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TRANSACTIONS

OF THE

WISCONSIN ACADEMY

OF

Sciences, Arts, and Letters.

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THIRTEENTH ANNUAL MEETING.

FOURTEENTH ANNUAL MEETING.

TWELFTH ANNUAL MEETING.

DECEMBER 27 AND 28, 1881.

PROGRAMME.

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WEDNESDAY MORNING, DECEMBER 28, 9 o'clock.

Paper: "Land Communities among the Ancient Germans." — W. F. ALLEN, Professor of Latin and History, University of Wisconsin.

Paper: "The Number, Distribution and Function of the large Ganglion Cells of the Frog's Spinal Cord." —E. A. BIRGE, Professor of Zoology, University of Wisconsin.

Paper: "The Causes of Insanity."— A. O. WRIGHT, Secretary State Board of Charities and Reform.

Paper: "Medieval German Schools." —J. D. BUTLER, LL. D., Madison.

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WEDNESDAY AFTERNOON, 2 o'clock.

Held in Lecture Room of Natural History, No. 36, Science Hall, University of Wisconsin.

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Paper: (1) American Glacial History in the Light of Recent Investigations. (2) The Harmony of Recent Observations on Moraines, with Croll's Hypothesis of the Origin of the Glacial Epoch." — T. C. CHAMBERLIN, State Geologist, Beloit.

Paper: Proportional Representation in Legislation." — G. SCHUMM, Editor *Radical Review*.

WEDNESDAY EVENING, 7:30 o'clock.

Paper: "My Visit to the Hawaiian Volcano." — PROF. J. D. BUTLER.

Paper: "Human Liberty Empirically Considered." — PRESIDENT JOHN BASCOM, State University.

FREEDOM OF WILL EMPIRICALLY CONSIDERED.

By JOHN BASCOM, D. D. LL. D., President University of Wisconsin.

It is not our present purpose to present again the proofs of liberty in human action. These proofs are so primitive in their charater, approach so nearlythe first principles of reason, that later discussions of them between the defenders of philosophical systems do not often subserve any purpose of conviction.

The object we now have in view is a consideration of liberty as it offers itself in experience, first, in the relation of the mind to the brain; and, second, in the reaction between the powers of the mind and the products of those powers in the world about it. If we were to grant liberty theoretically, should we find its exercise possible under our present experience? This is the question we wish to answer.

It will not be amiss to remind ourselves in starting of the nature of the interests involved in this discussion of liberty. Moral facts are supreme facts in human society. The axiomatic principle on which these rest in the general mind is, Responsibility is commensurate with power. This involves at once choice as the indispensable condition of virtue. We are not considering in morals a balance of tendencies, but a balancing of tendencies — a dealing of the mind with tendencies. No adverse statement at this point has weakened the general convictions on which morality proceeds, or presented itself as more than an ingenious evasion of them. Virtue and liberty rise and fall together; whatever the one loses the other loses also.

The same relation belongs to truth and liberty. Truth is to be inquired into and sought out. It may be attained, and it may be missed. That movement of mind, therefore, which is to be occupied with this work of inquiry, must be flexible and spontaneous; must be at liberty to guide itself by the purely intellectual laws of logic. If thought is in any way subjected to forces beyond itself it can no longer shape itself freely to its own conditions. Conclusions reached under a physical necessity have nothing to do with truth. They are facts, not truths. The laws of logic are not laws in this sense, the mind must move logically; but in this sense, the mind must move logically if it is to reach the truth. The implication is that the mind may easily move illogically, and miss the truth; that it shapes its own movement to its own object; that it is free, and that truth is the reward of freedom wisely exercised.

The beauty of the world involves a like conjunction of liberty and activity, though less obviously so. Beauty is fitting thought and feelings rendered in a form wholly suitable to them. Its pursuit involves, therefore, an ideal, and a spontaneous movement toward that ideal. Impulsion and force are alien to beauty. Attraction and freedom are of its very nature.

Nor, indeed, does the plain idea of serviceabless—rendered as man always will render it—lack this notion of liberty. The world is made up of forces that may be used, and of powers in man that may use them. It is made up of the fixed and the flexible, and neither term can be lost and the serviceable process remain. State the case strictly under the forms of empirical forces, and not only do virtue, science, art disappear, use also disappears. We use things in this higher sense when we shape them to our purposes. We use air not when we breathe it spontaneously, but when we fill our air-brakes with it. We use water when we convert it into steam in our boilers, rather than when we drink it under an organic impulse. If the world, both in matter and in man, is made up of forces under settled laws of interaction, man no more uses matter than matter uses man. If we include in the natural what is causal and fixed, and in the supernatural what is free and flexible, the natural can never be in any way handled or interpreted or used without the supernatural. Whenever interpretation reaches either comprehension or use it must do so by virtue of the supernatural, and in behalf of the supernatural. To these ideas of knowledge and of service the one is as necessary as the other. The knowing and using agent is not at the same time and in the same relation a part of the thing known and used.

Human knowledge and human liberty fundamentally planted in this union of the physical and spiritual, as we here conceive them, show empirically two lines of limitation. The first of these appears in connection with the brain, the medium by which the mind receives influences, and the instrument by which it communicates energies. We may pass at once to the extreme conclusion which science is approaching, that the nervous system in man, with its great centre, the cerebrum, is constructed throughout with definite lines of inner and outer movement. Organic connections differ from mechanical ones in admitting a greater variety of offices, and allowing a freer substitution of one organ or one method for another; yet a distinct constructive purpose rules an organism as it rules a mechanism. The definiteness of the nerves and of the exterior termini of nerves in the nervous system carries with it a corresponding definiteness of offices both in them and in the great nerve-centres. Exactness in superficial relations without exactness in interior ones, would be futile, the meaningless juncture of order and disorder. The distribution and precision of the surface indicate like exact inner relations in completion of the one plan. Observation of the effects of obstruction and of disease in the brain, and of artificial irritation of its different localities, serves also to disclose explicitness of office combined with organic flexibility.

There is nothing in this which liberty may not easily accept. This dependence of the mind on the body gives strict conditions to liberty, but does not take away its first terms. The tool is an instrument to the hand; the hand is an instrument to the brain; the tool, the hand, and the brain are conjoint instruments to the mind. The workman cannot go beyond the possibilities of his tools. His circuit of liberty lies within those possibilities. The mind united to the body receives from it what we may call two sets of limitations, or two sets of powers as we choose to regard them: those which pertain, in the senses, to the ingress of knowledge, and those which pertain, in the muscular system, to its egress in action. The nervous system is the medium in each case, and the bond between the two.

The only view which at all interferes with liberty at this point is that which regards all action in consciousness as a secondary accompaniment of this interplay of stimuli and activities in an organism, and so determined in its phenomena by it. If the chief nerve-centres, more especially the cerebrum, in man are the seat of a series of interactions which take place between the inward movement and the ontward one, and are governed by them; if the phenomena of consciousness are simply the accompaniments of these complex actions and reactions in the brain, then liberty is lost, not limited, by such conditions.

The adverse reasons are many. (1) A very large share, much the largest share, of nervous interplay goes on both in the lowest and in the highest life without consciousness. Consciousness is certainly no necessary product of merely nervous interaction. (2) Consciousness regarded in this light is from beginning to end a superfluous term. If consciousness is incident to forces seeking directly their own ends, we have no more use for consciousness in living than in dead things; no more need of it in securing the muscular activities that follow thought than in the circulation of the blood, or in uniting the recognition by the eye of the characters on the printed page with the muscles of the throat in articulation. If no state of consciousness is of itself productive of subsequent states of consciousness, but all are alike dependent on underlying cerebral conditions, then each state of consciousness and the entire series of states are, in reference to physical events, supernumerary results. Between these states and these events it is impossible to affirm any correspondence which is of the nature of knowledge. (3) Consciousness has been introduced in development, on the contrary, as a new term in a higher life, incident not simply to organic relations, but one that seems greatly to extend them and put them to new service. (4) There is no known counterpart of any given thought in any given molecular changes of any nerve substance. The first and fundamental step of proof in this direction has not yet been taken.

The whole theory of correspondence has not one explicit fact to sustain it. The senses are definite in their outer conditions and inner impressions; the activities are definite in their inner conditions and outer effects; but our experience does not extend or cannot extend to any pure mental state as the exact counterpart of a physical one embraced between these two lines of ingress and egress. Arguments looking to such a conclusion are all inferences from insufficient grounds.

There are two contrasted views that we may take of the relation of the processes of pure thought to cerebral action. We may regard them as strictly incident to cerebral changes which intervene between sensation and action. This supposition implies an exact and causal connection of each specific cerebral state with a corresponding state in consciousness. The line of efficient forces is thus maintained in the physical world. Or, we may regard pure intellectual activity as a distinct term, under its own laws, which is introduced between sensor impressions and muscular actions, as the musician is an independent agent between the sheet of music that lies on the piano and the instrument itself. On this supposition the mind as mind receives impressions, correlates them in its own fashion, arrests them or passes them on in effects according to its own ends. We may, if we choose, modify this second opinion by still further supposing that there is a distinct molecular state of brain as the necessary accompaniment of each thought, but that it is secured by existing states of mind and not by antecedent sensations. This expansion of the theory, however, seems to be a weak concession to physical ideas, as no such correspondence can be proved, and the cerebral states thus accompanying pure thought would have causal connections neither with antecedent nor subsequent cerebral states, would be a dead term in the material world, and serve no known purpose in the mental one.

This intervention of mind does not imply any chasm in physical sequences, any break of relations between sensations and actions, but simply the power of the mind to penetrate, and in a great variety of ways to modify, these connections; thus heat alters physical sequences, without interrupting them. The change does not lie in the insertion of alien terms, but in the control of congenital ones.

Several empirical reasons are urged for the strict dependence of thought on cerebral states. In insanity, it is said, the mind is subverted in its action simply by disease of the brain. But this it should be under either view. The mind is dependent for its facts or supposed facts on a nervous organism, and an abnormal state of the organism may wholly alter the data of thought. The quickness, however, and accuracy with which the patient reasons from his premises are often very observable. If the sensor and active physical powers are broken down by disease, the mind on the one side loses data, and on the other side the power of expression. Aphasia, or the inability to utter or to write words, is often offered as a proof of this dependence. This fact, however, seems to look in the opposite direction, as the idea is still grasped by the mind even when it cannot control the organs of utterance.

But the experience which looks most directly to a constant and complete dependence of thought on cerebral conditions is the sense of fatigue and the waste of nerve-tissue which accompany the action of mind. This fact requires careful consideration. Under all theories the brain is the medium of impressions and expressions, and the action of the mind lies between the two. The only question is whether it lies as intervening cerebral links between cerebral states, to which connection thought is incidental; or as a relatively independent spiritual power to which no cerebral state need be set apart. In either case the action of mind involves sensor activity and motor activity, and this, too, in a much higher degree than is usually thought. It is this incipient or complete ministration of sensor and motor action of the brain to the mind that we would regard as a sufficient explanation of the fatigue of mental activity.

Things and words are the counters of mind, and without them it can make only the feeblest advances in reflection. But things involve sensor impressions, and our acts of attention, analysis, and arrangement involve sensor impressions and motor activities. The sensor and motor terms are as omnipresent in inquiry as are the two poles in an electric current. Still more if possible is this true in the use of words, the most intimate and constant means of thought. When the words of others direct us, they become sensor impressions that call for careful attention. When we ourselves guide our thoughts by words, they are either distinct motor terms or *quasi*-motor terms.

All acquisition commences with language and seeks its constant aid, and as language has a definite cerebral term involved in its use and expression, we find in this fact an occasion for a consumption of nerve-tissue in all mental action. Children, if circumstances admit the habit, prefer to study aloud; that is, to aid the comprehending process by a full use of its counters. If the habit is inconvenient, the pupil will often move his lips without emitting any sound. He still finds the incipient utterance of the accompanying words a help to the mind. Some adults are aided in understanding a book by reading it aloud. All persons observe the much greater clearness of thought which follows the utterance of one's conclusions or the writing of them. Even dreams frequently lead to talking in sleep. All these things show that it requires considerable effort on the part of the student to reduce the language which he employs in thought to its lowest terms in nascent expression.

A little attention to our mental processes will show us that language never disappears in thought, but that our most silent processes still go forward by its aid. This dependence of thought on expression is also well illustrated in the education of mutes. "Though the deaf-and-dumb prove clearly to us that a man may have human thought without being able to speak, they by no means prove that he can think without any means of physical expression. . . . Herein lies the necessity of utterance, the representation of thought. Thought is not even present to the thinker till he has set it forth out of himself. . . . The deaf-and-dumb gesticulate as they think. Laura Bridgman's fingers worked, making the initial movements for letters of the finger-alphabet, not only during her waking thoughts but even in her dreams. . . Heinicke gives a description of the results of his teaching his pupils to articulate, their delight at being able to communicate their ideas in a new way, and the increased intelligence which appeared in the expression of their faces. . . . The teachers of Laura Bridgman used, to restrain her from making inarticulate sounds, but she felt a great desire to make them, and would sometimes shut herself up and 'indulge herself in a surfeit of sounds.' But this vocal faculty of hers was chiefly exercised in giving what may be called name-sounds to persons whom she knew, and which she would make when the persons to whom she had given them came near her, or when she wanted to find them, or even when she was thinking of them. She had made as many as fifty or sixty of these name-sounds." * These cases indicate the aid which the mind immediately receives from any method of expression, and the consequent pleasure it takes in it.

Deaf mutes are accustomed, in acquiring their lessons, to spell out the results on their fingers. The training of imbeciles opens with an effort to give them a better control of their hands, their senses, and their organs of speech. Impotence, vagueness, uncertainty in these directions are the expression of kindred mental qualities. One who does not articulate words well finds difficulty in recalling them.

When a name we have forgotten is rightly articulated we recognize it at once. Language is the full realization to the mind of its own activity. We are also to bear in mind the greater fatigue which attends on thought when it receives full vocal utterance, as in oratory. The accompanying activity of the nerves and organs of articulation with the necessity of continuous and rapid expression often make the fatigue very great. This labor is also much increased if the subject discoursed on is one whose vocabulary we have not fully mastered, or if the discussion is carried on in a language with which we are not perfectly familiar.

On the other hand, an exact but familiar process, as the multiplication of large numbers, is much more trying if we

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* "Early History of Mankind," pp. 67–74.

are compelled to carry it on mentally, and are not allowed visible counters. In this case the steps are no more difficult, but the difficulty of retaining them is greatly increased. Mere reverie, in which the transitions are very loose, is restful rather than fatiguing.

It is an ultimate fact in neurology that connections once established in images or in actions, become increasingly easy and spontaneous. The power to utter words by rote, into which complete memory is constantly passing, is plainly the result of nervous and muscular training. Literary matter which has just been learned can be repeated but slowly and hesitatingly. A repetition on successive days greatly increases the facility of movement, and a repetition at distant periods very much strengthens the hold of the mind. We often render aloud lines of poetry, giving full sway to the rhythm, as a means of recalling one or more missing words. The loss of memory by disease and its restoration of health find explanation in these neural connections. More recent occurrences suffer most from this loss of recollection, and the power of memory returns by first regaining more distant events, those whose connections have been fully established in the nervous system. This method of restoration is made plain by the simple fact that memory is supplemented by vital connections in the nervous system of perceptions and of actions. A memory which easily lays hold of an idea, but retains with difficulty the precise words in which it is stated, is doubtless to be explained by diversity in the cerebral conditions of language; as much as is hesitancy in speech as contrasted with volubility. Memory is evidently much modified by the fact that it so often involves the physical condition of expression.

