krohn's Lake, August, Algoma.

Crepidotus mollis Schaeff. The watery margin seems to be quite a constant character even in dry weather. Berkeley, Out., *Pl. 9, fig. 6*, represents the common form. On decayed trunks, Schmeiling's swamp, August, Algoma.

Crepidotus versutus Pk. A small white species common from June to October on dead limbs. Melchior's woods, Algoma.

Cortinarius cinnamomeus Fr. Otto's woods, June, Algoma.

Cortinarius corrugatus subsquamosus Pk. The reddish spots and corrugations on the pileus are the identifying marks. On the ground in mixed woods, Fluno's Bluff, July, Mauston.

Cortinarius lilacinus Pk. The stipe is solid and bulbous, much more slender than that of *C. violaceus*. The whole plant is lilac-colored but fades in drying. On bogs, Stewart's woods, July, Mauston; Alaska lake, August, Alaska.

Cortinarius purpurascens Fr. The flesh of the pileus and stipe turn deep purple when bruised. Clustered in dry places, Blahnik's woods, September, Algoma.

Cortinarius sebaceus Fr. The pileus is whitish to alutaceous, the remainder of the plant white throughout, the gills remaining white even after the salmon-rust-colored spores have traced a ring on the stipe. On the ground under birch, Ihlenfeld's grove, September, Algoma.

Cortinarius violaceus Fr. Lanzi, Fung. Mang. *Pl. 61, fig. 1*, and Schaeff., Icones, *Pl. 3*, illustrate this common species. Among grass in open places, Detjen's woods, September, Algoma.

Paxillus corrugatus Atk. Easily identified by Atkinson's figure, Mushrooms, *Pl. 48*, 1900. The spores are yellowish-ochre. On decayed logs, Schmeiling's woods, August, Algoma. Rare.

Paxillus atrotomentosus Fr. Under white cedar along banks of Lake Michigan, Braemer's flats, August, Algoma.

Paxillus involutus (Batsch.) Fr. The pileus is frequently 15 cm. broad. On the ground among needles under dense growth of young coniferous trees, Schmeiling's woods. A very much smaller and more slender variety showing rusty-purple stains on the stipe and pileus was found on logs, Krohn's Lake, September, Algoma.

Bolbitius fragilis Fr. The gills are watery and deliquesce after one or two hours but they do not dissolve. The margin of the pileus is striate. On dung, after rains, Ray's pasture, June, Algoma.

Agaricus campestris L. Rare. Kashbom's pasture, September, Rio creek.

Agaricus haemorrhoidarius Schulzer. The pileus is beautifully adorned with pointed scales. The flesh of both the pileus and stipe turns rose-red immediately after being bruised. On the ground under leaves of beech and maple, Blahnik's grove, September, Algoma.

Agaricus placomyces Pk. Hard, Mushrooms, p. 315, *fig. 256*, gives a good figure of this plant. It grows in groups in pastures under oak trees; July, Fluno's bluff, Mauston.

Agaricus silvicola Vitt. The fresh specimens are white as figured by Rolland, Atlas Champ., *Pl. 72, fig. 160*. They turn yellow in drying without being bruised. Cooke, Illust., *Pl. 529*. Common in woods, but never occurs in plowed grounds or fields around Algoma. Stony Creek Foscora; Krohn's lake, August, Algoma.

Agaricus subrufescens Pk. The pileus is whitish, covered with soft scales formed by bunches of short hairs, broad conical, 8–10 cm. broad. The lower surface of the large annulus which hangs down about 4 cm., is pinkish and furfuraceous. The stipe is hollow, enlarged at the base, 3 cm. thick at the lower end, flattened at the apex. Said to be similar to *A. fabaceus.* Under beech, Blahnik's grove, July, Algoma.

Stropharia semiglobata Batsch. It is extremely difficult to find any two characters differentiating this species from *S. stercorarius* Fr. They vary toward each other constantly. Forms with hollow stipes frequently have spores 10–12 x 16–20 mic. Comparing figures, Sow. Eng. Fung., *Pl. 248,* Grev., Scot. Crypt., 6:344, and Cooke, Illust., *Pl. 113, 114,* the external characters seem to be similar. Common on dung in pastures, Erdman's farm, June to October, Algoma.

Hypholoma appendiculatum Bull. Common in lawns after rains, June, Mauston and Algoma.

Hypholoma candolleanum Fr. The pileus is dark-brown, being hygrophanous even in dry weather. Scattered along roads in woods, June, Fluno's farm, Mauston.

Hypholoma incertum Pk. On *débris* of old lumber piles in groves, Blahnik's July, Algoma. Peck *vid.*

Hypholoma perplexum Pk. Densely clustered on saw-dust, veneer factory, November, Algoma.

Hypholoma rugocephalum Atk. A very characteristic species with spotted gills somewhat ochre-colored. The spores are purple-black, inequilateral, pointed, 7–8 x 9–10 microns. The gills and spores indicate a relationship to the genus *Panaeolus.* On the ground, solitary, in paths and open woods, Devine's, September, Algoma.

Hypholoma sublateritium Schaeff. Distinguished from the related species by the solid or stuffed stipe and the soapy taste of the flesh. In clusters or scattered over the grass around maple stumps, Schmeiling's grove, October, Algoma.

Psathyra maestiger B. & Br. The pileus is 2 cm. broad and high, date-brown, hygrophanous. The characteristic breast-shaped pileus is well shown even in the dried plants. The stipe is 0.4 x 7–15 cm., brittle, flocculose at the apex. Remnants of a veil cling to the margin of the pileus, although there is no ring on the stipe. The spores are deep-purple, blunt elliptical, 4–6 x 8–10 microns. In black mould in a hollow log, by a roadside in open woods, September, Casco.

Psilocybe foenisecii Pers. On lawns and meadows, July, Algoma.

Psilocybe spadicea Schaeff. On rubbish heaps, Blahnik's grove, September, Algoma.

Coprinus atramentarius Fr. Common in dense clusters under alder in pastures and in newly made lawns, June to August, Algoma.

Coprinus comatus Fr. It required four days for one plant to reach maturity, when it was 25 cm. broad. Perry's lumber yard, August, Algoma.

Coprinus ebulbosus Pk. *(Coprinus picaceus ebulbosus* Pk.). Hard, Mushrooms, p. 336,*fig. 274*, gives a good figure of the specimen found in cemetery woods, June, Madison.

Coprinus ephemerus Fr. There is little substance to the gills or caps. The species grow in hot-beds and around horse stables; each day's crop turns to ink and disappears in a short time. April to June, Algoma.

Coprinus micaceus Bull. The gills are purple-brown in most of the Algoma plants. Peck says that the spores are sometimes blackish-brown. The gills do not deliquesce unless the air is moist. On lawns, dirt-covered poles in pastures and around stumps in woods, May to August, Algoma.

Coprinus ovatus (Schaeff.) Fr. A form which springs up in gardens and soon turns black. The ring is inconspicuous and the stipe deeply rooting. July, Mauston.

Coprinus plicatilis Fr. This species grows in mulching under rose bushes. It is well illustrated by Sowerby, Eng. Fung. *Pl. 364*. Eppling's yard, July, Algoma.

Panaeolus papilionaceus Fr. Common on dung in groves, June, Schmeiling's, Algoma.

Panaeolus retirugis Fr. This differs from the preceding species in having large fragments of the veil attached to the margin of the pileus, which is wrinkled and not cracked into areas. Figures by Atkinson, Mushrooms, *Pl. 11, fig. 45*, Gillet, Champ. Fr. On dung, Detjen's pasture, June to November, Algoma.