More than one instance of this kind has come to my knowledge. A person, awakened from a deep sleep, has recalled certain thoughts that were present to the mind, and also words that accompanied them. Giving the subject closer atention, he has been surprised to find that the words did not belong to the thoughts, but seemed to have been evoked vaguely by them. The thought-process stirred the faculties of expression without controlling them. In like manner sounds that enter the ear are distorted in dreams so as to suit the circumstances of the dream, rather than the external fact. Both of these results indicate a momentary separation between the thinking process and the organs of expression and preception which accompany and sustain it.

The hesitancy and difficulty with which the mind sometimes meets in trying to recall a word seems to lie in the feeble hold of the memory on the one side, and the inability of the mind to guide the organs of utterance on the other. The image of the written word and the sound of the word are both partially present, and both fail of perfect form. Thus one may have uttered yesterday a difficult sound, and have lost to-day the power of repeating it.

If we allow an exact correspondence between cerebral condition and pure thought, we confound the distinction between instinct and reason. Instinct is plainly characterized by a direct connection of external stimuli with appropriate actions; the transition being, however, more or less protracted, and united with the ordinary variable experiences of life. Reason, under the view now combated, would be simply an extension of instinct, whereas it manifests itself not only as a new combination of powers, but also as one that is constantly setting instinct aside and reducing it to its lowest terms.

This theory of an exact correspondence between cerebral states and rational activity makes no sufficient and no plausible provision for the growth of rational powers. Cerebral states and cerebral actions are not inexhaustible. If a distinct combination is demanded by each distinct thought, and if memory requires the preservation of these combinations, the capacity of the brain would be steadily exhausted by its development, and we should experience in reason, as we do experience in instinct, limits to mental unfolding. So small a substance as the brain cannot, in its molecular states, be the counterpart of the entire universe in all the actual and possible relations of its parts. There must be some limit to the discursus of reason if each thought appropriates a definite portion of a limited power. The theory is unreasonably complicated, and in that degree improbable. It would also imply increased difficulty in the acquisition of mental power, when the facts disclose increased ease. Nor is it any relief to this embarrassment to say that the special senses, like the eye, give the mind very complex impressions by an equally complex organic state. The image of a landscape is displaced by each succeeding image. The eye is a specialized organ that has been developed to its present power by stages of growth that date back almost to the beginning of animal life, and yet its maximum power is represented in the reproduction of a single landscape, with very great limitation of distinctness of vision beyond the immediate centre of observation. The method and degree of reproduction in the eye and the ear give no color of plausibility, but the reverse rather, to the supposition that the cerebrum has in its molecular action an exhaustless representative and retentive power both in the regions of imagination and of abstract thought.

Mathematical truth and all exact knowledge lead to the opposite conclusion. Cerebral states as physical effects can never be the precise counterparts of each other in different brains. No truth, therefore, dependent on such states could be absolute and universal. Some kind of color-blindness would sooner or later show itself in all directions.

The deductive reasons already referred to come in to confirm this conclusion of the relative independence of pure thought in an unmistakable way. No physical relation can be the equivalent of logical convictions; and no convictions can be merely physical effects. The two lines of law are not parallel, and cannot be made the counterparts of each other. The conditions of thought are not those of force.

We may then pass all strictly physical experience as indeed giving limits to liberty and sometimes limits crowding very close upon it, but limits that never abolish it as long as thought remains. We turn now to our intellectual experience in its relation to freedom.

Men start with a balance of powers and a bias of disposition which are not easily modified or resisted. This natural disposition is the result of primitive passions and tastes that are stubborn facts by no means to be wiped out by a simple choice, nor indeed altogether to be rooted out by the most faithful and continuous effort. A portion of these proclivities may be attributed to physical inheritance, and a portion to original endowment. For our present purpose we need not strive to settle the balance between them or even stop to enforce the existence of the second constituent. The position of the individual in reference to liberty is not much altered whether his first make-up comes to him by descent or by gift, or by a combination of the two. The stubbornness of these first tendencies experience clearly records. Those who have the training of children attach great importance to parentage and antecedents. Even in the earliest instruction these forces make themselves felt. The parent and the teacher are constantly aware in the same household of diversities of temperaments and tastes as fundamental considerations in discipline. It is true that much more can be done in shaping these forces early in life than later in life, but they can at no time be overlooked, and will often undo unskilful and even skilful labor in a sudden, resentful way.

It is also to be remembered that the moral inheritance of early surroundings and discipline so adds itself to, and incorporates itself with, primitive endowments as to be practically inseparable from them. By the time a young man begins to come within the range of his own personal freedom a composite stream of strong currents has him in hand. He need not lose time to inquire how he came by his inclinations, whether by native endowment, by physical inheritance, or by direct instruction; to guide and shape these energies, already realized in volume and direction, becomes his sufficient labor. The limitations of liberty are, therefore, very obvious and very great. They are allied to those of a gunner whose position and piece are given him. Said an active boy in answer to the complaints of his sluggish companion, "I do not walk so fast on purpose, I cannot help it." If we look at the limitations of liberty in reference to the immediate actions that are to follow them, we may regard freedom as not having much to do with the ordering of life. Indeed, hasty reasoners often come to this conclusion.

A restriction closely concurrent with this of primitive disposition is that of habit. We all become increasingly aware of this restraint as we advance. We are not simply hampered by physical habits, but by intellectual ones also. The lines of thought we have taken up we pursue with increasing ease, but we are at the same time more and more reluctant to accept new ones. In youth we were adepts in mathematics or quick in languages; in middle life we discover we have much narrowed these powers by disuse. We have passed the point of indifference in reference to any class of attainments, and find them all positively easy or positively hard.

The convictions we have reached, especially those touching action and character, personal, social and religious, though they themselves may have grown up in the exercise of liberty, are still limitations upon it. Especially is this true if a dogmatic spirit enters into them and we regard our opinions as finalities.

What Lanfrey says of Napoleon is capable of much wider application. He is speaking of wilfulness — which is really the want of well-ordered will — as united with very great intellectual powers. "The studied frenzy of a calculating mind is without remedy, because it does not depend on a sentiment, but on the very form of the intellect itself." This is true of all mental activity in proportion as it becomes deep and narrow. The life flows on in it as a river in a cañon, not merely beyond flexion, but for the most part beyond observation. A dogmatic intellect does not simply open before us one way, it systematically closes up all other ways. Dogmatism is a universal loss of liberty, and most of all in the inner life of the mind.

The remoteness of primary principles from the truths which flow from them leads to the same result. Most of the discussion by which the current of empirical philosophy is resisted in our day goes for little or nothing. It lies far out among marginal truths, and can find no acceptance with minds adversely disposed, and rarely leads to a fundamental renovation of thought. A boy sits upon the bank of a stream and gives his slight boat an impulse up the current; it soon returns to him, because the water flows in the opposite direction. The tidal movement of many minds is something not often comprehended, difficult to be resisted, and hard to be overcome. While the questions involved are questions of reason, the questions are very many, and the reasons very many, and are arrayed like armies. Single men or single regiments of men, can no longer wage successful war.

Another restraint which overtakes freedom in its unfolding is that which arises from the accumulating force of feelings and of social relations. It is thought that the minds of women are less open to the force of reason than those of men. So far as the assertion is true, it is largely due to the emotional energy which characterizes them. This medium of thought refracts and colors the light on all personal topics, till a presentation is insensibly reached that suits the temper of the inquirer. Light is full of all colors, and will yield them all according to our analyzing prism. Wise men find that in dealing with the foibles of others they must not expect to remove them, but rather to accommodate themselves to them. Friends that undertake thoroughly to correct each other will soon reach aversion. Refractions that belong to the very atmosphere of the mind itself must be patiently borne. It is far easier for those who see these disturbances of vision in others to endure them than for those who suffer under them without recognition to remove them.

Not only are the feelings themselves very persistent forces, all our social relations become objective provocations to them, renewing them constantly and with great energy. As we interpret society to-day we interpret it to-morrow; and it acts on us vigorously to perpetuate ruling impressions. Hence it is not our own emotional atmosphere simply, but the atmosphere of the world we live in, that is unbraiding the light for us, and casting sombre or brilliant colors on the objects about us. To these physical and intellectual restrictions are to be added secondary ones which arise from their interaction. Disease, fatigue, old age, success, failure, predispose the mind to certain judgments which are not easily cast off. The unsuccessful man becomes untrustworthy in his opinions.

We care not to trace these limitations further, but wish rather to inquire how they leave the problem of liberty. So profoundly are some minds impressed with these subtile and overwhelming influences that human liberty sinks out of all high estimate. Life seems but a painful beating of the waves of the ocean by a swimmer who must ultimately sink. Constraining forces are of the most pervasive and insinuating order; they are often nearest us when we think least of them, and bind us most when we seem to ourselves most free.

Accumulative impressions, like those now brought forward, require corresponding care in the search for compensatory considerations or they quite confound the thoughts. We are too much accustomed to think of liberty as the immediate casting off of restraint, and as efficient, therefore, in the degree in which this is accomplished. This is far from the truth. The value of liberty lies in its power to work under and with invariable and permanent forces. If liberty involved mobility simply, it would lose its possessions as fast as it gained them. The air is mobile, and for that reason its distribution of parts has little interest. We can carve nothing out of it and record nothing on it. Rocks are comparatively immobile, and immediately they become material in many forms of work, while their distribution is an important fact. If results followed on after vagrant wishes, choice would gain apparent power, but would suffer immense loss. The thing done would be as quickly undone, and the clash of choices would be as idle as the collisions of winds. Indeed, there can be but one Aladdin with his magic lamp. He alone must be left to act on things fixed and permanent for all but himself. A pair of them would subvert the world, become spirits with invulnerable bodies who could settle nothing in conflict.

The resistance which surrounding conditions offer to liberty represents the strength and tenacity of the material at the service of the mind, and is a question simply of the right degree. If the resistance is slight, the gains are slight; if the resistance is great, the labor must be great, but so also may be the results.

Now the individual and the race encounter in the exercise of freedom two lines of resistance: that offered by matter and that offered by the mind itself. The first of these is, in the strictest sense, the coherence and firmness of material. It is the office of mind, availing itself of inorganic and organic laws, to permeate matter and hold it to fixed and extended service. The most complete illustration of this is the human body, penetrated in every part with nerves of sensation and action, and so becoming not itself merely an arena of mind, but a powerful instrument of mind, operating by means of it freely in the physical world. To complete this mastery of mind over matter, to establish it as a settled intellectual dynasty, is what wise men are about in the world. Now material laws are sufficiently pliant to thought to make this labor possible, and sufficiently resistful to make the gains of infinite worth when secured. Men soon learn that mere vaporing accomplishes nothing, but they also learn that skill and patience are surprisingly effective. The stream does not flow like water, but it flows like a glacier. It can hardly be said that the physical material offered the hand of man is so intractable as to waste liberty; it has rather that degree of tractability which stores liberty.

But the second line of resistance is one of equal interest — the restraints which the laws of mind offer to mind. It has been found a universal social law, that if freedom is to grow, wisdom and virtue must grow with it. It is the same truth we are contemplating in the limitations of liberty within the mind itself. The agency slips away from the agent unless the agent masters himself also. While man is held back from the control of the physical world by laws within that world, he is equally held back by laws within himself, and the two sets of laws must be handled together and mastered together; otherwise the movement will soon find arrest. When the mind stagnates within itself its external force is lost also.

What do the limitations of freedom which we have found arising within the mind itself signify but this, that the growing points of intelligence and virtue must be carefully maintained? If these are lost, freedom is lost. The mind settles down under fixed opinions, becomes subject to an unbroken sequence of feelings, and accepts the social sentiments that prevail about it.

The one condition of freedom is to maintain unimpaired intellectual activity in all directions of action. This alters the horizon, varies the grounds of effort, breaks up and subordinates habit, and holds in arrest the aggression of other minds. The mind that ceases on any topic — for instance, on that of religion — from fresh intellectual activity has turned down the light by which it should be guided, and it is only fortunate, therefore, that it begins to fall into a calculable routine of action, that it does not go plunging on with nothing to direct it. When the buds of a tree cease to shoot the leaves may come and go for awhile with the seasons, but the constructive life is arrested. The limitations of liberty do not show the power of man to be nothing, but only that there are moments, places, and ways of its skilful application.

We are not to conceive liberty in men as a gigantic power, easily executing its purposes and holding fast results with a firm grasp. We all start under conditions alien to ourselves, organic influences, educational influences, social influences. Here is a young man brought up on a farm to hard labor, close economy, and a limited intellectual horizon. External circumstances and parental precept and example have concurred in deepening the ruts in which he is slowly moving onward. None the less it is possible that some new activity shall come to his thoughts, that he shall of a sudden say to his astonished father, on the occasion of some new exaction, "I do not think so." From that moment he may begin to break the cords that have bound him, and, in the progress of years, get to himself new incentives with a new outlook. Motives have force, not in themselves, but in relation to the mind to which they appeal. Change the mind and you change the motive. When a man thinks to some some new purpose the chains of custom drop off him. Every man, in his experience, is liable to share the astonishment of the father, when his son says to him for the first time, "I think differently." As a man thinketh so is he. Here is a pivot of revolution which no external facts can control, but upon which they in turn are dependent. If we introduce liberty in human action at this centre of thought, and leave it to extend itself by a steady modification of internal conditions, and to maintain itself by fresh acquisitions, freedom is reconcilable both with the theory of life and the facts of life, and is seen to be the one significant factor in them both.

If there is a slow accumulation of circumstances about one which hedge the way, the fact is due to the passivity of the mind in the ripening of events. If the mind is active and watchful, this infinite division of particulars, this slow gathering of difficulties are in favor of liberty. By foresight and effort the mind increases its powers of resistance and guidance. The problem of life is indefatigable will at war with unwearied forces, but forces can be divided against themselves, and enlisted on the side of will.

While spontaneity exercised in thought — and in this way productive of light — is the condition of continuous freedom, the condition of the condition is virtue, feelings that turn on and subordinate themselves to the truth. If the intellectual movement is not honest in its incipiency it shortly fails of thoroughness. It is not light alone that is the efficient constructive force in the green tissue of leaves; it is light and heat. It is not truth alone that maintains the vitality of growing points in the mind, but truth and feeling. Feelings that are alien to the facts soon alter our conception of the facts, and so the facts shake us off and escape us. We are not masters, because we have lost the true word of command.

Personal liberty is like liberty in the state. Its safe possession is one of profound obedience to deeply implanted principles. It is not, therefore, the less liberty or of less worth. On the one side the very condition of strength is a struggle with domineering tendencies, and on the other their steadfast government under new conditions. Liberty is a movement from law to law, each succeeding law being higher, broader, more inclusive, and more fortunate.

The value of liberty is that it enables the mind freely to conform to law. The liberty that does not pass instantly into law is like the seed that is not sown in the soil. It abides alone. Liberty that confines itself to its narrow field, that is content to knit skilfully together the past and the future at the one plastic point, the present, is not weak, it is well-nigh omnipotent. It only requires long times and large spaces in which to unroll its power; it merely calls for material of every order and the union of every law by which to record its work. There is no reason in any limitation of liberty why, under the laws of inheritance, man should not in time walk the earth with the bounding life of an archangel, govern it with the strength of an archangel, and take home its thoughts and feelings to the pure and serene experience of an archangel.

The one law of this progress is continuous intelligence and virtue.

THE INCREASE OF INSANITY.

By A. O. WRIGHT, Secretary of the State Board of Charities and Reform.

The United States census of 1860 showed in the state of Wisconsin 283 insane persons. The census of 1880 will show probably about 2,000. This is not an isolated fact. An increase of insanity is shown by these two enumerations in the twenty years from 1860 to 1880 in every state of our Union, and in some of them as great an increaee as in Wisconsin. Is the increase a real increase, and what are the causes of it?

I. This is not all a real increase. The census of 1880 was taken much more accurately than ever before, and this increased accuracy shows itself especially in the enumeration of the defective classes. The United States deputy marshals were sometimes careless in counting the numbers of population, and much more careless in gathering such special statistics as those of the defective classes. Their sins were generally of omission rather than commission, and therefore the more accurate methods of the last census caused an apparent increase in the number of the insane, as of all the defective classes. Thus this census will show in Massachusetts one insane person to every 338 of the population instead of one to 350 as before supposed.

II. An apparent increase of insanity is caused by the wider definitions of insanity given nowadays by physicians in charge of insane hospitals. A wide range of diseases of the brain and of mental and moral perversions is now called insanity, which formerly would have been called nervousness, or eccentricity, or wickedness, as the case might be. Consistently with this theory an expert witness lately testified in the Guiteau trial that one in five persons on the average are insane. The effect of these teachings has been to cause many persons now to be considered insane who formerly would not have been so considered. The disease or the mental or moral perversion would have been there, but it would not have been called insanity. The increase of insanity from this cause is like the astonishing increase of some cities, made on paper by taking in outlying suburbs.

III. A very large apparent increase of insanity has been made by the better care now taken of the insane than formerly. The barbarous treatment of the insane which lasted as the rule in Wisconsin down to about 1860, when the State Hospital was fairly opened, and after that in most jails and poorhouses until after the State Board of Charities and Reform began their work of improvement of those institutions in 1870, and which is still found in a few places in this state to-day, tended to greatly shorten the lives of the insane. Living in filth and squalor, chilled by frost and scorched with heat, given too little food and drink, shut in dark, damp dungeons away from the healing beams of the sun, they died rapidly. Now, under humane treatment, with proper food, warmth, exercise and fresh air, the chronic insane live at least as long as the average of mankind. There is little in the mental disease itself to destroy life, and people cared for according to the laws of health in hospitals and county asylums are less liable to disease and death than those who are free to neglect their health outside of insane asylums. Now this process of preserving the lives of the insane has been going on in this state for the last twenty years with the inevitable result of increasing the number of the insane. For while as many have been becoming insane as ever, fewer have been dying cff, and thus the number insane alive at any given time is growing greater.

IV. Another cause of the increase of insanity is the increase of population. Wisconsin has increased from 775,000 in 1860 to 1,315,000 in 1880. While the population has nearly doubled it is not wonderful that the number of insane should increase also.

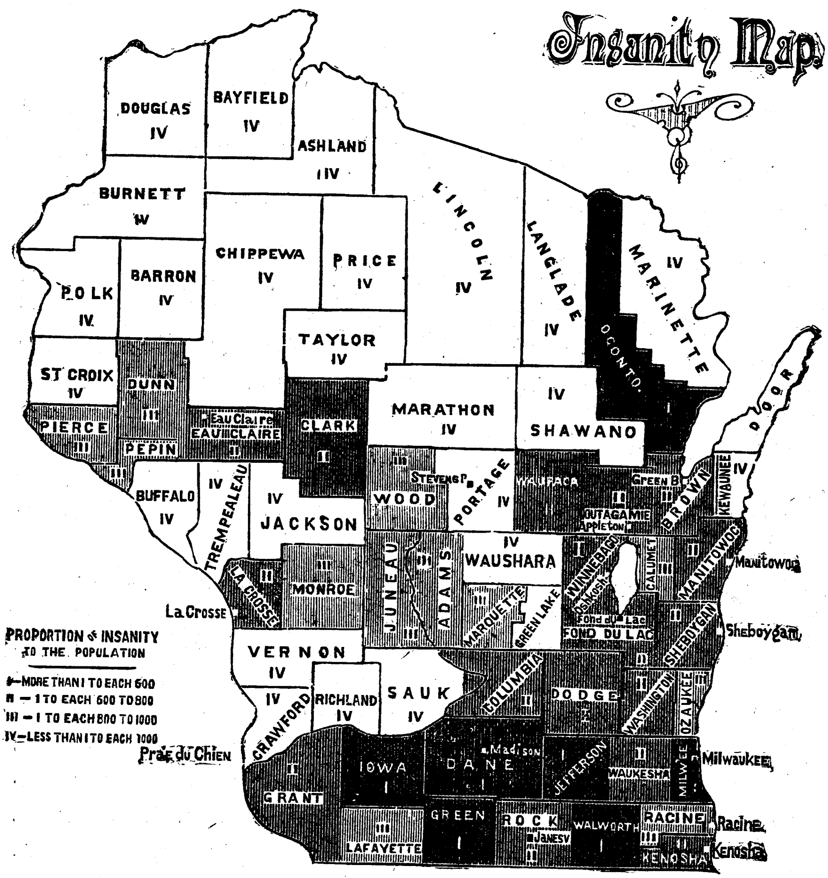
V. An important cause of the increase of insanity in this state is that Wisconsin is passing from a new state to an old settled state. The first generation of pioneers who settled the southern part of the state are passing away. When they came here, they were usually people of vigorous health and in the prime of life. Like most settlers of a new country they left their defective classes behind them. There were few insane among the immigrants who came first or among those who have followed them since from the eastern states or from foreign lands. The cases of insanity we have had have mostly been produced upon our own soil. Now, bearing in mind the great part that heredity has in producing insanity, it is plain that a body of immigrants selected for healthfulness of body and mind, as nearly all immigrants are, will have less insanity for several generations than the people of an old settled country. The ratio of insanity to the population will show this. The census of 1860 shows insanity in the ratio of one insane person to every 2,740 of the population. A census which I have recently taken of the insane under public care which is at least as imperfect as that was, because it gives only those under public care, and not those cared for at home, gives a ratio of one insane person to every 743 of the population. This shows a sufficiently rapid increase in the ratio of insanity. But the same census when shown by counties as in the subjoined table, and illustrated by the map which I have prepared, shows very clearly that the increase in the ratio of insanity has been in the older settled counties. Thus the same law is at work within the state as between the counties which is at work upon the state at large.

When the results of the United States census of 1880 in regard to the insane are published, there will probably be about 2,000 insane shown to be in the state or one to every 656 of the population.

Of the five causes for the apparent or real increase of insanity, we may suppose that hereafter we shall have as accurate returns of insanity as the nature of the subject admits of. While it is questionable whether certain persons are insane or not, no one can count the insane with entire accuracy; but they will be hereafter counted as accurately as possible. The second cause in the wider definitions of insanity has gone about as far as it is likely to go in increasing the number of the insane. If anything, there is likely to be a reaction as the result of Guiteau's trial, and of other causes, to narrow somewhat the definition of insanity and thus slightly reduce the number of those called insane. The increase of insanity caused by the more humane treatment and therefore longer lives, is, we may trust, a permanent increase. Rather than resort to the old, barbarous methods, it would be far better to give these poor creatures the euthanasia afforded by an overdose of laudanum. If they are to be killed off, let it at least be done without unnecessary cruelty. But though the increase in the number of insane from this cause is doubtless a permanent one, it will not be as rapid in the future as in the past.

When the expectation of life among the insane has once been permanently lengthened by more humane modes of treating them, they will not continue to accumulate forever, but will die off as before, only at a greater age. We have not yet reached the end of this change for the better in the treatment of the insane. But when we have done so, then this source of increase will soon cease. The increase of population in our state will doubtless go on, but at a slower rate, and with it necessarily that increase in the total number of insane which goes with it. The increase of insanity, which arises from our state becoming an old settled state, will of course keep on until we attain our fair average.

What that average is becomes then an interesting question. In Massachusetts, as I learn from Mr. F. B. Sanborn, who has charge of that subject there, the rate of insane to the population is about one to 338. In Scotland it is about one to 290. If we assume that we shall reach the ratio of one to 500 under public care in twenty years more, and shall have a population then of 1,600,000, both low estimates, we must expect in 1900 to provide for at least 3,200 insane persons.



If supported in state institutions at anywhere near the rates these institutions now cost, the charge to the public will be at least $640,000 annually, besides $3,000,000 for buildings, a burden which the state will find it difficult to bear. This whole question is one which is now pressing on us for solution and which deserves the attention of every philanthropist and every statesman.

TABLE SHOWING INSANITY IN WISCONSIN BY COUNTIES, 1884.

Counties.	Total insane under public care.	Ratio to population: one to each.	Counties.	Total insane under public care.	Ratio to population: one to each.
Adams	8	825	Marathon	8	2,140
Ashland	0	....	Marinette	5	1,786
Barron	4	1,756	Marquette	9	990
Bayfield	1	564	Milwaukee	240	572
Brown	44	775	Monroe	21	1,029
Buffalo	5	3,106	Oconto	18	547
Burnett	3	1,047	Outagamie	42	684
Calumet	17	978	Ozaukeee	19	814
Chippewa	11	1,408	Pepin	7	889
Clark	14	765	Pierce	21	845
Columbia	40	700	Polk	9	1,112
Crawford	11	1,422	Portage	14	1,266
Dane	89	598	Price	0	....
Dodge	67	685	Racine	37	836
Door	11	1,059	Richland	11	1,652
Douglass	1	655	Rock	53	733
Dunn	20	841	St. Croix	13	1,458
Eau Claire	26	769	Sauk	25	1,149
Fond du Lac	78	660	Shawano	9	1,152
Grant	59	641	Sheboygan	54	633
Green	37	587	Taylor	1	2,311
Green Lake	12	1,207	Trempealeau	15	1,148
Iowa	41	576	Vernon	23	1,010
Jackson	13	1,020	Walworth	50	525
Jefferson	58	554	Washington	37	634
Juneau	16	974	Waukesha	46	629
Kenosha	21	644	Waupaca	29	723
Kewaunee	12	1,316	Waushara	9	1,410
La Crosse	37	732	Winnebago	54	751
La Fayette	25	851	Wood	10	898
Langlade	0	....	State at large	47	....
Lincoln	1	2,011			
Manitowoc	62	605	Total	1,773	743

THE INCREASE OF INSANITY.

SECOND PAPER. 1882.

By A. O. Wright, Secretary State Board of Charities and Reform.

Last year I presented to the Academy a paper upon the increase of insanity in this state, in which I gave a census of the insane under public care, by counties, the first ever made in the state, showing that we had then 1,773 insane persons under public care or one to every 742 persons in the state, and predicted that we should probably reach the number of 3,200 insane in the state by the close of this century.

I have completed another census of the insane under public care, and am able to give statistics for this year. There were on September 30, 1882, under public care in this state, 1,913 insane persons. This is an increase of 140 over last year. If the same increase occurs for the next eighteen years, or until 1900, we shall have about 5,000 insane persons at that time under public care.

On the supposition that we shall have about 1,600,000 population at the close of the century, that would be one insane person to every 320 of the population, or not far from the proportion of Massachusetts.

But it is not likely that the increase during the whole period will be so rapid, or the number of insane at the end of the century so great as these figures seem to show. In all probability insanity will continue to increase until eventually we reach the ratio of Massachusetts or even of Scotland, one to 290. But this increase will be by a continually retarded ratio. As the number of the insane increases, the rate of increase will grow less, until some fixed ratio is reached, from which the variations will be slight and temporary, as long as the conditions of society remain the same.

The increase, or in some cases, decrease, of insane by counties, is shown by the following table:

The counties which have had the largest increase are:

Milwaukee	27	Chippewa	7
Winnebago	14	Columbia	7
Green	11	Trempealeau	7
Brown	9	Buffalo	6
Sheboygan	9	Calumet	6
St. Croix	8	Iowa	6
Waukesha	8		

The counties which have had a decrease of insane under public care, are:

La Crosse	6	Washington	3
Manitowoc	5	Pierce	2
Racine	4	Eau Claire	2
Clark	3	Green Lake	2
Dane	3	Pepin	2
Dodge	3	Kenosha	1
Door	3	Wood	1
Fond du Lac	3		

The decrease in the insane under public care may come from three different sources: The insane may recover, or at least improve so much as to be discharged from public care; they may die; or they may be returned as chronic insane from the state institutions to the counties, and in consequence of the counties having no adequate provision for them they may be left under private care by their relatives. Decrease, of course, occurred from all these causes, and in the counties just named the decrease from these causes was greater than the increase from new cases of insanity, or from old cases placed under public care. From the fact that none of the counties have had during the past year adequate accommodations for the chronic insane, though some of them are preparing such accommodations, I think it is fair to conclude that in most of the counties this decrease is not a real decrease of the insane, by death or recovery, but only an apparent decrease, caused by sending chronic insane back from state institutions to the care of their relatives.

If this is the case, we shall see another year a considerable increase in the number of insane under public care, owing to the increased accommodations which will be provided in the new county asylums.

I am unable to find any law governing the distribution of insanity in this state, except the one I gave last year, that the older settled portions of the state have a greater population of insanity than the newer portions. I cannot find that the proportion of native or foreign-born persons seems to affect the proportion of insanity, or that any other of the causes so frequently alleged to be the chief factor in producing insanity, has any considerable influence upon the geographical distribution of insanity in the state.

NOTE: The delay in the publication of the proceedings gives me opportunity to give the numbers of the insane under public care on September 30, 1883. The three years show as follows:

Number of insane under public care in 1881	1,773
Number of insane under public care in 1882	1,913
Number of insane under public care in 1883	2,075
Net increase from 1881 to 1882	140
Net increase from 1882 to 1883	162

As was predicted above, the increased accommodations for the insane provided by the new county asylums, opened in the year 1883, have caused an apparent increase of insanity in addition to the real increase. The real increase, however, has been large.

THE PRIMITIVE DEMOCRACY OF THE GERMANS.*

By W. F. ALLEN, Professor of Latin and History, University of Wisconsin.

The political institutions of the ancient Germans, as described by Tacitus, are of an essentially democratic character. Some of their nations have kings, but royalty is not a necessary part of their constitution, for many nations have no king, and where there is one, he is not invested with any very positive or absolute powers.† Nobles are frequently mentioned, but special privileges or powers are never ascribed to the nobility, and, so far as appears from the in-

*This paper is composed of two papers; one, upon the village community system, read at the meeting of the Academy in 1881; the other at the meeting in 1883. Being properly supplementary to one another, they have been united, and the discussion of both papers brought down to the date of publication.

† *Nec regibus libera aut infinita potestas* Tac. Germ. 7.

formation in our possession, it was a social rather than a political aristocracy. There are serfs, but we are absolutely without information as to their origin or their relative numbers — whether they are Germans, who have sunk from a condition of freedom, or the remnants of a conquered race; whether they are few or many. We cannot, of course, expect to find organized government of the modern type, or any precise definition of powers; but so far as we are warranted in any positive conclusion upon the subject, we may say that the sovereign power was in the hands of the whole people, acting collectively, meeting in a general assembly at stated intervals. (Tac. Germ. 11–12.) The people, in their family organizations, also compose the army; * from a comparison of Tacitus with Cæsar,† an earlier writer, we have a right to infer that these same family organizations live in common occupation of independent districts of land. There are magistrates, holding their office it would seem for life, elected by the people in their national assembly, and acting as a board of administration in the intervals between the meetings of assembly,‡ but also having each his own district where he presides over the adminstration of justice. ‖ From other authorities we know that in this district administration of justice the magistrates only preside; the verdict is rendered by the people of the district in an assembly of the district.

This is a thoroughly republican constitution of society, and this sketch, which rests in every detail upon positive statements of Tacitus, supplemented in only two instances by evidence from other but equally unimpeachable authority, justifies us in the statement that the political institutions of

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* *Non casus nec fortuita conglobatio turmam aut cuneum facit, sed familiae et propinquitates.* (Tac. Germ. 7.)