BOLETINEAE.

Boletinus paluster Pk. [*Boletinellus paluster* (Pk.) M.] The specimens are not as bright red as figured by Peck, Rept. 23, *Pl. 6, figs. 4–6*. In Sphagnum swamps, Blahnik's, November, Algoma.

Boletinus pictus Pk. The ochre-colored spores and larger, more angular pores distinguish this species from *B. spectabilis* which grows in the same locality. Under cedar and tamarack, Ahnapee river swamp, September, Algoma.

Boletinus porosus (Berk.) Pk. [*Boletinellus merulioides* (Schw.) M.] A species with large, angular, golden-yellow tubes. Shaw's swamp, September, Foscora.

Strobilomyces strobilaceus Berk. In dense woods around Mauston, June to September. Not found at Algoma.

Boletus bicolor Pk. [*Ceriomyces bicolor* (Pk.) M.] Not common. North side of Mile Bluff, August, Mauston.

Boletus Americanus Pk. Among grass in open places, Detjen's swamp woods, September, Algoma.

Boletus chrysenteron Bull. [*Ceriomyces communis* (Bull.) M.] Along banks in gulleys and ravines, July, Mauston; in open groves, Krohn's Lake, August, Algoma.

Boletus Clintonianus Pk. The Bohemians call this the "butter mushroom." Common under tamarack after the first rains in September. Algoma.

Boletus cyanescens Bull. [*Gyroporus cyanescens* (Bull.) M.] Frequently found with two or three joined together at the base of the stipe. In sandy soil, Robinson's bulff, June, Mauston; Stony Creek, September, Foscora.

Boletus elbensis Pk. The entire plant is whitish-gray. The pileus is covered with a brown glutinous substance. The flesh is thick, but is so soft and spongy that the Bohemians will not eat even the young specimens. The tubes are large, angular and frequently compound. Their arrangement in irregular radiating rows would suggest that the species should be placed in the genus *Boletinus*. The stipe is clothed with a furry coat somewhat resembling that of *Strobilomyces strobilaceus*. The flesh of both stipe and pileus sometimes changes color to a blue-green when bruised, but this character is not at all constant in the plants found growing several seasons in the same location. It is a very distinct species and one easily identified. Under tamarack and cedar in low swamps along the Ahnapee river, September, Algoma. Peck *vid.*

Boletus edulis Bull. [*Ceriomyces crassus* (Batt.) M.] The lilac-purple stains on the stipe and pileus are present where the plants have been bruised as usually described for *B. eximius*. The tubes are greenish-white, the young forms having the mouths stuffed. The stipe is never enlarged at the base and is always delicately reticulated, at least on the upper half, thus suggesting *B. affinis*. We have referred specimens, collected in the same locality, with pileus deeply cracked into pyramidal areas, to *B. frustulosus*. Under boards, logs and in grassy places, under beech and maple along the border of Blahnik's grove, August, Algoma.

Boletus felleus Bull. [*Tylopilus felleus* (Bull.) M.] Heuer's woods, August, Algoma. Small forms in low grounds, Stewart's swamp, July, Mauston.

Boletus frustulosus Pk. [*Ceriomyces frustulosus* (Pk.) M.] In these specimens the pileus is whitish, or tinged with brown, cracked deeply into polygonal areas, showing the white flesh underneath. They agree exactly with "Type No. 1" of the species collected by Underwood, and it may be that the description should be enlarged to include the forms listed above under *B. edulis*. Plants growing in dry sod where there was little shade would naturally become deeply cracked. Under beech, south edge of grove, Blahnik's, August, Algoma.

Boletus glabellus Pk. [*Ceriomyces miniato-olivaceus* (Frost) M.] Under pine, along pasture borders, Fluno's bluff, June, Mauston.

Boletus luridus Schaeff. [*Suillellus luridus* (Schaeff.) M.] The stipe is merely dotted with fine points and not reticulated, dark-red or yellow. The tubes are minute with uneven cinnabar-red mouths. The quick change of color of the flesh to dark blue when broken is very characteristic. Under beech and maple, Blahnik's grove, August, Algoma.

Boletus niveus Fr. A variety of the rough-stiped form which is white throughout. It is much smaller than *B. scaber* and has only a rough stipe in common with that species and *B. punctipes*. This white form seems to be a distinct species with constant characters. Under alder and tamarack, Detjen's swamp, September, Algoma.

Boletus piperatus Bull. [*Ceriomyces ferruginatus* (Batsch.) M.] Where snails had eaten the tubes, the flesh was rose-pink. The tubes at the margin are 5–6 mm. long, giving the plants a blocky appearance. Murrill, Mycologia, *Pl. 19, fig. 2*, gives an excellent figure of this species. Common on mossy hummocks, Blahnik's grove, August, Algoma.

Boletus Russellii Frost [*Ceriomyces Russellii* (Frost) M.] North side of Mile Bluff, August, Mauston.

Boletus scaber Bull. [*Ceriomyces viscidus* (L.) M.] Common in mixed woods, Ihlenfeld's, July to September, Algoma.

Boletus spectabilis Pk. The pileus is covered with a reddish fur-like tomentum which cracks into patches forming triangular scales which are easily rubbed off. In wet weather these patches are jelly-like. The lavender colored veil, which covers the tubes at first, melts into a jelly as the plant ages. The purple-brown spores are characteristic of the species. The Bohemians will not eat this *Boletus*. In swamps along the Ahnapee river, September, Algoma.

Boletus subluteus Pk. In sandy soil under pine and oak, Fluno's Bluff, August, Mauston.

Boletus subtomentosus L. [*Ceriomyces subtomentosus* (L.) M.] Common around Mile Bluff, July, Mauston.

Boletus sphaerosporus Pk. This species was found growing abundantly in grassy places along the drive in the University grounds during the first weeks in June. The appearance of young specimens is uninviting owing to the purplish slime which covers the thick leathery veil extending from the stipe to the margin of the pileus. The edibility of the species was carefully tested. The flesh is solid, free from larvæ and of excellent flavor when broiled or fried. Old plants are dry and spongy and would not be gathered for food. The annulus was not white in any of the specimens seen. Madison.

Boletus versipellis Fr. The constant characters of this species as we find it which serve to distinguish it from *B. scaber* are the bright rusty-orange color of the pileus, the appendiculate margin of the same color as the pileus, the quick change of color of the flesh to a "coppery-red" or purple, the more coarsely roughened stipe, the dark points often arranged in reticulations, and the lighter colored and smaller spores. The pores may be either yellowish or white in young forms. The stipe becomes greenish or purple after being broken, finally becoming blackish. In young forms the pileus is scarcely broader than the stipe when the latter is full grown at this period. E. Michael, Fuehr. Pilz. No. *4*, Bresadola, Fung. Mang., *Pl. 93*, Pat. Tab. Anal., fig. *666*, Richon, Atlas Champ., *Pl. 54, figs. 4, 5, 7*, are all good illustrations of these forms. Common under beech and alder, Ihlenfeld's woods, July to September, Algoma.

Boletus granulatus L. [*Rostkovites granulatus* (L.) Karst.] Under pine and hemlock, Schmeiling"s woods, September, Algoma.

POLYPORACEAE.

Polyporus adustus (Willd.) Fr. [*Bjerkandera adusta* (Willd.) Karst.] Common on old logs and stumps, September, Kohlberg.

Polyporus arcularius (Batsch.) Fr. On old limbs, Shaw's woods, Foscora. Rare.

Polyporus betulinus Fr. [*Piptoporus suberosus* (L.) M.] Common on birch stubs, Devine's woods, August, Algoma.