† *Magistratus ac principes in annos singulos gentibus cognationibusque hominum quantum et quo loco visum est agri attribuunt.* B. G. vi. 22.

‡ *De minoribus rebus principes consultant, de majoribus omnes,* Tac. Germ. 11.

‖ *Principes qui jura per pagos vicosque reddunt.* id. 12.—*Principes regionum atque pagorum inter suos jus dicunt controversiasque minuunt.* Cæs. B. G. vi. 23.

the primitive Germans were essentially democratic. This is also the conclusion at which we should arrive by the analogy of other primitive peoples, especially those of the Indo-European family. Most of them established a kingly office, most of them had slaves, or serfs, or imperfectly qualified citizens to whom they stood in the relation of a ruling aristocracy; but as a rule all authority is regarded as emanating from the body of the citizens.

There was, however, an institution of the Germans, not inconsistent in its original character with the democratic theory of their institutions, which, nevertheless, must have interfered materially with the democratic working of these institutions, and which in the end effected a complete revolution in them of a strongly aristocratic character. This was the so-called *comitatus,* the body of personal followers. It appears to have been of relatively recent origin, for as Cæsar describes it,* it was quite imperfectly developed, consisting simply in the custom of voluntary leaders in times of war, around whom gathered a group of voluntary followers, the relation apparently continuing only for the period of the war. In the time of Tacitus, one hundred and fifty years later, it has been converted from a *custom* into an *institution;* the relation is a permanent one. The followers live at the expense of their chief in peace as well as war.† There are grades in dignity among them, and the several chiefs emulously rival one another in the number and prowess of their followers.‡

Both Cæsar and Tacitus use the word *princeps,* "chief," to designate the leader of the *comitatus,* and this is the same word which is used by both writers to designate also the permanent magistrates who have been already described. The question has naturally arisen, and has been debated with

* *Ubi quis ex principibus in concilio dixit se ducem fore, qui sequi velint profiteantur, consurgunt ii, etc.* Cæs. B. G. vi. 23.

† *Epulae et quamquam incompti largi tamen apparatus pro stipendiis cedunt.* Tac. Germ. 14.

‡ *Gradus quin etiam et ipse comitatus habet judicio ejus quem sectantur; magnaque et comitum aemulatio, quibus primus apud principem suum locus, et principum cui plurimi et acerrimi comites.* Id. 13.

considerable warmth, whether the right of entertaining a *comitatus* was confined to the magistrates or chiefs of the state. Some have held that any person who chose might gather about him a body of followers; others, on the other hand, have taken *principes* in this relation to mean "nobles," and have regarded the right as a privilege of nobility. I have already said that neither Cæsar nor Tacitus ascribes any political privileges to the nobility, which appears, therefore, to have been a purely social distinction; and this statement is correct, if we take only the terms *nobiles* or *proceres* to mean "nobles," they being the words regularly used in this sense. The word *principes*, on the other hand, does not properly mean "nobles," but "chiefs" — individuals invested with certain governmental powers. It is purely begging the question to assume that, in relation to the *comitatus* it is used in a different sense from its usual one. But the connection in which the word is used is conclusive upon this point. Both the writers in question speak of the *principes* as magistrates before speaking of them as leaders of the *comitatus;* and in Tacitus the passages follow close upon one another with no interruption. He passes directly from the election and the judicial functions of the *principes* to the description of the *comitatus;* the conclusion is irresistible that the *principes* who maintain the *comitatus* are the same as those who administer the government of the state and preside over the judicial assemblies of the districts.

It will be readily seen that an institution like this, which, as Tacitus says, had a direct interest in war,* must have had a powerful influence in converting a peaceful community of peasants into the turbulent and quarrelsome nation of warriors who invaded and overthrew the Roman empire. But our immediate connection is with the constitutional change which it effected. We see a body of elected magistrates (to use a modern term) holding their office for life, and therefore, virtually irresponsible, administering the government in the intervals between the assemblies, having the administration of justice wholly under their direction and

* *Magnum comitatum non nisi vi belloque tueare.* Germ. 14.

gathering about them a body of armed retainers, whom they support in peace as well as in war, but whose interests are wholly in war. The elected magistrates are to all intents and purposes converted into barons, holding their fellow-countrymen in control by armed force. Moreover, although there is no indication and no likelihood that nobility of birth was a necessary qualification for the office of *princeps,* it was natural that an office of so much power would be filled almost exclusively from the wealthy and distinguished members of the nobility. The *principes* were not nobles as a class, or by any necessity; but as individuals they must in almost every instance have been of noble birth.

We are able, in the light of this condition of things, to interpret the single passage which has appeared to identify the *principes* with the nobles: Tacitus Annals, i. 55, where it is said that Segestes, the friend of the Romans, urged the Roman general Varus, in view of the impending revolt of his countrymen, to put in custody both himself, his rival Arminius, and the rest of the nobles — the common people would venture upon no movement when they had lost their chiefs.*

The *principes* and the *proceres,* in their origin wholly different — the one elected magistrates, the other a social aristocracy — became identified with each other; the office of *princeps* would tend to become hereditary, and the social aristocracy was gradually converted into a political aristocracy.

The primitive and fundamental democracy of the Germans was, therefore, in the time of Tacitus, confronted by a wealthy and powerful official aristocracy, the forerunner of the feudal nobility. By the side of the national army, the organic divisions of which were formed by groups of kindred, there appeared the bands of military followers, fighting under the leadership of their personal chief, who at the same time, in his official capacity, must have commanded also the national host. By the side of the primitive communities of free tribesmen, also composed of family groups, there appeared the baronial residences of the chiefs,

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* *Ut se et Arminium et ceteros proceres vinciret: nihil ausuram plebem principibus amotis.*

like feudal castles among the villages of peasants. Both of these systems, the democratic and the aristocratic, are clearly described in the Germania of Tacitus, the work in which he treats of their institutions from an antiquarian point of view. In his historical works, where the Germans are introduced, we see clearly the aristocracy as the preponderating force. The same appears also in native pictures of Germanic life, like the poem of Beowulf and the Icelandic sagas.

In two books published within the past year by Mr. Frederic Seebohm,* an eminent English writer, and Mr. D. W. Ross,† of Cambridge, Mass., these baronial — or, as Mr. Seebohm prefers to call them, manorial — features of the primitive Germanic constitution are sketched with great learning and cogency. Other writers have emphasized the aristocratic features of this constitution, but to Mr. Seebohm, approaching the subject from an economic rather than a historical point of view, belongs the credit of having first pointed out that the German institutions were working themselves out upon "manorial lines." But, just as the generally accepted democratic theory undervalues the aristocratic elements of German society, so Mr. Seebohm appears to undervalue its democratic elements. To him the German institutions appear to have been fundamentally aristocratic, while the sketch given above represents the aristocratic features as a relatively late outgrowth.

The argument of Mr. Seebohm and Mr. Ross, is founded principally upon a passage in the Germania of Tacitus (Chap. 16), which we will now proceed to consider. It is as follows: "They dwell separate and scattered, as a fountain, a plain, or a grove catches their fancy. They build their villages, not like ours, with houses touching one another, but each house has a space about it."‡ Here are two modes of habitation described — that of villages, and that of iso-

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* English Village Communities. London. Longmans & Co.

† Early History of Land-holding Among the Germans. Boston. Soule & Bugbee.

‡ *Colunt discreti ac diversi, ut fons, ut campus, ut nemus placuit. Vicos locant non in nostrum morem conexis et cohaerentibus aedificis; suam quisque domum spatio circumdat.*

lated homesteads. The passage, like most passages in ancient works, has been variously interpreted; the interpretation of Mr. Seebohm and Mr. Ross is, that the method first described is that followed by the free tribesmen, and that the villages are of their serfs. This very ingenious theory leaves the democratic features of the German institutions wholly out of account. It represents the free tribesmen as petty barons, each with his village of serfs, and of necessity assumes the free tribesmen to have been a relatively small number of nobles ruling over a large conquered or subject population. It explains half the facts in the case, but leaves the other half unaccounted for, — and this not only in the antiquarian statements of the Germania, but also in the incidental mention in the historians, poets and writers of sagas. For while, as has been already remarked, the aristocratic character appears very strongly in these works, it is no less apparent that the free tribesmen are a numerous, homogeneous body, inferior in wealth and influence, but equally qualified members of the state.

Again, the language of Tacitus does not warrant any so broad contrast between the dwellers in the isolated homesteads, and those in the villages. Mr. Seebohm remarks, (p. 339), that "It is obvious that the Germans who chose to live scattered about the country sides, as spring, plain or grove attracted them, were not the villagers who had spaces round their houses." This we may admit; but when he adds: "We are left to conclude that the first class were the chiefs and the free tribesmen, . . . while the latter, the villagers, must chiefly have been their servile dependents," the inference is not so clear. It would seem that if Tacitus had meant to distinguish not individuals but classes, and especially if he had meant that the one class were chiefs and the other their servile dependents, he would have said so in plain terms. The two kinds of residence are so coupled together, that the only natural inference is that they were alike the residences of the free Germans of whom he is speaking. They are his subject throughout the early part of his work; it is not until he is nearly through with speaking of them, in the 25th chapter—eight chapters later than the passage under discussion—that he mentions the serfs.

We must conclude, therefore, that the free tribesmen lived in villages as well as in isolated homesteads; and this conclusion is supported by the incidental mention of villages in other relations: for example, in the first book of the Annals, chapter 56, in an invasion of the German territory by Germanicus, Tacitus says that the Germans scattered into the woods, leaving their districts and villages, *amissis pagis vicisque*. If then, some of the free Germans inhabited villages, while others inhabited isolated homesteads; if, further, some of the free Germans fought in companies by family groups, while others followed personal chieftains; and if these personal chieftains were at the same time really noblemen and public officers, it seems probable that it was these chieftains who lived in isolated homesteads, surrounded by their free retainers and their serfs—just as is assumed by Mr. Seebohm and Mr. Ross—while the common freemen, a class ignored by their theory, lived in other villages.

Assuming, then, that the common freemen of the Germans lived in villages, the question arises, what kind of villages were they, and what was the nature of their occupation? In other words, are we warranted in assuming the existence of free village communities among the Germans of Cæsar and Tacitus, as is done by many modern writers. The evidence as to this point is very scanty, being confined to a few isolated statements of these writers, but it is, I think, sufficient to warrant a positive conclusion, partly affirmative, partly negative.

We must begin by defining our terms. The village community is a group of persons occupying a tract of land, which they own and cultivate in common. For the purpose of this common cultivation they must have their residences near together, in a village, from which the arable lands, the meadows, pasture and wood land will be equally accessible to all. The view of the German writers, Von Maurer, Thudichum and others, who have worked up the theory of village communities, is that some communities, *Markgenossenschaften* had such villages, and others not. It is only those that had them that formed *Dorfgenossenschaften* or village communities proper; and they hold that this was the prevalent form of the occupation of land in the countries occupied by Germanic nations in the early middle ages. The land being owned in common, all members of the community were, originally at least, equal partners; a democratic structure of society is therefore necessarily taken for granted by the theory.

As time went on, individual property in land came into existence. The lands were divided up — the lots occupied by individual marksmen became their property; first the house-lot, then the strip of arable land, became the subject of individual ownership, and when this had taken place, the entire aggregate belonging to one member of the community — house-lot. share of arable land, and right to the pasture, forest, etc. — was called in English, *hide*. Every member, therefore, of the primitive democracy, had an equal property at the outset. The irregularities in wealth and station were the outgrowth of the natural workings of competitive relations in the more advanced state of society.

The question of village communities is essentially a question of the occupation of land, and its theory stands in the closest connection with the history of the origin of the feudal tenure of land. It necessarily involves, moreover, the discussion of another subject, which may be treated independently in other historical epochs, but which in the early history of institutions is inextricably connected with that of land — the structure of society. The reason of this is that, whereas in modern society the state, or political organization, starts with a given territory, and embraces all occupants of that territory; in ancient society it was exactly the reverse. The tribe or nation was the starting point, a given body of persons; and the state — if we may use this expression for this period — comprised whatever territory was occupied by these persons. We see survivals of this primitive condition of things in the tribal organization of our North American Indians. Although occupants of part of the territory comprised within the limits of the United States, they are, nevertheless, not recognized as belonging to that nation, for the reason that they keep up their tribal organization, with a *quasi* authority over the lands assigned to them by the national government.

The structure of society forms, therefore, the first subject of inquiry in the history of early institutions. And here we notice a still more fundamental contrast with modern society. Modern society, at least here in the United States, has no structure at all beyond the loose institution of the *family;* apart from these petty communities our society is composed simply of individuals with no organic connection with one another, except such as grows out of political relations or private association. But all early societies are highly organized and closely coherent. The man does not exist except as a member of an organization. Any person who stands outside of the organization is in the strictest sense of the term an outlaw. The structure of society must, therefore, be sought first, and the land system will necessarily be an outgrowth of that.

I will first examine the earliest writer, Cæsar, by himself, then see how far the statements of Tacitus agree with those of Cæsar, and what system of society and land tenure may be assumed for both periods.

It has become a common place of political history that early society was founded upon the Family; or, if we go back to the rudest beginnings, where the Family as an institution did not exist, upon Kinship. That this was the case among the ancient Germans, and that the occupation of the land was based upon the family, is testified to in the most positive manner by Cæsar (B. G. vi. 22), where he says that the lands are assigned by the magistrates to the several clans and kindreds of men (*gentibus cognationibusque hominum*). This assignment, he adds, is made for a year at a time (*in annos singulos*), and that it is made at a public gathering, appears to follow from the words *qui una coierunt*, "who have assembled together," where the relative must refer to *hominum*, "men." Among the reasons mentioned for this custom of annual division is the significant one that thus they are able to maintain an equality of possessions (*cum suas quisque opes cum potentissimis aequari videat*, "each one of the community seeing his own possessions equal to those of the most powerful"). This fact is further emphasized by the statement that no one has land of his own (*neque quisquam agri modum certum aut fines habet proprios*); and he adds that this annual shifting is imperative and under the direction of the government (*anno post alio transire cogunt*). These last statements are found also in the description of the Suevi (iv. 1); *privati ac separati agri apud eos nihil est, neque longius anno remanere uno in loco incolendi causa licet.* "There is among them no private and individual land, nor are they allowed to remain longer than a year in one place for the purpose of habitation."

In these few clear and positive statements Cæsar gives us the materials for determining precisely the stage of social progress reached by the Germans of his time. They were still in the patriarchal stage, in which kinship rather than territory formed the basis of their organization; but they had passed beyond the stage of nomadic life. The individual had no permanent home, neither had the family, but the nation had. More than this, it would appear that there were already certain fixed and determinate territorial divisions of the territory of the nation, for the assignments of land are made with absolute authority by the magistrates, who assign lands and compel the annual changes; and these magistrates, as we learn from Chap. 23, have authority over territorial districts (*principes regionum atque pagorum*). From this we may infer that the shiftings of occupation were made rigidly under the direction of the magistrates, and within the limits of definite territorial districts. Thus Horace (Od. iii, 24, 12) says of the Getæ, a Germanic people:

Immetata quibus jugera liberas
Fruges et Cererem ferunt.
Nec cultura placet longior annua,
Defunctumque laboribus
Æquali recreat sorte vicarius.