Polyorus borealis Fr. [*Spongipellis borealis* (Fr.) Pat.] On logs, Detjen's woods, May, Algoma. Rare.

Polyporus brumalis (Pers.) Fr. [*Polyporus polyporus* (Retz.) M.] Common on old logs and sticks, Detjen's, October, Algoma.

Polyporus caesius (Schrad.) Fr. [*Tyromyces caesius* (Schrad.) M.] Our forms are rather large for the species, frequently being 10–12 cm. broad. On logs, Heuer's woods, September, Algoma.

Polyporus chioneus Fr. [*Tyromyces chioneus* (Fr.) Karst.] On dead maple, Schmeiling's woods, August, Algoma. Common.

Polyporus circinatus Fr. Sections of several specimens of fungi originally identified as *P. tomentosus* showed the duplex character ascribed to *P. circinatus*. Lloyd, Myc. Notes, p. 30, *fig. 198*, finds that there is a distinct difference, and that the two species differ, as Fries maintained. The color of the pileus in our forms varied from light yellow to dark ferruginous brown. The stipe is usually eccentric. Under tamarack and pine, Detjen's woods, November, Algoma. Bresadola *vid.*

Polyporus elegans (Bull.) Fr. Some of these forms have an even and not umbilicate pileus with a thick blunt margin, and a short, more or less eccentric stipe, as figured by Bulliard, Hist. Champ., *Pl. 124.* Other forms have a thin umbilicate pileus, 3 cm. broad, and a stipe up to 12 cm. long. Common on old limbs, Detjen's, September, Algoma.

Polyporus distortus Schw. [*Abortiporus distortus* (Schw.) M.] On old stumps of deciduous trees, September, Krohn's Lake, Algoma, Murrill *vid.*

Polyporus flavidus Pk. [*Grifola fractipes* (B. & C.) M.] The pileus is 5–8 cm. broad, whitish to alutaceous, faintly zoned, depressed and slightly tomentose at the center. The pores are small, white, and decurrent. Three or four stipes may arise from the common basal mass. Fellow's woods, September, Foscora.

Polyporus frondosus (Dicks.) Fr. [*Grifola frondosa* (Dicks.) M.] On old stumps, August, Kohlberg.

Polyporus fragrans Pk. [*Bjerkandera puberula* (B. & C.) M.] On old stumps, Ihlenfeld's woods, September, Algoma. Murrill *vid.*

Polyporus fumosus (Pers.) Fr. [*Bjerkandera fumosa* (Pers.) Karst.] At the base of a living poplar, Blahnik's woods, August, Algoma. Murril *vid.*

Polyporus gilvus Schw. [*Hapalopilus gilvus* (Schw.) M.] Common. On living maple, Devine's woods, August, Algoma.

Polyporus guttulatus Pk. [*Tyromyces guttulatus* (Pk.) M.] On old coniferous logs, probably hemlock, Devine's woods, August, Algoma. Peck *vid.* Murrill *vid.*

Polyporus lacteus Fr. [*Tyromyces lacteus* (Fr.) M.] On fallen timber, Devine's woods, September, Algoma. Murrill *vid*

Polyporus lentus Berk. A small centrally stiped plant, 1–1.5 cm. broad and 5 cm. high, with large angular whitish pores which are decurrent. On limbs, Heuer's woods, Algoma. Rare. Neumann *vid.*

Polyporus officinalis Fr. [*Fomes laricis* (Jacq.) M.] There is considerable doubt as to the correctness of the identification of the specimen referred to here on account of its having been collected in an apparently growing condition on a piece of slab of some coniferous wood lying in a damp woodshed. The context is chalk-white and has a very bitter taste like that of *P. officinalis.* July, Algoma.

Polyporus osseus Kalch. Several pilei are closely imbricate, tapering downward to a common stipe-like portion. The flesh is soft and watery in fresh specimens, at first white, drying alutaceous and very hard. Shaw's w oods, October, 1905. Krohn's Lake, on coniferous log, August, 1909, Algoma. Bresadola *vid.*

Polyporus picipes Fr. [*Polyporus fissus* (Berk.) M.]. The pileus varies from 2 cm. to 20 cm. broad and from 0.5 mm. to 10 mm. in thickness at the center. The chestnut color of the pileus with the blackish center, and the hard, brittle flesh of dry specimens are constant characters. On logs, Krohn's Lake and Belgian settlement, July and August, Algoma.

Polyporus resinosus (Schw.) Fr. [*Fomes annosus* (Fr.) Cooke]. A thin, non-resinous liquid is usually found hanging in drops from the pore surface of growing specimens. Such animals as mice and rabbits will eat plants remaining on stumps during the winter. They are too tough to eat even when well cooked. Common. On logs and stumps, Blahnik's woods, July to September, Algoma.

Polyporus Spraguei B. & C. [*Tyromyces Spraguei* (B. & C.) M.] On decayed logs, Krohn's Lake, September, Algoma. Murrill *vid.*

Polyporus squamosus Fr. [*Polyporus caudicinus* (Scop.) M.]. One centrally stiped plant was collected from the top of a maple stump, Blahnik's grove, July, Algoma.

Polyporus subradicatus Murrill. The stipe is about 8 cm. long and only 4–6 mm. thick, otherwise the description given by Murrill, N. Am. Fl., 9:63, applies well to this form. On the ground near a log, Otto's woods, July, Algoma. Murrill *vid.*

Polyporus sulphureus Fr. [*Laetiporus speciosus* (Batt.) M.]. Common. On logs, stumps, and on the ground, growing from buried sticks. July to September, Algoma.

Polyporus tomentosus Fr. [*Coltricia tomentosa* (Fr.) M.]. Similar to those identified as *P. circinatus* except that the flesh of the pileus is not duplex. The whole plant is dark ferruginous. On the ground among pine needles, Shaw's woods, September, Algoma.

Polyporus umbellatus (Pers.) Fr. [*Grifola ramosissima* (Scop.) M.]. Rare. Detjen's woods, September, Algoma. Neumann *vid.*

Polyporus varius Fr. Gillet, Champ. France, Bolton, Hist. Fung., *Pl. 83*, *168*, Grev., Scot. Crypt., *202*, represent these forms. The pileus is frequently 10 cm. broad with flesh 1–2 cm. thick, variously deformed and doubled. On logs, June, Blue Mounds; Heuer's woods, October, Algoma.

Polyporus sp. Pileus 5 cm. broad, deeply umbilicate, light drab, slightly squamulose, the margin strongly inrolled; flesh 1 mm. thick, white, fragile; tubes hexagonal elongated radiately, 1 x 1.5–2 mm. across and about 3 mm. long, decurrent; stipe central, brownish, 0.5 x 10 cm., rough tomentose toward the base; spores white, hyaline, smooth, ovoid, 5 x 6 microns. Peck refers the specimen somewhat doubtfully to *P. lentus* Berk. Although the plant was fully developed, few spores were obtained, and these differed materially from the spores of *P. arcularius* Schw. On the ground, growing from buried wood. June, Blue Mounds.

Glœoporus conchoides Mont. Brought in on oak cord-wood, April, Algoma.

Merulius lacrymans (Jacq.) Fr. On under side of planks, Decker dock, June, Algoma.

Merulius tremellosus Schrad. On bark of oak and on decayed logs, Tornado, September, Kohlberg.

Polystictus biformis Klotz. [*Coriolus biformis* (Klotz.) Pat.]. On maple stumps, Danek's woods, January, Algoma. Peck *vid.*

Polystictus cinnabarinus (Jacq.) Fr. [*Pycnoporus cinnabarinus* (Jacq.) Karst.]. Figured by Bulliard, Hist. Champ., *Pl. 501, fig. 1.* On trunks and limbs, June to October, Algoma.

Polystictus cinnamomeus (Jacq.) Sacc. [*Coltricia cinnamomea* (Jacq.) M.]. Common in sandy soil, June, Hale hill and Mile Bluff, Mauston; Krohn's Lake, July, Algoma.

Polystictus conchifer Schw. [*Poronidulus conchifer* (Schw.) M.]. Both forms common on dead limbs, Krohn's Lake and Danek's woods, October, Algoma.

Polystictus fibrillosus Karst. [*Pycnoporellus fibrillosus* (Karst.) M.]. A form frequently reported as *P. aurantiacus* Pk. Occasionally plants become much faded with age. Rare. On coniferous logs, October, Awe's grove, Foscora.

Polystictus hirsutus Fr. [*Coriolus nigro-marginatus* (Schw.) M.]. Common. On dead limbs, Otto's woods, November, Algoma.

Polystictus perennis (L.) Fr. [*Coltricia perennis* (L.) M.] Well illustrated by Rolland, Atlas Champ., *Pl. 89, fig. 197.* On the ground, Schmeiling's grove, August, Algoma.

Polystictus pergamenus Fr. The violet color of the pore surface of the young plant is a constant characteristic. Common on limbs, logs and standing trunks of frondose treees, September, Algoma.

Polystictus pubescens (Schum.) Fr. [*Coriolus pubescens* (Schum.) M.]. The pileus is coarsely pubescent and the whole plant is white, with little change in drying. On decayed stumps, Krohn's Lake, September, Algoma. Murril *vid.*

Polystictus versicolor (L.) Fr. [*Coriolus versicolor* (L.) Quel.]. Good figures by Hussey, Illust., *Pl. 24*, Schaeff., Incones, Pl. *263, 268*, and Rolland, Atlas Champ., *Pl. 96.* Common. Danek's woods, August, Algoma.

Fomes applanatus Pers. [*Elfvingia megaloma* (Lev.) M.]. Several authors have held that the brown spores that are frequently found on the pileus in growing seasons are conidia which arise from the upper surface. They are in reality basidiospores that have been borne upward by air currents and deposited on the upper surface. Several isolated plants were thoroughly cleaned and paper tacked over the pileus. After a few days the papers were covered with the same spores but none were found on the pileus under the papers. There are also several conflicting opinions as to the relation between the American and the European forms of this species. Lloyd, Myc., Notes, No. 6, p. 60; Murrill, N. Am. Fl., 9; 114; Moffatt, Bull. Nat. Hist. Surv. 7:108; Atkinson, Ann. Myc., 6: 179. Common on deciduous woods, Algoma.

Fomes conchatus (Pers.) Fr. [*Pyropolyporus conchatus* (Pers.) M.]. On dead alder, Perry's woods, August, Algoma.

Fomes connatus Schw. [*Coltricia focicola* (B. & C.) M.] On stub of partially decayed beech, Devine's woods, August, Algoma.

Fomes Everhartii Ellis & Gall. [*Pyropolyporus Everhartii* (E. & Gall.) M.]. Originally figured in Journal of Mycology, vol. V, 1889, *Pl., 12*. On old logs, Mile Bluff, July, Mauston.

Fomes fomentarius (L.) Fr. [*Elfvingia fomentaria* (L.) M.]. The pileus is light colored and only slightly sulcate. Sow. Eng. Fungi, Pl. *133*, Gillet, Champ. Fr. Pl. *467*, are of this type. Devine's woods, on birch, September, Algoma. Lloyd, Myc. Notes, pp. 22, 341, 373, *Pl. 194*, describes a rare form that has a hard, shining, black, strongly concentrically sulcate crust. He does not agree with Murrill that it is *F. fomentarius* of advanced age and indurated. The sulcations dip into the pore layers. Such specimens were found in June at Mile Bluff, Mauston.

Fomes graveolens (Schw.) Cooke. [*Globifomes graveolens* (Schw. M.]. Hard, Mushrooms, p. 405, *fig. 334*, figures the black, shining, overlapping pilei. Rare. On oak stub, Loomis woods, June, Mauston.

Fomes igniarius (L.) Gill. [*Pyropolyporus igniarius* (L.) M.] On oak, Coon Rock, July, Mauston.

Fomes lucidus Leys. [*Ganoderma Tsugae* M.]. A variable species, either sessile or long-stiped. The upper surface is often covered with brown spores, as is that of *F. applanatus*. Atkinson, Bot. Gaz., 46:334, 1908, discusses the variations of this species and considers that the name *Ganoderma pseudo-boletum* (Jacq.) M. should be applied to the American plants. Common. On trunks and stumps of *Tsuga canadensis*, Krohn's lake, August, Algoma.

Fomes nigricans Fr. On decayed poplar log, Trumble's ravine, July, Mauston.

Fomes ungulatus (Schaeff.) Sacc. The margin is yellow or reddish, depending on the season. In the spring of the year the pore layers are easily separated from the pileus. On fallen tamarack trunks, Detjen's woods, April, Algoma.

Fomes roseus (A. & S.) Cooke. On sidewalks, and on trunks of coniferous trees, Perry's swamp, June, Algoma.

Daedalea ambigua Berk. [*Daedalea Aesculi* (Schw.) M.] On fallen maple, Blahnik's grove, August, Algoma.

Daedalea confragosa (Bolt.) Pers. The pores are whitish-lilac in fresh plants and are fairly regular, but with age become split in lines forming gills. Such forms are sometimes called *Lenzites corrugata.* On fallen birch, Krohn's lake, August, Algoma.

Daedalea obtusa (Berk.) Neumann. [*Spongipellis unicolor* (Schw.) M.]. The pileus may be either hoof-shaped with a thick margin, or flat-expanded with a thin margin. Full grown plants are ashy-white in wet weather, the yellow colors appearing only in the dried specimens. They make good substitutes for sponges. Common on oaks, August, Mauston.

Daedales quercina (L.) Pers. On oak stumps, Fluno's bluff, July, Mauston.

Daedalea unicolor (Bull.) Fr. [*Cerrena unicolor* (Bull. M.]. Common on oak and maple stumps, June, Mauston; Runke's woods, August, Algoma.

Favolus alveolaris (DC.) Quel. [*Hexagona alveolaris* (DC.) M.]. Other names: *F. europaeus; F. canadensis; F. boucheanus.* On hickory and beech, Danek's, June, Algoma; Heineman's, August, Mauston.

Favolus rhipidium Berk. Distinguished by its resemblance to *Panus stipticus.* On blocks of hewn timber, Coon rock, June, Mauston.

Solenia anomala (Pers.) Fr. Common on alder twigs, December, Perry's swamp, Algoma.

Poria Blyttii Fr. The pores are small, regular, cinnamon-colored. Awe's, September, Foscora. Bresadola *vid.*

Poria laevigata Fr. Perry's swamp, December, Algoma.

Poria salmonicolor B. & C. Covered the under side of a hemlock log for several inches. Krohns' Lake, August, Algoma.

Poria subacida Pk. Common on old logs, Detjen's woods, March to August, Algoma.

Poria vulgaris Fr. Krohn's Lake, September, Algoma. Neumann *vid.*

Poria nigra Berk. On oak log, Mile bluff, July, Mauston. Murril, *vid.*

Trametes odorata (Wulf) Fr. Differs from *T. protracta* Fr. in having much longer tubes, 4–8 mm., a blunt or sometimes rolled margin, and in the color and character of the surface. Common. Otto's woods, September, Algoma.