Here are clearly indicated the shifting annual occupation, and the lack of any permanent boundaries to the cultivated fields — no ownership, but temporary occupation and use; perhaps also the alternation of agriculture and service in the field, described by Cæsar, B. G., iv. 1. *Singula millia* *armatorum bellandi causa ex finibus educunt. Reliqui qui domi manserunt se atque illos alunt. Hi rursus in vicem anno post in armis sunt, illi domi remanent.*

Passing now to the account given by Tacitus, who lived about one hundred and fifty years later, we find that his description partly confirms and partly supplements that of Cæsar; that it nowhere contradicts it, but in some points shows the changes which might reasonably be expected to take place in the course of a century and a half, among a semi-barbarous, but vigorous and intelligent people, in direct contact and constant intercourse with a highly civilized nation.

As to the structure of society, Tacitus testifies, just as Cæsar does, to the persistence of the family principle; only he mentions it in connection with the military organization, instead of the occupation of land (Germ. ch. 7.); *non casus nec fortuita conglobatio turmam aut cuneum facit, sed familiae et propinquitates.* "Their divisions of cavalry and infantry are not made up by chance or accidental assembling, but by families and neighborhoods"— the same patriarchal groups no doubt, which are described by Cæsar's *gentibus cognationibusque.* The two statements naturally form the complement to each other; if patriarchal groups lived together as Cæsar says, they naturally formed military divisions together, as Tacitus says.

Tacitus does not tell us that the patriarchal groups lived together, but it may be inferred that this was the case, from the fact that they fought side by side. When he takes up the subject of the occupation of land (Chap. 26), he merely speaks of the land being occupied by communities, *ab universis.* The passage is so important and so difficult to interpret, that I will cite it at length: *Agri pro numero cultorum ab universis in vices occupantur, quos mox inter se secundum dignationem partiuntur; facilitatem partiundi camporum spatia prœstant. Arva per annos mutant, et superest ager.* "It is their practice to have their lands taken into possession by communities, turn by turn, in amounts proportioned to the numbers of their members, and afterwards to share these out among the members according to rank; the wide extent of the tracts occupied makes this division easy. They change the fields in cultivation every year, and there is land left over."

Here we have, just as in Cæsar's description, a periodical shifting of occupation, and this is the only feature of the two descriptions which we identify positively. For the reasons already given, we may infer that these communities, like those of Cæsar's time, were patriarchal, at least prevailingly so; but the distribution was probably no longer a yearly one. It will be noticed that two distinct procedures are described — the shifting occupation (*agri . . . occupantur*) and the shifting cultivation (*arva per annos mutant*). It is hardly possible that there could have been any shifting cultivation, that is, rotation of crops, unless the occupation was for more than one year. I think, therefore, that although not explicitly stated, it is distinctly implied, that the assignment of lands was made for a period of years, as is the case with the Russian *Mir* and the Hebrew seven-years' period. This points to a marked progress of society in the period between Cæsar and Tacitus.

In another point this progress is more positively asserted We have seen that in Cæsar's time there was not only no private property in land, but no disparity in property or in occupation. Tacitus, on the other hand, states with equal positiveness that the lands were assigned according to rank, *secundum dignationem*, that is, there was still no private property in land, but the amount of land temporarily assigned to individuals varied according to their rank. This disparity probably had reference only to the nobles and magistrates; the most of the common freemen in all likelihood received equal lots. And when, at the end of the period, the community was transferred to another tract of land, the process was begun over again. There could therefore be no aggregations of landed property, but there was a condition of things out of which such aggregations might easily grow, as soon as the occupation of a definite tract of land by a particular community should become permanent.

We find from this analysis, that in the first century after Christ, the Germans were grouped in family communities, not yet established in permanent homes, but probably changing their residences at intervals of some years, although always within a definite territorial district. This district was, as we learn from the same authority, a permanent political institution. It follows as a matter of course that at this period there was not only no private property in land, but no common property in land, that is, no property in land at all. Neither the community nor the family *owned* the land or occupied it personally, any more than the individual. It might perhaps be urged that the district owned the territory within which the shifting occupation took place, but it may be doubted whether even this would be a correct statement of the facts. Property in land was probably a conception which lay wholly outside of their imagination as well as their experience. The land, like the air, was a free gift of nature, to be used in common, but with no thought of ownership.

As the theory of the village community implies not merely permanent occupation, but ownership of the land, on the part of the group of occupants, our conclusion must be that the village community did not exist in the time of Tacitus. Nevertheless, it must be admitted, on the other hand, that the condition of things here described is one out of which the village community could very easily have arisen. In the fact that the distribution was periodical instead of annual, we see a movement towards permanence of occupation, and therefore towards ownership, on the part of the community. The time would very soon come, in the progress of society, when the community would have accumulated so much fixed wealth in the course of its occupation, that it would be a hardship and an injustice to force it to change its habitation. The next change therefore — hardly a greater change than that from annual to periodical re-distribution — would be to convert the temporary occupancy into permanent occupancy, which means property. If this stage was reached — and it is hard to conceive of its not being reached, at least as a temporary condition of things — there resulted to village community: that is, the ownership in common of a definite tract of land by a group of persons who were in their origin an enlarged family.

By the side of the movement towards permanency of occupation, we saw another, towards inequality of possession. The important testimony of Tacitus shows that already in his time there was, not individual property in land, or inequality of ownership, but inequality of station and of temporary occupation. Out of this would speedily be developed the inequality of property which the theory of village communities recognizes as one of the causes of the dissolution of the institution. And thus we find confirmed, from the point of view of the occupation of land, the conclusion drawn from the evidence of political and military institutions, of the development of an aristocracy of a baronial type; or, in Mr. Seebohm's words, of development on manorial lines.

NOTES ON THE DISPERSION OF DRIFT COPPER.

By Prof. R. D. Salisbury, Beloit, Wis.

Although the fact of its wide distribution has long been known, and used as evidence of the northern origin of our drift, yet no general recent compilation of the known data relating to the dispersion of drift copper seems to have been made. The study now entered upon has been undertaken at the suggestion of Prof. Chamberlin. The present paper is little more than a collection of what is to be found bearing on the subject in survey reports and scientific contributions. Frequent reference is made in geological literature to the fact that native copper has been found, and that quite generally, scattered throughout the drift region of the interior, viz.: Ohio, Indiana, Illinois, Missouri, Iowa, Michigan, Wisconsin and Minnesota, and perhaps Nebraska and Dakota. But the particulars of its occurrence, e. g., its exact localities, the size of specimens, whether or not worn and rounded, what the limits of its distribution, how abundantly the metal is found in the formation in which it occurs, whether it is uniformly scattered, or whether there is grouping in the dispersion, whether it is in lacustrine or true drift deposits, and if in the latter, whether in modified or unmodified drift; these particulars are rarely given. An attempt to bring together and map what can be obtained from the survey reports of the several states, at once reveals the fact that the observations on this subject have been of an extremely general character. The following compilation is believed to include essentially all that has been printed, bearing on the subject.

In Ohio, Col. Whittlesey[1] has noted a specimen from Weymouth, Medina county, thirty miles south from Lake Erie. This, so far as is known, marks the eastern limit of the dispersion of copper. Again, in Clermont county, Prof. Orton, of the Ohio Survey,[2] notes the occasional occurrence of fragments of copper in the bowlder clay. Reference is also made in the Ohio reports,[3] to the frequent occurrence of copper in the drift of the northwestern part of the state, but no localities, or details as to its occurrence are given.

In Indiana, R. B. Warder, of the Indiana Survey,[4] notes a specimen found at Weisburg, in Dearborn county, on Tanner's Creek, weighing twenty-six ounces. Other specimens also have been found in the adjacent counties, Ohio and Switzerland. Still farther down, in the southwest corner of the state, in Vanderberg county, small fragments have been noted by Prof. Collett,[5] and a little to the north, the same authority notes small specimens from Knox and Brown counties. In Warren county, larger nuggets have been found, and Prof. E. T. Cox[6] is authority for the statement that some large pieces and many small ones have been found in the drift both of northern and southern Indiana.

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[1] Smithsonian Contributions; On Fresh Water Glacial Drift of the Northwestern States.

[2] Vol. I, p. 441.

[3] Vol. I, p. 87.

[4] Indiana Geological Report, 1872, p. 403.

[5] Geological Survey, 1875, p. 284.

[6] Geological Report, 1878, p. 117.

Of the copper in Illinois we have somewhat fuller notes, though not more detailed. In this state, drift copper reaches its southern limit, so far as now known. In Saline county, near Gallatin, latitude 37° 40′, a nugget "larger than a hen's egg," with not infrequent smaller ones, have been found by Dr. Smith, and noted by Prof. E. T. Cox, then of the Illinois Survey, in the beds of streams and in ravines.[1] The same is true of Hamilton county, lying just north.

Prof. Worthen has noted the existence of copper in the drift of Clark and Cumberland counties,[2] and Mr. F. H. Bradley in Edgar, Champaign and Ford counties, lying just to the north. In Vermillion county, still further north, the same authority[3] says that several large masses of copper, and many small ones have been taken from the upper drift beds. The occurrence of copper in Hancock, Adams, Brown[4] and Schuyler[5] counties has also been noted by Prof. Worthen; and in Stephenson and Winnebago counties, where the nuggets are spoken of as much worn and rounded, and Boone, Ogle and Lee counties,[6] by James Shaw, of the Illinois survey. Woodford[7] and La Salle counties, have also yielded specimens of "float mineral," as noted by H. A. Greene. In Will county, a specimen of considerable size was found near Wilmington, probably in a lacustrine formation, while many smaller ones have been discovered both here and in Cook county.[8]

The dotted area on the map represents the area of the copper-bearing series, essentially as determined by Prof. R. D. Irving. The drift copper is represented by dots, located as exactly as the data at hand will permit. No attempt is made to show the relative sizes of the different pieces. Where the statement has been made that "float copper" is frequently found in a certain county, several dots have been placed within the limits of such county. Where but a single find has been authoritatively reported from a given district, the fact is indicated by a single dot.

[1] Vol. I, Illinois Geological Report, p. 232.

[2] Ibid., vol. VI, pp. 10 and 98.

[3] Ibid., vol. IV, p. 244.

[4] Ibid., vol. IV, p. 65.

[5] Ibid., vol. IV, p. 77.

[6] Ibid., Vol. V.

[7] Ibid., Vol. IV.

[8] F. H. Bradley, ibid., vol. IV.

In Missouri, specimens, on the authority of G. C. Brodhead, State Geologist, have been found in the eastern part of Putnam county.[1]

In Iowa, Dr. White has noted the occurence of copper in various parts of the state, and a single bowlder mass weighing upward of 30 pounds, has been taken from the drift in Lucas county.[2] In Lee and Henry counties, the occurrence of the metal in question is recorded by Prof. Worthen.[3]

In Minnesota, copper has been found in Fillmore county,[4] and at Pleasant Grove, in Olmstead county. In a description of Travers county, Mr. J. O. Barrett, speaks of its occurrence, but his language is somewhat ambiguous, and it is uncertain whether the copper referred to belongs to the county under description, or to the coteau in the adjacent part of Dakota.

Prof. G. D. Swezey, of Doane College, Nebraska, informs me that it is current report that copper has been found in small fragments in Nebraska, but he is unable to give localities.

In Michigan, a mass of copper was found at Northport, Leelenaw county, which was sold for $80, and hence must have been of great size. In Benzie, Antrim and Grand Traverse counties also, copper has been frequently met with. Col. Whittlesey speaks of a specimen the size of a man's fist, from Ada, Kent county, with frequent smaller fragments.

In Wisconsin, Dr. Lapham says[5] that in the form of drift bowlders copper is often found in eastern Wisconsin, the masses varying from a few ounces to several hundred pounds. The largest, near Huntsford, in Dodge county, had a weight of four hundred and eighty seven pounds. Prof. Chamberlin[6] states that copper is frequently found at all points along the Kettle range.

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[1] Geological Survey of Missouri, p. 289.

[2] Vol. I, Geological Survey of Iowa, 1870, p. 96.

[3] Geological Report of Iowa, 1878, p. 178.

[4] N. H. Winchell's Report of 1875, p. 71.

[5] Wisconsin Geological Report, vol. 2, p. 27.

[6] Geological Report of Wisconsin, vol. 2, p. 210.

Prof. Irving[1] says further that fragments of copper are far more abundant in Wisconsin than elsewhere, and far more abundant here than has been commonly supposed, and that specimens of forty to fifty pounds weight are not uncommon, and have been made of economic use. It is stated by E. T. Sweet,[2] on the authority of Mr. S. Vaughan, that a copper bowlder of seventeen hundred pounds weight was formerly taken from the bed of the Sioux river, six miles south of Lake Superior, and that a bowlder of one hundred pounds weight was taken from Outer Island only a few years ago.

Col. Whittlesey[3] speaks of the copper drift in Wisconsin and northern Michigan as follows: "A copper rock weighing three thousand pounds was found in the red clay on the west fork of the Ontonagon river. One was found in 1845, opposite La Pointe, on the mainland, weighing eight hundred pounds. Three miles south of the Minnesota Mine on middle fork of the Ontonagon, another copper bowlder was taken from the red clay, which weighed between three and four hundred pounds. In a well in Madison one was found at a depth of twenty feet, having a weight of thirty pounds." At the mouth of the Menominee river a chunk three or four pounds in weight has been found, and another at the mouth of the Oconto of about the same size, while a much larger piece was taken from the Pesaukie river. In Walworth county, near the state line, Col. Whittlesey also notes a boulder of forty or fifty pounds weight. Copper has also been noticed from Ripon and Kenosha in gravel beds. In addition to these occurrences cited by Col. Whittlesey, Prof. Chamberlin has had record of about thirty specimens from Walworth county. Aside from these, one was recently found at Geneva Lake which weighed upward of seven pounds. Prof. Chamberlin is authority for the statement that a specimen of one hundred and fourteen pounds weight was taken from Newark, Rock county. This bowlder had also attached to it fragments of Lake Superior Keweenawan

[1] Wisconsin Geological Report, vol. 2, p. 619.

[2] Wisconsin Geological Report, vol 4, p. 353.

[3] Smithsonian Contributions, 1866.

rock. In Sauk and Chippewa counties, on the same authority, specimens have been found. I have picked up two specimens of copper on the shore of Lake Michigan in Ozaukee county, after a severe storm during which they were probably washed from the red clay, which there borders the lake. These specimens were both very irregular, and showed no signs of having been subjected to corrasive action.

The area over which copper is scattered is thus seen to be very great, perhaps not less than 450,000 square miles. If all the fragments came from Lake Superior, some of them must have been transported about 600 miles to the south, others, 150 or 200 miles, or perhaps more, to the west, and small specimens have been carried more than 100 miles east of the eastern limit of the locality from which the copper is supposed to have come. There is then an east-west distribution, accepting the testimony from Nebraska, of more than 700 miles, and a north-south distribution about 100 miles less.

Farther than the fact of its occurrence, however, little at present can be said of the copper in these various localities. Specimens have been found about Lake Superior and along Lake Michigan, both in Wisconsin and Illinois, in lacustrine deposits. Again, specimens have been found in bowlder clay, in lower and upper drift beds, in beds of streams and in ravines. But the character of the deposits in which the copper has been found, has, in by far the larger number of cases, not been indicated more closely than by the statement that it is drift. Pieces have been found both north and south of the kettle moraine, as well as in it. The general fact that these specimens diminish in size southward, seems to be well established, but to this there are some exceptions. Many of the nuggets are worn and rounded, but this does not seem to be universal, for angular fragments, and fragments having the irregular, scraggly form peculiar to this metal, have been found well down in Illinois. What the agency or agencies concerned in this wide spread dispersion is an interesting question. If fuller observations had been made, or if those noted had been more exact — *e. g.*, if the precise character of the formations in which the copper occurs had been determined in each case, the size, shape and condition of the specimens, and their frequency in any locality, this might give us the data required for explaining the dispersion. There appear to be localities where the copper is more abundant than at others, as at Grand Traverse Bay, at the mouth of the Illinois river, and along the lower course of the Wabash. The seemingly greater abundance at these points, however, may only be due to fuller observation or record of the metal found at these points, and not to its really greater prevalence.

It may not be out of place to call attention to the probable fact that the Illinois river, about whose mouth many specimens have been found, was once the outlet of Lake Michigan, and that the Wabash, about whose lower course much copper has also been found, was the channel for discharge, in post-glacial times, of Lake Erie. It is evident that if the copper were all transported from Lake Superior by glaciers, they must have had, at different periods, very divergent courses to account for the east-west dispersion. The fact that copper has been found in the red clay both of Lake Superior and Lake Michigan, suggests that along the lake borders, pieces of copper may have been dropped by floating ice, and the roughness of at least a portion of the specimens here found, is in harmony with such a view.

There is of course a possibility in all cases, and this possibility may at times amount to probability, that the dispersion of copper has been by human agencies. A single loose specimen, for instance, has been found in the "driftless area" in Jo Daviess county, Illinois, in a rock crevice. But in regions where frequent specimens are found scattered through the drift, there is little probability that their occurrence can be explained by human transportation.

Dr. Bell, of the Canada Survey,[1] has described a formation on Hudson's Bay, which has a strong resemblance to our Keweenawan system. He has indicated his belief that the formation is the equivalent of the Nipigon group, which is supposed to be continuous with the Keweenawan, and, therefore, its equivalent. Dr. Bell describes copper sulphide in the as-

[1] Geological Report, 1878.

sociated formations about the Bay, but does not note native copper, which seems not yet to have been discovered. If it should be found to exist there, this would furnish a second center of dispersion, but as it is nearly north of the Lake Superior region, this would not greatly facilitate the explanation of the extensive east-west dispersion.

Fuller notes, which it is proposed to collect at an early date, will doubtless throw fuller, and, it is to be hoped, important light on the question of the dispersion of drift copper, the agency or agencies by which it was effected, and their method of action, and this solution may in turn have some bearing upon other interesting geological problems.

Since the above notes were presented in 1881, the following additional facts have been secured through the kindness of the parties to whom they are accredited. In *Ohio*, Mr. M. C. Read states that "there is an important belt of drift running through Licking, Knox and Richland counties, in which many fragments of copper have been found." Mr. C. R. Barnes reports from *Indiana*, a specimen weighing 3,125.8 grams, somewhat flattened, from Moot's Creek, White county. Another piece "four inches long by two and one-half broad, and three-fourths of an inch thick, worn smooth," was found "in glacial gravel," in Vermillion county, near Eugene (J. T. Scovell). From the same state, Mr. Joseph Moore gives information of four specimens. One was found near Richmond, Wayne county, weighing 17 oz. Another of two pounds weight was found three miles from Elkhart, Elkhart county. A third piece (mostly carbonate), has been found in Henry county, and a fourth near Brookville, Franklin county. Besides these finds, Mr. Moore also states on the authority of Mr. Farrar, that copper is frequently found about Peru, Miami county, in isolated lumps, also that a piece weighing 30 pounds was found "in shelly limestone, where they were excavating for a road." From *Michigan*, Prof. I. W. McKeever, gives information of a piece of copper from Jackson county, which the finder (Dr. Baker, of Adrian) believed to be of meteoric origin. It is claimed that it was seen while falling, and taken the next day from the opening found in the earth where the meteor was seen to strike. It was found eight feet below the surface. It is further asserted that "fragments of copper were found all the way down." This interesting specimen is "about two inches thick, having an area of about one square foot. It looked as if it had been melted. There were spots of green carbonate upon it," when seen by Prof. McKeever, but these, he suggests may have formed since it was found. From *Wisconsin*, Mrs. G. W. Esterley, in an article in the *Evening Wisconsin*, reports the finding of a piece of thin, flat copper insinuated among the beds of Trenton limestone, in a quarry near Lake Koshkonong. Prof. Chamberlin reports a similar case of insinuation in Galena limestone near Belvidere, Ill.

Professor H. E. Storrs writes from Jacksonville, *Illinois*, that a fragment of copper was some time since found twenty-five feet below the surface, in digging a well in that city; the same being three inches long by one and one-half broad, and one-fourth of an inch thick. The same gentleman also speaks of two other specimens of copper in his possession, weighing six and one-half ounces, and four pounds, three ounces respectively, the second being "evidently worn in transit." The precise localities of these two specimens is unknown. "A small piece of native copper was found . . . in the city of Alton, . . . in löss," according to Professor Charles Fairman, who also adds that it is locally reported that large bowlders containing copper were formerly found in that locality.

Professor N. H. Winchell, furnishes the following facts concerning drift copper in Minnesota:

State.	County.	Town.	Size of Specimens.	Condition.	Formation
Minnesota	Le Sueur........	Le Sueur.........	?	?	?
Minnesota	Scott	Jordan	?	?	?
Minnesota	Scott	Marian	?	?	?
Minnesota	Hennepin.......	Minneapolis.....	3 pounds..	Rounded.	Gravel.
Minnesota	Hennepin	Eden Prairie.....	78 pounds.*	....	....
Minnesota	Olmstead.......	Rochester	4 ounces..	Rounded..	Among stones near the rock.
Minnesota	Olmstead.......	Zumbrota	5 pounds..	Rounded and corroded...	....
Minnesota	Olmstead.......	Pine Island......	¾ pound	Rounded .	On surface.
Minnesota	Ramsey	White Bear......	2 pounds...	Rounded .	Near surface
Minnesota	St. Louis and Carlton.......	Knife Falls to N. Pacific Junc..	Hundreds. of pieces.	?	Among stones and rounded bowlders.
Minnesota	Pine...........	Various places..	?	?	?

* Found in a railroad cut,

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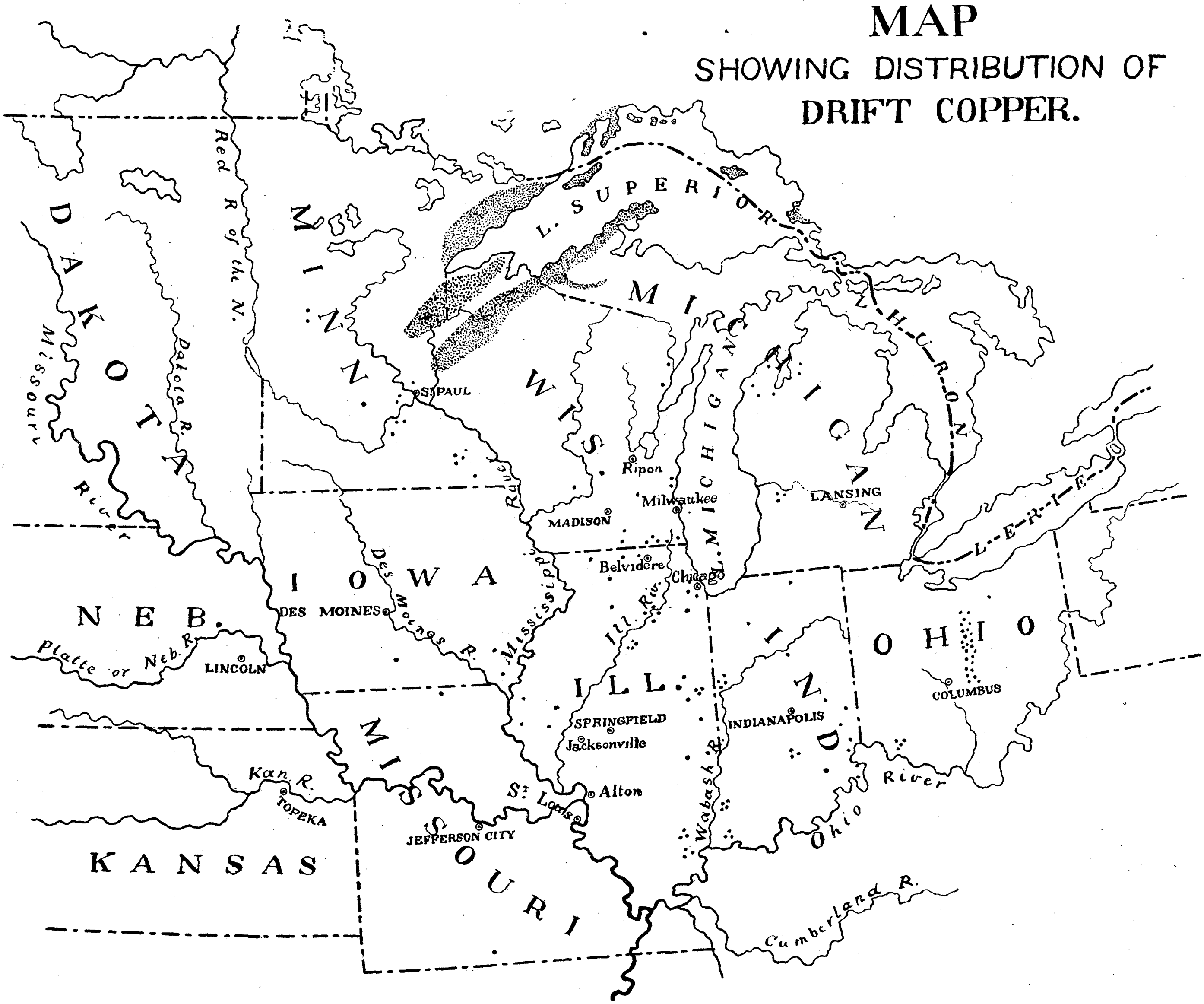


ON THE MOTOR GANGLION CELLS OF THE FROG'S SPINAL CORD.

By E. A. BIRGE, Ph. D., Professor of Zoölogy, University of Wisconsin.

The following paper was originally published in the "Archiv für Anatomie and Physiologie," for 1882. A synopsis of the work is here presented in English.

The reason of our defective knowledge of even the most important numerical relations of the elementary structure of the body lies in the incomplete methods of investigation which were formerly employed. STILLING'S attempts to determine the number of the elements of the central nerves system have not been carried further, because the means of investigation were too imperfect to secure certain results even with the greatest care and industry. Rough approximations only were made, which naturally were often incorrect. The enumerations recently made of the fibers of the optic, and of certain spinal nerves have shown that the more perfect methods now at our command, have brought us nearer to accurate results.

The method of saturating the specimens with a substance which binds all parts together and gives them a like consistency, obviates one of the greatest dangers to be found in counting the cells of an organ, viz., the loss or destruction of part of the cells. Further in the possibility of staining specimens *en masse*, in perfect and rapid microtomes, in the accurate arrangement of specimens upon the slide, we have gained means which reduce to the work of a few months, tasks, for which, a decade since, a life-time would not have sufficed.

Two conditions must be fulfilled in the counting of the cells of an organ. The cells must be brought under the microscope without loss, and must be so colored that they can be at once and easily distinguished. If these conditions are met, the enumeration will be easy and quick, as well as trustworthy; but if one must deliberate whether to count certain elements or not, the process will be exceedingly slow and wearisome, and the result thoroughly untrustworthy. Since our methods of discriminating staining are yet far from perfect, the structures capable of counting are still few. Dr. Gaule, of the Physiological Institute at Leipsic, under whose direction this paper was worked out, called my attention to two structures which filled both the above conditions, and which were of great interest. These were the medullated nerve-fibres of the anterior roots of the spinal nerves, and the large ganglion cells of the anterior horn of the gray matter of the spinal cord. The enumeration was made upon the frog, the most favorable animal, both because of its small size and because of its importance in experimental physiology.

The value of such enumerations as the following depends, of course, entirely upon their accuracy. I have attempted in every way to assure myself of the reliability of my results. The close correspondence of the number of cells found on right and left sides, seems to me the clearest proof of the accuracy of the counting.

The numbers of the elements which I have determined lead to certain conclusions, apart from any theoretical considerations. 1. The frog has an equal number of cells in the anterior horn of the spinal cord, and of fibres in the anterior roots of the nerves. Each motor cell, then, corresponds to a motor fibre. 2. There is a general correspondence between the number of cells in any region of the spinal cord and of fibres entering that region. When an individual frog shows peculiarities of distribution of fibres to different nerves there is a corresponding peculiarity in the distribution of the motor cells. It is thus probable that the ganglion cell belonging to a particular fibre lies not far from its entrance to the cord. 3. The number of fibres and cells varies with the weight of the frog. Each frog starts with a certain minimum number which is regularly increased with the increase in weight. Hence (a) the fibres and cells must be constructed during the life of the frog; (b) a certain relation obtains between the weight of the muscles and the number of the motor fibres and cells.

I. NUMBER OF MOTOR FIBRES.

The roots were treated *in situ* with osmic acid, one per cent., for two to six hours, and imbedded in paraffine. The sections must not be over 1-100 mm. thick, better 1-200 mm., since if the axis of the fibre is not exactly perpendicular to the section the light will not pass through it unless the cylinder is very short. If the fibres overlie each other, or if they are so long that their obliquity cuts off the light, rapid and accurate counting is out of the question.

The counting was performed with an eye-piece micrometer divided into squares. Some counts were made with the camera lucida, marking each fibre by a pencil dot. This was a less accurate method. All nerves were counted twice, and the work was repeated if the difference was over two per cent.

The results are shown as follows:

TABLE I.

Number of frog	49	46	41	36	40	43	42
Weight in grammes	1½	9½	23	63	67	87	111
Motor fibres on one side.	2,992	3,209	3,529	4,283	4,746	5,002	5,734
Total motor fibres	5,984	6,418	7,058	8,566	9,492	10,004	11,468

The total number is reached by doubling the number obtained on one side. As will be seen later in the section on ganglion cells the number is the same on the two sides.

A somewhat regular increase of fibers proportionally to the increase of weight is seen:

TABLE II.

Frog	49	46	41	36	40	43	42
Increase of weight	......	8	21.5	61.5	65.5	85.5	109.5
Increase of fibres	......	497	1,064	2,582	3,508	4,020	5,484
Fibres per gram. of increase	......	62	50	42	53	47	50

From this table it becomes possible to compute *a priori* the approximate number of fibres, at least for Rana esculenta. The addition of fifty fibres for each gramme in weight to the fixed number 6,000 will come near the required result. The female frogs must be weighed without ovaries.

How does this increase in number of fibres take place? It may come either by division of fibres previously present, or by new formation. The latter method is on all grounds more probable. The relative size of fibres in young and old frogs forbids us to think of division as the process, since in young frogs the fibres are of far smaller average size. This is shown by the number of fibres which stand in a given area, as the following table exhibits:

TABLE III.

	Frog 49, w't 1½ grm.	4 23 grm.	36 63 gr.
Area of cross section of 2d motor root	0.046 sq. mm	0.105	0.125
No. of fibres	968	1098	975
Fibres per sq. mm	21,434	10,457	7,800

Hence the fibres in the smallest frog had hardly one-third the area of those in the larger frog. The large fibres in both are about the same size, but there are in the smaller frogs a vast number of minute fibres. There are also, probably, others not yet medullated and hence not rendered visible by osmic acid, which develop into the new nerve fibres of the older frogs.

The size of the fibres is by no means the same in the different nerves of the same frog as the following table will show:

TABLE IV.

Frog No. 36 — Wt. 63 grm.