Trametes protracta Fr. Well illustrated by Fries, Icones, *Pl. 191.* His figure shows zonate marks on the pileus although it is not so described. A cross section is triangular, showing a thin margin. Perry's woods, October, Algoma.

Trametes Pini (Thore) Fr. [*Porodaedalea Pini* (Thore) M.]. Common on living spruce, Perry's swamp, August, Algoma. Well figured by Sicard, Hist. Nat. Champ., *Pl. 60 fig. 307,*

Trametes rigida Berk & Mont. Stony Creek, September, Foscora.

Trametes serialis Fr. Common on logs, Detjen's woods, April, Algoma.

Trametes stereoides Fr. On dead limbs, Runke's woods, October, Algoma.

HYDNEAE.

Hydnum adustulum Banker (*Steccherinum adustulum* Banker). A small species with a cream colored, pubescent pileus marked with brown zones. The stipe is eccentric in Algoma forms. On pieces of wood among needles in swamps, under *Larix* and *Thuja*, Ahnapee river, September, Algoma.

Hydnum caput-ursi Fr. [*Manina caput ursi* (Fr.) Banker.] The large tubercle is narrowed behind into a small point of attachment. The branches are short and thick, 2–3 cm. long. Fries, Incones, Pl. 7, shows a good cross section view of the plant. A somewhat different form is figured by Peck, Rept., 51. Pl. 56, fig. *8–12*. Otto's woods, September, Algoma.

Hydnum coralloides Scop. [*Manina coralloides* (Scop.) Banker.] The whole plant branches into primary and secondary divisions, the first devoid of teeth except where they are on slight protuberances or abortive branches. May be confused with *H. caput-ursi* on account of the massive branches and long pendent teeth. Atkinson, Mushrooms, *Pl. 67, fig. 185*, 1900, has such a figure for *H. caput-ursi.* Schaeff, Icones, *Pl. 142 H. coralloides* is a good illustration of our specimens. On oak and maple, Tornado, Kohlberg, September.

Hydnum laciniatum Leers. The teeth are short, flexible and slender, 2–5 mm. long. The branches are long, narrow, often anastomosing, and having the teeth distributed uniformly on the lower surface. Bull., Hist. Champ., *Pl. 390*, Peck, 48th Rept. *Pl. 24 fig. 11 13*, Atkinson, Mushrooms, 1900, *fig 184*, McIlvaine, Am. Mush., *Pl. 134*, represent the forms referred here to *H. laciniatum.*

Hydnum erinaceum Bull. On oak, Tornado, September, Kohlberg.

Hydnum floriforme Schaeff. [*Hydnellum floriforme* (Schaeff.) Banker). The color of the pileus varies from light yellow to reddish orange. Often reported as *H. aurantiacum* A & S. On the ground, Heuer's woods, August, Algoma.

Hydnum graveolens Delast. [*Phellodon graveolens* (Delast.) Banker]. On the ground, Shaw's woods, September, Algoma. Common.

Hydnum rhois Schw. [*Steccherinum rhois* (Schw.) Banker]. On fallen limbs and on deciduous woods, September, Krohn's Lake, Algoma. On base of frog crates in zoological laboratory, June, Madison.

Hydnum ochraceum Pers. [*Steccherinum ochraceum* (Pers.) Gray]. Common. On decayed limbs, Perry's woods, December, Algoma.

Hydnum pulcherrimum B. & C. [*Steccherinum pulcherrimum* (B. & C.) Banker]. Young plants are pure white, sessile, sometimes imbricate. A white milk exudes from wounded portions. This milk later becomes sticky and hardens, changing to reddish purple. Older plants are yellowish, turning reddish in drying. Pieces of wood are usually attached to collected specimens. Common on dead oak trees, birch stumps, and on living maple. Mile Bluff, June, Mauston; Otto's woods, September, Algoma.

Hydnum repandum L. Common. On the ground under beech, maple, etc., Schmeiling's, June to August, Algoma.

Hydnum septentrionale Fr. [*Steccherinum septentrionale* (Fr.) Banker]. Several pilei are closely imbricated forming a semiglobular mass attached at a narrow vertical line. Plants often fall off from the place of growth owing to their weight. On dead maple, Tornado, November, Kohlberg.

Hydnum velutinum Fr. [*Hydnellum velutinum* (Fr.) Banker]. The whole plant is soft and spongy, rusty-brown, tomentose. The substance at the upper portion of the stipe is convex-transversely zoned. The deformed and spongy stipe is well figured by Gillet, Champ. France, *Pl. 324*, Pat., Tab. An., *fig. 677*, Bull., Hist. Champ., *Pl. 453*. Sometimes referred to *H. spongiosipes* Peck. Common. Under pines, Detjen's woods, September, Algoma.

Irpex fuscescens Schw. (*Irpex cinnamomeus* Fr.) Common. On dead alder, willow, etc. Perry's swamp, Algoma.

Irpex lacteus Fr. On stumps, September, Casco.

Irpex tabacinus B. & C. Almost entirely resupinate, covering the end of a large log, *Tsuga canadensis*. The teeth are long, 4–7 mm., whitish, seriate. The color of the plant is dark tobacco brown. Krohn's lake, August, Algoma.

Irpex tulipiferae Schw. On small dead limbs of various deciduous trees, Stony Creek, October, Algoma.

Phlebia merismoides Fr. The spores are subglobose, smooth, white, minute, 3-4 microns. On under side of deciduous log. Detjen's swamp, April, Algoma.

Phlebia radiata Fr. Some forms do not show the radiating structure of the folds. Common. On decayed logs, Ihlenfelds' woods, September, Algoma.

THELEPHOREAE.

Thelephora caryophyllea (Schaeff.) Pers. A thin, coríaceous, stipitate form with uneven or lacerated margin. The entire surface is smooth and silky. Saunders & Smith, Myc. Illust., *Pl. 41, figs. 7-12*; Schaeff., Icones, *Pl. 325.* Blahnik's grove, July, Algoma.

Thelephora intybacea Pers. Soft spongy plants, unevenly colored purplish-brown, several growing together irregularly and climbing up on small bushes. Sowerby, Eng. Fung., *Pl. 213*; Bull., Hist., Champ., *Pl. 483.* In Sphagnum swamps, November, Algoma.

Thelephora palmata Scop. On the ground, Hale's woods, August, Mauston.

Thelephora Schweinitzii Fr. Common on the ground in woods, June to September, Mauston and Algoma.

Craterellus cornucopioides Fr. Mature specimens are sometimes not over 2 cm. tall and 0.5 cm. broad. Lanzi, Fung. Mang., *Pl. II, fig. 5,* shows the more common large forms. On the ground, Van Deusen's woods and Mile Bluff, August, Mauston.

Stereum complicatum Fr. Common on alder, Perry's swamp, December, Algoma.

Stereum fasciatum Schw. On logs and stumps, June to September, Mauston and Algoma.

Stereum frustulosum Fr. On logs and stumps, Tornado, August, Kohlberg.

Stereum hirsutum Fr. On fallen timber, Krohn's Lake, August, Algoma.

Stereum purpureum Pers. On fallen limbs of some deciduous
Stereum radians Fr. The pileus is covered with silky hairs,
tree, Krohn's Lake, August, Algoma.
radiately striate, 1-2 cm. broad. Seems to be similar to *S. sericeum* Schw. On twigs and limbs, Blahnik's swamp, July, Algoma.

Stereum rufum Fr. On some coniferous stub, Perry's swamp, December, Algoma.

Hymenochaete tabacina (Sow.) Lev. On dead limbs of willow, Perry's swamp, December, Algoma.