Nerve.	I	II	III	IV	V	VI	VII	VIII	IX	X
Area of mot'r root in sq. mm	0.087	0.125	0.052	0.018	0.024	0.02 26	0.04	0.152	0.067	0.015
No. of fibres	783	975	481	106	114	159	142	870	441	212
Fibres per sq. mm	9000	7800	9257	5888	4750	7035	3550	5723	6582	14133

The differences are obvious, and unquestionably depend on the function of the nerves. The first three nerves, which supply the tongue, forward extremity, etc., have an area of

0.264 sq. mm., with 2,239 fibres, while the seventh, eighth, ninth nerves which supply the lumbar plexus, have an area of 0.259 sq. mm., with only 1,453 fibres, that is, with approximately the same area, there are only two-thirds as many fibres. The fourth, fifth and sixth nerves stand in size of fibres between the two groups, while the tenth nerve has the smallest fibres, possibly since it contains those which supply the lymph hearts.

Since the muscle fibres of the hind legs are so much larger than those of the fore legs one cannot help thinking that there is a relation between size of motor fibres and the muscle fibres supplied by them. But this question needs further investigation.

Another striking fact, like that of the size, and found also in the ganglion cells, is that of the number of fibres in brachial and lumbar plexus respectively. In spite of the smaller size of the anterior extremities they receive an equal or greater number of nerve fibres than do the hind limbs. These facts will become more apparent by the following table:

TABLE V—MOTOR FIBRES.

Number	49	46	41	36	40	43	42
Sex	—	♀	♂	♀	♀	♂	♀
Wt. in gram.	1½	9½	23	63	67	87	111
Nerve. I	359	416	652	783	754	653	1023
II	986	764	1098	975	1051	1307	1256
III	151	574	226	481	559	767	788
IV	142	155	119	106	187	146	117
V	79	96	92	114	102	118	106
VI	110	116	137	159	127	96	236
VII	135	123	137	142	162	112	141
VIII	583	309	501	870	967	446	515
IX	383	593	450	441	631	755	1248
X	64	63	112	212	206	602	310
Sum.	2992	3209	3524	4283	4746	5002	5134

The table shows that considerable individual differences are present. In No. 36 the 8th nerve has twice as many fibres as the 9th. In No. 42 the relation is reversed. Usually the 6th nerve is larger than the 5th, but occasionally the 5th is the larger, etc. The relations are more regular when groups of nerves are considered. If we neglect the contribution of the 1st nerve to the brachial plexus and that of the 10th nerve to the lumbar plexus, we have:

TABLE VI.

Number	49	46	41	36	40	43	42
Plexus brachialis	1,237	1,338	1,304	1,456	1,710	2,074	2,038
Plexus lumbalis	1,101	1,025	1,088	1,453	1,760	1,413	1,904

The brachial plexus contains at least as many fibres as the lumbar, and the relative size would be still more striking if the parts of the 1st and 10th nerves were assigned to their respective places.

The variation in individual nerves appears most plainly in the hinder half of the cord, and is very probably due to the relation of points of exit of nerve from cord and spinal column. When a nerve fibre has considerable distance to travel before leaving the spinal canal, it makes little difference whether it leaves the cord in one or another root. It is only necessary that it gain the proper nerve-trunk and this is determined by the plexus.

II. The Motor Ganglion Cells of the Spinal Cord.

The cords whose cells were to be counted were stained in Grenacher's alum carmine, imbedded in paraffine, and the sections cut of a uniform thickness, usually 1-50 mm. They were mounted in order and covered with xylol balsam. In this method the nerve fibres are little stained, while numerous granules and ganglion cells are tinged with a more or less deep red. In the anterior horn of the gray matter lies the group of closely-joined, large motor cells whose number is to be determined. The only difficulty in counting lies in the presence of a number of small ganglion cells, apparently belonging to the motor center, but whose small size makes them hardly distinguishable from the "granules" of the cord. In the first frogs investigated, these cells were not counted. Later it was found that they belong to the small motor fibres and they were enumerated. In frog number eighteen, whose large cells only were first counted, the small cells were afterwards determined and about six hundred were found on each side.

The number of cells in the motor group varies in each section from 2–3 to 25–30, according to its thickness and the region of the cord to which it belonged. Single, very thin sections from the center of the cord, occasionally contain no cells.

There is no difficulty in determining with fair accuracy the number of cells, if all mechanical aids are employed, so that individual attention can be given to counting. One source or error, however, cannot be avoided. There is no natural limit to the motor center toward the medulla oblongata, but the cord gradually passes into that structure. The only fixed point is that where the spinal canal opens into the fourth ventricle, and this arbitrary line was chosen as the only one which could be determined. The following table gives the result of the counting.

TABLE VII.

Number of frog.	Total number of cells.	Right.	Left.	Difference.	Per cent. of difference.
49	4,871	2,457	2,414	43	1.8
18	6,760	3,385	3,375	10	0.3
12	6,892	3,424	3,468	44	1.3
39	8,539	4,272	4,267	5	0.1
43	11,517	5,777	5,740	37	0.6
25	11,131	5,567	5,564	3	0.1

The correspondence of the two sides is so close that it might be supposed that the exactness was attained by unconsciously following, on one side of each section, the number found on the other. This is not the case. The cells lie in small clusters, which are seldom cut in the same position, and hence the number of cells on the two sides of the same section rarely corresponds exactly. It is therefore impossible to be influenced by the preceding counts in such a way as to "force a balance."

I add the complete enumeration of the cells of one frog, No. 43. Sections 1–146 lay in the medulla oblongata.

TABLE VIII.—No. OF CELLS.

No.	Right.		Left.		No.	Right.		Left.	
147	9		11		204	10		8	
8	10		6		5	7		12	
9	8		9		6	11	46	11	48
150	5		7		7	13		9	
1	6	38	6	42	8	7		8	
2	5		3		9	8		8	
3	6		3		210	6		10	
4	3		4		1	11	45	9	44
5	3		3		2	12		12	
6	2	19	1	14	3	11		9	
7	3		4		4	10		11	
8	4		2		5	9		10	
9	2		1		6	8	50	7	49
160	0		4		7	4		8	
1	2	11	2	13	8	11		7	
2	3		2		9	9		8	
3	7		2		220	7		8	
4	6		1		1	10	41	8	39
6	3		2		2	11		7	
6	4	23	7	14	3	7		6	
7	7		1		4	11		8	
8	3		5		5	4		12	
9	3		7		6	8	39	6	39
170	6		4		7	9		8	
1	1	20	3	20	7′	8		13	
2	3		4		8	11		9	
3	4		2		9	6		10	
4	3		4		230	15	49	15	55
5	6		5		1	9		9	
6	5	21	5	20	2	11		13	
7	2		3		3	7		8	
8	5		3		4	8		6	
9	6		4		5	8	43	13	49
180	6		2		6	11		12	
1	7	26	5	17	7	8		7	
2	6		5		8	13		10	
3	5		5		9	7		7	
4	6		6		240	8	47	6	42
5	6		9		1	9		11	
6	3	26	8	33	2	10		13	
7	4		8		3	9		12	
·8	4		5		4	13		5	
9	1		4		5	8	49	20	61
190	3		5		6	21		9	
1	4	16	1	23	7	23		10	
2	3		5		8	18		11	
3	8		6		9	8		12	
4	7		9		250	10	80	16	58
5	10		11		1	11		16	
6	12	40	9	40	2	9		14	
7	6		7		3	17		7	
8	7		10		4	19		14	
9	11		6		5	19	75	11	62
200	9		7		6	12		13	
1	9	42	9	39	7	10		17	
2	10		9		8	13		12	
3	8		8		9	16		19	

TABLE VIII. — NO. OF CELLS — Continued.

No.	Right.		Left.		No.	Right.		Left.	
260	17	68	18	79	315	13	73	19	72
1	13		11		6	14		13	
2	15		17		7	10		12	
3	18		12		8	14		16	
4	15		13		9	13		14	
5	11	72	17	70	320	12	63	7	62
6	15		15		1	15		18	
7	10		11		2	11		12	
8	19		12		3	13		9	
9	12		11		4	18		11	
270	7	63	9	58	5	22	79	15	65
1	12		12		6	16		12	
2	11		12		7	12		15	
3	11		8		8	14		12	
4	7		12		9	13		9	
5	19	60	16	60	330	9	64	12	60
6	8		9		1	17		16	
7	10		11		2	15		18	
8	13		8		3	13		10	
9	15		16		4	8		14	
280	8	54	10	54	5	12	65	12	70
1	14		12		6	23		18	
2	11		10		7	13		11	
3	14		8		8	12		8	
4	11		9		9	17		12	
5	10	60	10	49	340	12	77	18	67
6	12		15		1	13		19	
7	13		21		2	15		11	
8	12		10		3	21		18	
9	19		17		4	16		11	
290	11	67	20	83	5	14	79	13	72
1	12		18		6	19		14	
2	11		12		7	12		16	
3	9		13		8	13		11	
4	9		12		9	12		11	
5	10	51	16	71	350	9	65	12	64
6	15		18		1	15		23	
7	10		17		2	13		11	
8	12		8		3	12		10	
9	10		14		4	11		10	
300	9	56	12	69	5	15	66	14	68
1	17		15		6	15		12	
2	9		10		7	17		15	
3	8		13		8	11		13	
4	12		10		9	10		14	
5	10	56	9	57	360	12	65	8	62
6	9		19		1	13		13	
7	11		16		2	15		11	
8	7		17		3	18		15	
9	12		11		4	9		17	
310	13	52	12	75	5	18	73	13	69
1	13		17		6	9		10	
2	16		12		7	17		12	
3	14		11		8	24		17	
4	17		23		9	22		15	

TABLE VIII. — NO. OF CELLS — Continued.

No.	Right.		Left.		No.	Right.		Left.	
370	12	84	13	67	424	8	34	9	39
1	15		17		5	6		5	
2	14		20		6	7		12	
3	11		13		7	5		3	
4	14		17		8	4		4	
5	10	64	8	75	9	7	30	3	27
6	17		17		430	8		4	
7	11		10		1	5		9	
8	12		18		2	6		4	
9	18		20		2′	5		2	
380	11	69	12	77	3	6	31	4	23
1	17		16		4	4		6	
2	8		13		5	5		7	
3	11		16		6	6		5	
4	12		11		7	4		7	
5	6	54	5	61	8	5	25	6	31
6	4		9		9	2		2	
7	5		8		440	4		3	
8	8		12		1	7		4	
9	9		7		2	5		6	
390	8	34	10	46	3	0	23	6	21
1	7		8		4	6		2	
2	6		5		5	7		5	
3	5		7		6	3		5	
3′	9		5		7	6		8	
4	6	33	4	29	8	6	22	3	23
5	7		7		9	3		7	
6	3		4		450	3		2	
7	9		8		1	2		5	
8	7		9		2	4		2	
9	5	31	7	35	3	6	18	3	19
400	4		3		4	4		5	
1	7		8		5	7		3	
2	4		6		6	6		4	
3	8		3		7	6		4	
4	4	27	3	23	8	5	29	4	20
5	5		4		9	4		6	
6	6		4		460	5		3	
7	2		4		1	5		9	
8	6		8		2	5		6	
9	3	22	5	25	3	3	24	3	27
410	4		5		4	4		4	
1	3		7		5	6		5	
2	4		5		6	3		2	
3	6		2		7	3		2	
4	3	20	6	25	8	4	21	1	14
5	10		6		9	2		1	
6	7		4		470	1		3	
7	6		5		1	5		2	
8	7		7		2	3		5	
9	5	35	6	28	3	3	14	2	13
420	9		12		4	3		6	
1	10		8		5	2		5	
2	14		6		6	4		3	
3	7		4		7	3		2	

TABLE VIII — NO OF CELLS. — Continued.

No.	Right.		Left.		No.	Right.		Left.	
478	2	14	2	18	533	4	25	5	28
9	0		3		4	4		6	
480	2		5		5	5		3	
1	6		2		6	4		6	
2	5		3		7	5		3	
3	5	18	3	16	8	2	20	4	22
4	6		4		9	4		4	
5	4		4		540	7		5	
6	2		1		1	3		5	
7	4		8		2	6		7	
8	5	21	5	20	3	6	26	6	27
9	5		6		4	3		4	
490	4		5		5	3		2	
1	3		6		6	4		9	
2	1		3		7	3		0	
3	5	18	4	24	8	4	17	5	20
4	6		5		9	6		5	
5	6		4		550	8		9	
6	3		6		1	8		5	
7	5		3		2	4		7	
8	3	23	3	21	3	6	32	5	31
9	5		3		4	7		6	
500	2		7		5	5		6	
1	4		6		6	8		7	
2	5		2		7	6		8	
3	6	22	4	22	8	4	30	4	31
4	5		4		9	5		7	
5	6		3		560	7		4	
6	6		8		1	3		4	
7	7		4		2	5		10	
8	2	26	3	22	3	7	27	8	33
9	5		4		4	5		4	
510	3		5		5	5		6	
1	6		3		6	4		6	
2	3		5		7	5		3	
3	9	26	5	21	8	4	23	5	24
4	8		4		9	6		6	
5	5		6		570	5		4	
6	7		8		1	3		6	
7	6		9		2	5		6	
8	7	34	6	33	3	5	24	3	25
9	5		6		4	2		4	
520	8		5		5	4		3	
1	10		12		6	5		7	
2	8		5		7	5		4	
3	7	38	10	38	8	6	22	3	21
4	9		5		9	4		2	
5	6		5		580	5		3	
6	6		7		1	4		3	
7	8		6		2	3		2	
8	5	34	5	28	3	2	18	4	14
9	5		6		3	3		3	
530	6		4		5	2		2	
1	5		8		6	1		2	
2	5		5		7	3		4	

TABLE VIII.—NO. OF CELLS.—Continued.

No.	Right.		Left.		No.	Right.		Left.	
588	4		3	14	641	11		9	
9	2		5		2	6		5	
590	4		2		3	9	38	7	38
1	1		4		4	8		5	
2	4				5	6		5	
3	5	16	2	16	6	7		8	
4	2		3		7	6		5	
5	4		3		8	7	34	10	33
6	1				9	5		8	
7	2		2		650	6		5	
8	1	10		8	1	7		5	
9	3		4		2	8		7	
600	2		4		3	6	32	5	30
1	7		2		4	10		9	
2	1		3		5	6		7	
3	4	17	3	16	6	6		4	
4	2		4		7	9		6	
5	3		3		8	6	37	8	34
6	5		2		9	5		9	
7	4		5		660	8		7	
8	2	16	3	17	1	10		9	
9	5		5		2	5		8	
610	3		5		3	4	32	7	40
1	5		7		4	6		15	
2	2		3		5	4		5	
3	4	19	6	26	6	3		5	
4	3		4		7	4		3	
5	2		2		8	3	20	5	33
6	3		2		9	5		7	
7	3		2		670	3		2	
8	6	17	8	18	1	2		5	
9	7		8		2	4		4	
620	7		9		3	0	14	6	24
1	8		9		4	4		7	
2	7		8		5	3		2	
3	8	37	9	43	6	5		2	
4	11		9		7	3		6	
5	9		16		8	7	20	6	23
6	6		7		9	3		3	
7	4		9		680	2		5	
8	8	38	6	41	1	4		9	
9	5		7		2	3		2	
630	10		9		3	5	27	3	22
1	5		8		4	6		4	
2	8		9		5	5		4	
3	7	35	6	39	6	3		5	
4	11		8		7	5		6	
5	10		9		8	6	25	6	25
6	9		10		9	7		8	
7	7		6		690	6		6	
8	6	43	8	41	1	4		7	
9	7		10		2	9		6	
640	5		7		3	7	33	8	35

TABLE VIII.—NO. OF CELLS—Continued.