Hymenochaete ferruginea Bull. On logs, Blahnik's swamp, July, Algoma. Bull. Hist. Champ., *Pl. 378.*

Coniophora suffocata (Pk.) Massee. The spores are subglobose, 8-10 microns, pinkish-ochraceous, completely covering the thin bladdery hymenium. When the spore mass cracks, the whitish subiculum is seen as described by Moffatt, Bull 7, p. 11, Nat. Hist. Surv. Chi. On charcoal, spreading out on leaves, September, Algoma.

Corticium cinereum Fr. On old maple limbs, August, Schmieling's grove, Algoma.

Corticium laeve Fr. On dead branches, Heuer's woods, August, Algoma.

Corticium lilacino-fuscum B. & C. On dead willow, Belgian settlement, September, Kohlberg.

Corticium salicinum Fr. Common. On willow, Perry's swamp, August, Algoma.

Cyphella pezizoides Zopf. On oak and maple leaves, June, Foscora.

CLAVARIEAE.

Clavaria amethystina Bull. Berkeley, Out., *Pl. 18, fig. 2,* shows a form with violet-colored branches having whitish tips. The much branched forms as figured by Sicard, Hist. Champ, *Pl. 61, fig. 315*, are more common. Among grass under oak, Fluno's Bluff, June, Mauston.

Clavaria cinerea Bull. Bull., Hist. Champ., *Pl. 354.* Rare. Heuer's woods, September, Algoma.

Clavaria grandis Pk. This species seems to be near *C. tsugina* Pk, but has a very strong, heavy aromatic odor. On the ground among coniferous logs, Krohn's Lake, August, Algoma.

Clavaria coronata Schw. The spines are stouter and firmer than those of *C. pyxidata* which it resembles in having the cup-shaped tips to the branches. On decayed log, Blahnik's woods, July, Algoma.

Clavaria cristata Pers. Common. On decayed logs, Tornado, September, Kohlberg.

Clavaria inaequalis Muell. Branches twisted and divided at the apex as figured by Sowerby, Eng. Fung., *Pl. 253.* In groups under dense shade of alder, Stony Creek, September, Algoma.

Clavaria pulchra Pk. Small plants, 2 cm. high, slender club-shaped. The spores are bright yellow. Similar to those growing on earth in palm tub and identified by Dr. Peck. Krohn's Lake, September, Algoma.

Clavaria pyxidata Pers. Common. On logs and woody earth, Krohn's Lake, July to October, Algoma.

Clavaria stricta Pers. On wood-strewn earth, Krohn's Lake, August, Algoma.

Clavaria tsugina Pk. Dark ochre to rusty brown, the tips whitish, sharp. Tendency to branch from one large, central, stipe-like portion. Abundant. On logs, *Tsuga canadensis*, Krohn's Lake, August, Algoma.

Clavaria sp. Pure white plants 1–2 cm. high with slender branches. Solitary on leaves which were much decayed, Krohn's Lake, August, Algoma.

TREMELLINEAE.

Exidia glandulosa (Bull.) Fr. Common on old limbs and cordwood, March to November, Algoma.

Tremella albida Hud. On wet stumps and logs, Blue Mounds, June; Detjens' woods, September, Algoma.

Tremella foliacea Pers. On dead limbs, Perry's swamp, December, Algoma; cemetery woods, June, Madison.

Tremella frondosa Fr. On living tamarack, Ihlenfield's woods, September, Algoma.

Tremella fuciformis Berk. [*Tremella reticulata* (Berk.) Farlow.] A large white, much-branched plant. On the ground, Runke's pasture, August, Algoma.

Tremella intumescens Sm. Eng. Bot. Pinkish-watery when fresh, then tawny brown. The spores are oblong, curved. Very common on beech stumps after rains, Blahnik's grove, August, Algoma.

Tremella lutescens Pers. On old wood, Otto's woods, June, Algoma. Rare.

Tremella mesenterica Retz. On oak bark, Mile Bluff, July, Mauston.

Tremella mycetophila Pk. [*Exobasidium mycetophila* (Pk.) Burt.] On the pileus and stipe of *Collybia dryophila*, Krohn's Lake, August, Algoma.

Tremella sebacea Pers. On grass, July, Algoma.

Naematelia encephala Fr. This specimen consists of about a dozen curving folds forming a brain-like aggregation 7cm. across. The nucleus of each fold is tough, white, elastic, 0.5–1 cm. wide and 2 cm. high, sometimes branched. The nuclei of the folds run together into a common base of similar consistency. Each fold is covered with a firm gelatinous layer 1–1.5 cm. thick, which is about the color of boiled starch and not flesh-colored as described by Fries, Syst. Myc., p. 227. Neither is it reddish-brown until dry. When soaked in water the cluster of folds swells to its original size and assumes a whitish color. The maximum size has been given as 3–6 lines, Alb. & Schw., Cons. Fung., p. 301, but this may refer to a single fold. This cluster of folds is plainly a single plant. A section through the plant resembles a section through a brain. The external appearance is likewise brain-like. On living tamarack at a point where a stub of a dead limb protruded. Detjen's woods, April 1, Algoma.

Tremellodon gelatinosum (Scop.) Pers. Common on hemlock logs and stumps, Krohn's Lake, August; Schmeiling' woods, September, Algoma.

Dacryomyces multiseptatus Beck. When moist the plants are bright golden-yellow, but turn orange when dry. The spores are yellow, curved, 6–9 septate, 6 x 20 microns. This may be *Dacryomyces aurantia* (Schw.) Farlow. Common on old stubs, and at the base of living tamarack and spruce, Perry's swamp, June to September, Algoma.

Dacryomyces chrysocoma Bull. A form resembling a yellow discomycete when moist. On old sticks and limbs, Detjen's woods, September, Algoma.

Dacryomyces deliquescens (Bull.) Duby. On decayed board, Schmeiling's grove, June, Algoma.

Calocera cornea Pers. Growing from cracks on logs and limbs in wet weather. Common at Krohn's Lake and Schmeiling's woods, June, Algoma.

Guepinia spathularia (Schw.) Fr. On bark, Otto's woods, Algoma.

GASTEROMYCETES.

HYMENOGASTREAE.

Hymenogaster rufus Vitt. Resembles a young puff-ball; 3 cm. broad, whitish, changing to lilac-purple without and within when bruised. The gleba is white, masked by an immense number of rusty-brown spores. The spores are roughly reticulated, subglobose or blunt-elliptical, 7 x 8–8.5 microns, with a blunt hyaline apiculus 1.5 microns long, and a large central oil globule 3–4 microns in diameter. Among needles, Schmeiling's woods, September, Algoma. Bresadola *vid.*

Rhizopogon roseum Bres. *in litt.* This plant differs from *R. rubescens* in the character of the peridium and spores. The peridium is persistent, smooth, dark brown, devoid of adhering branched fibres. The cavities are minute. The spores are 3.5 x 12–13 microns. In sandy soil, partially exposed, under pine near "Stand rock," August, Kilbourn.

PHALLOIDEAE.

Dictyophora duplicata (Bosc.) Fischer. The pileus is very coarsely reticulated. The veil varies in length from 1 to 4 cm. In sand roads, swamps, and near stumps in woods. Common. Blahnik's grove, August, Algoma; Flunos' pasture, June, Mauston.

Ithyphallus Ravenelii (B. & C.) Fischer. The denuded pileus is scarcely wrinkled, not at all reticulated. There is a short, non-perforated veil which extends about one-third the length of the pileus and can be seen by making a section of the pileus. The tapering stipe and characteristic pileus are shown by Lloyd, Myc. Notes, *Pl. 115*, Atkinson, Mushrooms, *Pl. 74, fig. 202*, 1900. Algoma.

Phallogaster saccatus Morg. The hymenophore is composed of irregularly anastomosing bars and bands, pink or lilac. Spore mass green, foul smelling. On decayed poplar log, Fluno's woods, July, Mauston.

LYCOPERDACEAE.

Calvatia caelata (Bull.) Morg. These puff-balls are usually beaker-shaped as figured by Hollos, Gast. Ungar., *Pl. 15*, the young forms having well developed rhizomorphs, *Pl. 15, fig. 12*. The roughly warted or cracked peridium is not constant. Lloyd, Gast., ***Pl. 36*** and ***fig. 39***, shows the external markings. The sterile portion occupies one-half to three-fourths of the plant. Along roads and in pastures, September, Algoma. Common.

Calvatia craniiformis (Schw.) Fr. The greenish-yellow spores and the greater proportion of the sterile base distinguished this plant from *C. cyathiformis*. There is no resemblance to a cranium. Schmeiling's pasture at the edge of woods, August, Algoma.

Calvatia cyathiformis (Bosc.) Morg. The lilac-purple spores are echinulate and larger in diameter than the capillitial threads. The sterile portion occupies only a small part of the base. Perry's pasture September, Algoma.

Calvatia gigantea Batsch. Specimen 33 cm. across collected by Melvin Perry in the woods. The spores are light rust-colored. The sterile portion is small. M. Perry's woods, September, Algoma.

Lycoperdon cepaeforme Bull. In dry sterile places in pasture, Mile Bluff, July, Mauston. Peck *vid.*

Lycoperdon cruciatum Roth. Among moss and grass in swamps, under tamarack, September, Algoma.

Lycoperdon gemmatum Batsch. Common. On the ground and on decayed logs, Algoma.

Lycoperdon perlatum Pers. Seems to be a species quite distinct from *L. gemmatum*. The manner in which the peridium tapers to a well-formed stipe is very characteristic. Cespitose, in sandy soil, Thompson's woods, July, Mauston. Peck *vid.*

Lycoperdon pusillum (Batsch.) Fr. Devine's woods among grass, August, Algoma.

Lycoperdon pyriforme Fr. Common. On logs and stumps, Detjen's woods, August, Algoma.

Lycoperdon umbrinum Pers. In swamps after rains, under cedar and tamarack, Ahnapee river, September, Algoma, Peck *vid.*

Lycoperdon Wrightii B. & C. Peridium is white, covered with rough polygonal warts. Figured in Mycologia, November, 1909. Sandy soil, Mile Bluff, June, Mauston.

Bovista pila B. & C. Common in all pastures, September, Algoma.

Bovista plumbea Pers. Rare. F. Robinson's pasture, June, Mauston.

Geaster hygrometricus Pers. The rough spores and branched capillitium of this species have been made the basis of a genus, *Astraeus*, Morgan. On ground, Fish Creek, August. Not common.

Geaster limbatus Fr. This is often described as a black *Geaster*, but that is the color of only the inner peridium. Hussey, Illust., figures a form in Plate 2 which has a light gray inner peridium. Krohn's Lake, August, Algoma.

Geaster minimus Schw. The peristome and sharp beak are characteristic. Perry's swamp, August; Belgian settlement, September, Kohlberg.

Geaster rufescens Fr. Common. Krohn's Lake, August, Algoma.

Geaster pectinatus Pers. The inner peridium tapers into a slender pedicel which has a distinct collar at the base, and is marked by several striae or ridges as figured by Lloyd, Geastrae, p. 15, *figs. 20 22*, and Hollos, Gast. Ungar., *Pl. 8*. Both writers report that the species is a rare one. Along lake bank, Alaska, August, 1905; on upturned stump, Krohn's Lake, August, Algoma, 1909.

Geaster saccatus Fr. Well illustrated by Lloyd, Geastrae, *fig. 74*, for a variety of this species. Otto's woods, June, Algoma.

Geaster triplex Jung. This is the most common *Geaster* at Algoma. Schmeiling's woods, August.

NIDULARIEAE.

Crucibulum vulgare Tul. Common. On old sticks and on cow dung, Warners' grove, August, Algoma; Mile Bluff, June, Mauston.

Cyathus striatus Hoffm. Grows in dense clusters on old wood, Trumble's ravine, June, Mauston. These were of the form figured by Rolland, Atlas Champ., *Pl. 109, fig. 246*. A much less strigose form nearly gray in color was found in a garden, Fellows', June, Algoma.

Cyathus stercorarius Schw.) DeTon. On dung, Mile Bluff, Mauston.

Cyathus vernicosus DC. Common. In grain fields, Algoma.

SCLERODERMEAE.

Scleroderma cepa Pers. A Wisconsin plant is figured by Lloyd, Myc. Notes., p. 72, *Pl. 31*. The outer surface is smooth and dark colored. The peridium is thick and hard. Seems to prefer growing along beds of gullies formed in ravines by spring freshets. Trumble's, June to September, Mauston. Bresadola *vid.*

Scleroderma tenerum Berk. (*S. verrucosum minor* Bres. *in litt.*). The peridium is soft and thin, the outer surface covered with delicate scales. The color varies from white to purplish when bruised. Ripe specimens are 0.5 cm. to 2 cm. broad. The spore mass may be lilac-purple or rust-colored depending on how wet they are or in what state of decay. Common. In grass under oak and on rich bogs under willow, Fluno's bluff, June, Mauston.

Scleroderma verrucosum Pers. Not common. Melchior's grove, October, Algoma.

Scleroderma aurantium Pers. (*S. vulgare* Fr.). Some forms have no suggestion of a yellow color. Hussey, Illust., *Pl. 17*, and Gillet Champ. Fr., figure these rough varieties which grow in beds of *Polytrichum*, Fluno's woods, June to August, Mauston. The New York plants are deep golden yellow, with much thinner peridium and a longer stipe.

Mycenastrum corium Desv. The outer peridium cracks into areas about one centimeter broad. The hollow shell remains a long time after the spores have all escaped. In pasture lands, along lake bank, September, Algoma.

Secotium acuminatum Mont. Rare. Alaska Lake, Alaska, September.

ASCOMYCETES.

Elaphomyces granulatus Fr. Fresh specimens of this species were found by Richard Detjen about January 1, while engaged in uprooting alders. He reported that as the alders were very large he thought the fungus was buried about six inches beneath the surface. The only other specimen reported for the state was collected at Superior by E. M. Gilbert. This latter specimen was infected with *Cordyceps*. Algoma.

Nectria episphaeria (Tode) Fr. Parasitic on a species of *Valsa* on limbs of *Fagus*, Blahnik's woods, August, Algoma. Distributed as no. 585c, Rehm, Ascom. Exs. Rehm *vid.*

Nectria cinnabarina (Tode) Fr. On old limbs of frondose trees, Schmeiling's grove. August, Algoma.

Nectria peziza (Tode) Fr. On decayed stumps, Detjen's pasture, June, Algoma; Cory's lawn, June, Madison.

Sphaerostilbe cinnabarina Tul. In this species the perithecia were thickly scattered over the bark at the base of a stump. Well developed spores were found in the perithecia, but there was no evidence of a conidial form present. In cemetery woods, May, Madison. Rehm *vid.* Seaver *vid.*

Hypomyces apiculata Pk. On old leaves and rubbish, Krohn's Lake, August, Algoma. Seaver *vid.*

Hypomyces aurantius (Pers.) Tul. Completely covered large specimens of *Polyporus frondosus* which were in a foul state of decay, cemetery woods, June, Madison.

Hypomyces chrysospermus Tul. On *Boletus scaber, B. chrysenteron* and *B. subtomentosus.* Specimens of *Boletus* bearing this fungus were frequently found firmly attached to roots of stumps or old sticks by the white mycelium covering the caps. If fresh specimens are left in the collecting basket a few hours, the fungus will attach itself to the basket. Common, June to September, Algoma. Seaver *vid.*

Hypomyces lactifluorum Schw. A large number of specimens of *Russula delica* were found in all stages of infection by this fungus, which is said to attack species of *Lactarius.* Uninfected plants had a mild taste and possessed no milk, and as the series between these and the fully infected forms was complete, there seems to be little doubt as to the identification. Among needles, sandy soil. Mile Bluff, August, Mauston.

Hypomyces lateritius (Fr.) Tul. On *Lactarius zonarius* (Lamarck) Fr., Dewey's springs, August, Algoma.

Hypomyces polyporinus Pk. On *Polyporus versicolor,* Krohn's Lake, August, Algoma. Seaver *vid.*

Hypomyces torminosus (Mont.) Tul. Common on *Lactarius torminosus,* September, Blahnik's woods, Algoma.

Hypocrea aurantiaca Pk. Specimens of *Polyporus chioneus* bearing this fungus vary in color from light yellow to deep purplish red. Krohn's Lake, August, Algoma.

Hypocrea sulphurea Schw. On old limbs, Schmeiling's grove, August, Algoma. Seaver *vid.*

Claviceps purpurea (Fr.) Tul. On rye, Kumm's, Forestville.

Cordyceps militaris (L.) Link. Growing from pupa within a cocoon buried under bark of coniferous log, Perry's swamp, August, Algoma.

Cordyceps militaris form **Isaria farinosa** Fr. On pupae of small moths (?), among needles in swamps, Ahnapee river, September, Algoma.

Pleurage albicans (A. & S.) Griff. [Sordaria coprophila (Fr.) C. & DN.]. Immature specimens abundant on cow dung, Dewey's springs, August, Algoma. Rehm *vid.*

Pleurage vestita (Zopf) Griff. The spores are bluish black when mature, one end having a cylindrical appendage as long as the spore, the opposite end with several scarcely visible appendages. On cow dung, Schmeiling's grove, August, Algoma.

Sporormia minima Auersw. On cow dung, very common, Schmeiling's grove, July, Algoma.

Rosellinia aquila (Fr.) DN. var. **glabra** Sacc. On old twigs and limbs, Krohn's Lake, August, Algoma. Rehm *vid.*

Hypoxylon coccineum Bull. On limbs of Fagus, Krohn's Lake, August, Algoma. Rehm *vid.*

Hypoxylon coccineum, form **Institale acariforme** Fr. On decayed alder (?), Blahnik's swamp, August, Algoma.

Hypoxylon rubiginosum (Pers.) Fr. On old limbs in alder swamp, Perry's, December, Algoma. Rehm *vid.*

Daldinia concentrica (Bolt.) Ces. & DeNot. On old stumps and logs, common, June to September, Algoma.

Plowrightia morbosa (Schw.) Sacc. On wild species of *Prunus,* June, Algoma.

Ustulina vulgaris Tul. On hemlock stumps, common, Krohn's Lake, August, Algoma. Rehm *vid.*

Xylaria corniformis Fr. On decayed hemlock roots, Krohn's Lake, August, Algoma. Rehm *vid.*

Xylaria corniformis, form **Isaria flabelliformis** Schw. Very common on old sticks, Schmeiling's, July, Algoma.

Xylaria digitata (L.) Grev. The conidial stage resembles in form *X. corniformis,* fruiting stage. On old roots, common, Blahnik's woods, July, Algoma. Rehm *vid.*

Xylaria hypoxylon (L.) Grev. Completely covering decayed oak log, and on the ground underneath. Loomis' woods, July, Mauston.

Xylaria polymorpha (Pers.) Grev. On stumps, Froemming's lawn, August, Algoma. Rehm *vid.*

Scorias spongiosa Schw. This fungus grows on alder infected with the alder blight, *Schizoneura tessellata* Fitch. Large masses of it are often found beneath the trees from which they have fallen. Abundant after a season of wet weather, Ihlenfeld's woods, October, Algoma.

MYXOMYCETES.

Arcyria incarnata Pers. Stony creek, October, Foscora; Fluno's bluff, June, Mauston.

Arcyria magna Rex. The ash-gray, tawny-gray sporangia are unlike any other of this region in color. On maple tree, corner West Johnson and Park streets, July, Madison.

Arcyria nutans (Bull.) Grev. Heineman's woods, June, Mauston, September, Foscora.

Arcyria punicea Pers. Macbride makes this *A. denudata* (L.) Sheldon. Schmeiling's grove, September, Algoma.

Badhamia papaveracea Berk. & Rav. Stony Creek, October, Foscora.

Badhamia utricularis (Bull.) Berk. Tornado, September, Kohlberg. Rare.

Cribraria aurantiaca Schrad. Stony creek, August, Foscora.

Cribraria dictidyoides Cooke & Balf. Mile Bluff, June, Mauston; Stony Creek, July, Foscora.

Ceratiomyxa fruticulosa (Muell.) Macb. Common on wet logs, June, Algoma.

Diachea leucopoda Bull. & Rost. Shaw's woods, September, Foscora.

Enteridium rozeanum (Rost.) Wingate. The aethalium is 2 x 3 cm. across and 4 mm. thick. The hypothallus is white, 4 mm. wide. The spores are ferruginous, 7–9 microns, reticulated only on about three-fourths of the surface. On bark, Dells, May, Kilbourn.

Fuligo varians Sommf. One specimen 25 cm. broad and 2 cm. thick was found on sawdust in icehouse, June, Mauston; common at Algoma.

Fuligo violacea Pers. The aethalium is covered with a yellowish cortex, and the spores are purple-violet. McBride, N. Am. Slime Moulds, p. 24, reports that this species occurs everywhere but probably not distinguished from the preceding. On wood, June, Algoma.

Hemiarcyria rubiformis (Pers.) Rost. On oak and poplar bark, Dells, May, Kilbourn; common at Algoma.

Leiocarpus fragilis (Dicks.) Rost. On elm leaves and decayed wood, June to September, Algoma and Mauston.

Lindbladia effusa (Ehr.) Rost. Fluno's woods, June, Mauston.

Lycogala epidendron (Buxb.) Fr. On old limbs, Ahnapee river swamp, September, Algoma.

Lycogala flavo-fuscum (Ehr.) Rost. Several large aethalia, 3–5 cm. long, which had grown the preceding summer, were collected from a maple tree on which two other somewhat rare slime moulds, *Arcyria magna* and *Reticularia lycoperdon,* had been found. This tree is thoroughly infected with several other species of fungi. March, Madison; common on oak and maple, Mauston and Algoma.

Reticularia lycoperdon (Bull.) Macb. July, Madison.

Stemonitis Morgani Pk. Schmeiling's woods, September, Algoma.

Stemonitis Smithii Macb. Mile Bluff, Mauston.

Tilmadoche virdis (Bull.) Sacc. Hale's woods, June, Mauston; Warner's grove, October, Algoma.

Trichia fallax Pers. Stony creek, October, Foscora.

Trichia favoginea (Batsch.) Pers. Shaw's woods, September, Foscora.

Tubifera ferruginosa (Batsch.) Macb. On same log with *Lindbladia effusa,* Fluno's woods, June, Mauston.

Tubifera stipitata (Berk. & Rav.) Macb. No. 417, Campus woods, June, Madison.