No.	Right.		Left.		No.	Right.		Left.	
694	5		6		749	12		8	
5	5		7		750	6		11	
6	8		8		1	10		10	
7	5		4		2	9		12	
8	9	32	10	35	3	10	47	13	54
9	5		7		4	11		15	
700	8		4		5	6		11	
1	8		9		6	10		11	
2	7		6		7	13		16	
3	6	34	6	32	8	9	49	5	58
4	7		5		9	6		6	
5	4		9		760	15		13	
6	9		8		1	9		11	
7	8		5		2	8		5	
8	6	34	8	35	3	9	47	8	43
9	4		9		4	14		16	
710	5		3		5	13		12	
1	8		3		6	13		11	
2	4		6		7	6		6	
3	7	28	5	26	8	10	56	14	59
4	6		5		9	8		7	
5	4		9		770	9		10	
6	5		3		1	8		8	
7	4		4		2	5		4	
8	3	22	6	27	3	14	44	12	41
9	5		4		4	9		11	
720	13		12		5	5		6	
1	9		6		6	14		11	
2	7		10		7	8		5	
3	11	45	6	38	8	9	45	8	41
4	6		5		9	10		13	
5	10		13		780	11		9	
6	9		11		1	18		18	
7	8		14		2	7		6	
8	10	43	11	54	3	10	56	11	57
9	6		10		4	8		6	
730	6		8		5	9		9	
1	7		8		6	10		9	
2	7		7		7	16		8	
3	1	37	9	42	8	7	50	8	40
4	9		8		9	11		10	
5	9		10		790	9		5	
6	6		7		1	7		8	
7	12		10		2	9		11	
8	5	41	9	44	3	10	46	14	48
9	6		11		4	12		7	
740	9		10		5	6		6	
1	10		4		6	17		11	
2	9		8		7	17		18	
3	8	42	8	41	8	9	61	6	48
4	7		6		9	8		12	
5	6		5		800	5		9	
6	11		9		1	7		11	
7	5		9		2	9		9	
8	8	37	9	38	3	8	37	5	46

TABLE VIII.—NO. OF CELLS.—Continued.

No.	Right.		Left.		No.	Right.		Left.	
804	9		8		845	10		11	
5	9		4		6	11		12	
6	7		6		7	10		10	
7	8		5		8	11	50	7	47
8	9	42	7	30	9	11		12	
9	8		10		850	13		7	
810	11		10		1	13		14	
1	8		7		2	12		14	
2	9		6		3	8	57	10	57
3	13	49	12	45	4	12		8	
4	10		13		5	10		14	
5	9		6		6	18		6	
6	5		7		7	7		8	
7	6		6		8	10	57	8	44
8	9	39	10	42	9	7		11	
9	8		9		860	8		12	
820	7		10		1	6		5	
1	14		10		2	7		6	
2	9		12		3	9	37	4	38
3	16	54	10	51	4	8		7	
4	11		8		5	6		5	
5	9		11		6	8		4	
6	10		13		7	6		5	
7	12		14		8	3	31	3	24
8	14	56	18	64	9	4		6	
9	16		18		870	3		5	
830	10		20		1	3		4	
1	15		8		2	5		6	
2	14		12		3	2	17	2	23
3	16	71	17	75	4	4		3	
4	15		11		5	1		0	
5	10		7		6	3		1	
6	8		10		7	2		2	
7	9		8		8	0	10	1	7
8	17	59	13	49	9	2		0	
9	12		10		880	4		3	
840	13		11		1	2		2	
1	11		14		2	1		0	
2	6		9		3	0	9	0	5
3	8	50	5	49	4	1		1	
4	8		7		5	2		1	

The addition of all the cells gives 5,777 for the right side 5,740 for the left side, as in table I. It will be seen that the numbers in the same section usually differ and often considerably, while each group of five sections or one-tenth mm. shows a closer corrrespondence.

The total number of the cells varies in proportion to the weight of the frog as shown by

TABLE IX.

Number of frog	49	18	12	36	42	25
Weight in grammes	1½	22	44	63	111	115
Number of cells	4,871	6,760	6,882	8,539	11,517	11,137

In Nos. 12 and 25 only the large cells were counted and tho numbers are therefore too small. Nos. 49, 18 and 43 are male, 12, 14 and 25 female. The ovaries were removed from the latter before weighing. Hence we may conclude that there is a relation between weight and number of ganglion cells not unlike that which obtains between weight and motor nerve fibres.

In the brachial region the cells are distributed in small layers, each only one cell thick, and the spaces between the layers are occupied by the outgoing fibres. In the lumbar region no such arrangement is visible. The motor fibres of the brachial region pass off at right angles to the cord, and in the same way from the motor centre, while those of the lumbar region pass off obliquely both inside and outside of the cord. The most convenient method of showing the distribution of the cells is, therefore, that of taking a unit of space and showing the number of cells in that. I have chosen one-tenth mm. as the space, since it is small enough to show the influence of the nerves and large enough to eliminate differences in thickness of the sections. I give the result in tabular form and graphically in plates I and II which are to be compared with the tables.

TABLE X.

Frog No. 49. Weight 1½ grm. No. of cells in each one-tenth mm. See Plate I, Fig. I.

Sum.	Left.	Right.	Sum.	Sum.	Left.	Right.	Sum.
	35	42			25	35	
	37	43			35	32	
	51	51			21	21	
	68	72			26	26	
	89	98			30	32	
	192	137			43	52	
	104	108			52	56	
	90	96			53	53	
	114	131			68	71	
859	129	119	897	431	78	89	467
	120	111			85	75	
	100	89			83	72	
	33	33			87	101	
	26	28			88	97	
	38	22			94	87	
	22	16			95	87	
	26	21			83	80	
	16	19			54	55	
	24	27			29	28	
419	24	25	401	705	7	9	692
				2,414			2,547
						Total.	4,871

TABLE XI.

Frog No. 18. ♂ Weight 22 grm. Plate I, Flg. II.

Sum.	Left.	Right.	Sum.	Sum.	Left.	Right.	Snm.
	43	45			24	27	
	70	70			22	23	
	63	55			23	22	
	56	55			29	19	
	58	60			22	20	
	63	65			24	31	
	79	69			26	25	
	71	83			30	32	
	83	70			39	35	
667	81	82	654	268	29	32	266
	82	78			34	31	
	84	79			34	30	
	69	75			32	41	
	80	83			38	39	
	72	73			48	54	
	78	73			54	57	
	79	83			45	42	
	76	83			49	51	
	74	71			49	49	
751	47	56	754	429	46	39	433
	28	20			52	47	
	23	25			55	50	
	27	32			50	60	
	33	32			66	54	
	24	20			57	61	
	21	20			59	60	
	24	25			56	55	
	19	15			54	65	
	28	33			60	67	
252	25	23	245	576	63	66	585
	24	29			69	62	
	17	17			56	67	
	24	27			45	69	
	21	28			14	22	
	20	28			6	6	
	29	22			6	5	
	26	25					
	27	26					
	21	23					
237	28	20	245	195			201
				3,375			3,383
						Total..	6,758

TABLE XII.

Frog No. 36. Weight 67 grm. Plate I, Fig. III.

Sum.	Left.	Right.	Sum.	Sum.	Left.	Right.	Sum.
	7	11			21	24	
	11	19			18	21	
	32	37			16	13	
	22	35			21	15	
	31	34		214	24	20	197
	40	42			27	26	
	50	45			17	17	
	60	72			25	25	
	59	56			17	21	
358	46	52	403		21	24	
	42	39			20	26	
	40	37			26	27	
	52	54			18	18	
	74	64			10	19	
	62	65		198	17	30	233
	65	69			29	30	
	79	81			22	23	
	81	75			25	29	
	66	62			17	24	
625	64	73	619		26	25	
	62	72			21	33	
	74	74			32	29	
	64	57			17	20	
	62	61			21	21	
	65	69		232	21	21	255
	68	73			16	25	
	77	70			31	30	
	85	87			31	23	
	65	72			31	31	
708	86	69	704		37	37	
	73	71			35	33	
	76	69			45	37	
	78	73			46	45	
	53	50			63	58	
	56	46		396	61	56	375
	27	23			61	67	
	27	29			64	65	
	34	25			55	51	
	21	21			52	46	
465	20	24	440		52	49	
	24	26			55	43	
	27	26			45	45	
	23	20			41	39	
	23	25			34	43	
	35	26		487	28	32	480
	20	23			30	31	
	16	21			29	32	
	14	17			40	37	
	23	24			37	34	
226	21	20	228		40	38	
	23	16			44	41	
	29	23			33	34	
	23	19			36	38	
	22	30			23	25	
	17	17		343	21	13	323

TABLE XII. — Continued.

Sum.	Right.	Left.	Sum.	Sum.	Left.	Right.	Sum.
	6	5			1	1	
	2	3					
	2	4		15			16
	3	0					
	2	1		4267			4272
					Total	8539	

TABLE XIII.

Frog No. 42. Weight. 111 Grm. See Plate II, Fig. IV.

Sum.	Left.	Right.	Sum.	Sum.	Left.	Right.	Sum.
	38	42		607	33	29	618
	19	14			31	35	
	11	13			27	23	
	23	14			22	25	
	20	20			20	25	
	21	20			35	28	
	26	17			34	39	
	26	33			30	27	
	16	23			31	23	
240	40	40	236		25	31	
	42	39		278	23	21	277
	46	48			22	23	
	45	44			18	19	
	50	49			29	20	
	41	39			24	27	
	39	39			21	14	
	49	55			14	13	
	43	49			14	18	
	47	42			18	16	
451	49	61	466		21	20	
	80	58		199	18	24	194
	75	62			22	22	
	68	79			26	22	
	72	70			26	21	
	63	58			34	33	
	60	60			38	38	
	54	54			34	28	
	60	49			25	28	
	67	83			20	22	
650	51	71		274	26	27	262

TABLE XIII.— Continued.

Sum.	Left.	Right.	Sum.	Svm.	Left.	Right.	Sum.
	56	69			17	20	
	56	57			32	31	
	52	75			30	31	
	73	72			27	33	
	63	62			23	24	
	79	65			24	25	
	64	60			22	21	
	65	70			18	14	
	77	67			13	14	
664	79	72	669	222	16	16	229
	65	64			10	8	
	66	68			17	16	
	65	62			16	17	
	73	69			19	26	
	84	67			17	18	
	64	75			37	43	
	69	77			38	31	
	54	61			35	39	
	34	46			43	41	
270	38	38	287		56	59	
	34	33			44	41	
	32	30			45	41	
	37	34			56	57	
	32	40			50	48	
	20	33		477	46	40	479
	14	24			61	48	
	20	23			37	46	
	17	22			42	30	
	25	25			49	45	
264	33	35	299		39	42	
	32	35			54	51	
	34	32			56	64	
	34	35			71	75	
	28	26			59	49	
	22	27		518	50	49	
	45	38			50	47	
	43	54			57	57	
	37	42			57	44	
	41	44			37	38	
358	42	41	374		31	24	
	37	38			17	23	
	47	54			10	7	
	49	58		268	9	5	245
	47	43		5,740			5,777
						Total	11,517

TABLE XIV.

Frog No. 25. ♂ Weight 115 grm. See Plate II, Fig. V.

Sum.	Left.	Right.	Sum.	Sum.	Left.	Right.	Sum.
	23	25			21	21	
	18	20			16	16	
	24	22			23	17	
	32	31			16	14	
	32	35		209	22	23	204
	44	40			20	25	
	50	45			21	18	
	56	49			23	23	
	65	65			25	25	
438	94	76	408		23	28	
	64	64			26	26	
	64	61			29	26	
	58	50			21	25	
	60	51			22	20	
	38	53		229	19	19	235
	39	39			27	24	
	41	62			18	17	
	57	73			27	25	
	56	65			15	18	
547	70	71	589		18	12	
	76	75			16	20	
	90	100			13	19	
	74	72			11	12	
	77	82			18	25	
	79	76		183	20	19	192
	90	91			33	35	
	84	78			37	36	
	77	67			37	34	
	75	66			28	32	
789	67	84	791		37	37	
	77	50			45	36	
	62	58			38	37	
	67	71			41	34	
	65	60			34	30	
	67	59		364	34	34	345
	83	77			36	39	
	62	62			23	32	
	66	73			33	34	
	64	68			32	36	
685	72	70	648		34	32	
	73.	69			45	47	
	54	48			38	40	
	39	31			34	38	
	33	26			42	44	
	28	30		360	43	33	375
	18	18			43	35	
	17	19			36	33	
	14	18			34	33	
	21	20			38	36	
314	17	15	294		45	44	
	28	34			44	53	
	25	17			51	47	
	17	21			31	42	
	20	21			57	55	
	21	20		429	50	52	430

TABLE XIV.—Continued.

Sum.	Right.	Left.	Sum.	Sum.	Right.	Left.	Sum.
	44	47			22	20	
	68	70			16	14	
	60	62		383	4	9	417
	58	63			9	10	
	54	55			7	8	
	56	64			3	3	
	54	61			5	3	
	53	45			4	4	
	75	63			3	2	
594	72	68	598		2	2	
	62	70			2	2	
	58	70			1	1	
	54	65		38	2	3	38
	48	52			1	0	
	43	49			1	1	
	44	41		5,564			5,567
	32	27				Total.	11,131

If we consider the tables, or better, the plates, we shall see that the cells are arranged in two great groups, corresponding to the brachial and lumbar enlargements, which are connected by the slender dorsal region. We can then divide the spinal cord into three regions—one for the 1st–3d nerves, the second for the 4th–6th nerves, and the third for the 7th–10th nerves. We will consider each separately:

TABLE XV.

No. of Frog	49	18	12	36	25	42
Cells of brachial region	2076	2828	3204	4061	5306	5104
Total Cells	4871	6758	6892	8539	11131	11517
Per cent. of cells in brachial region	44.6	41.6	46.8	47.5	47	45.1

The length of this region does not correspond to the number of cells, as seen by

TABLE XVI.

No. of Frog	49	18	36	25	43
Length of cord, mm	4.1	7.6	11.6	13.9	14.7
Length of brachial region	1.2	2	3.5	4	4.8
Per cent. of total length	29.2	26.3	30.1	31.6	32.7

The cell-bearing part of the cord, only, is measured, and the table shows that the cells lie far closer in the brachial region than in the succeeding ones. It is also plain that there is no correspondence between the outside measurement of diameter of cord, or of the gray matter, and the number of cells contained.

It is further noticeable that the cells are very regularly distributed in the brachial region. There is a sudden rise in number, a tolerably regular maintenance of a maximum, and a rapid diminution at the close of the region. This fact is due to the direction of exit of the fibres, it being, as before said, at right angles to the cord. Part of the third ne v indeed passes forward and so serves to still more clearly mark the line between the first and second regions. It is not easy to draw a line between the second and third regions. In both the nerves pass off obliquely, and the roots overlap each other in such a way that no sharp rise is seen and no line of division can be drawn.

The two posterior regions together contain, in percentages, the following number of cells.

TABLE XVII.

Number of Frog	49	18	12	36	25	42
	55.3	58.3	53.2	52.5	52.9	54.9

In the second region it is not possible to find, in most cases, enlargements corresponding to the nerves. The cells are pretty evenly distributed.

In the third region several facts are noticeable:

1. The small number of cells in proportion to the weight of muscle supplied. The weight of the leg muscles is far greater than that of the arm muscles, but the ganglion cells, though larger are scarcely more numerous. The fibres of the muscles are much larger in the leg, and of course, investigation should turn on the relation of number of cells to fibres. This has not been worked out.

2. The cells increase gradually to a maximum and very rapidly fall off in number at the rear end.

3 The position of the maximum is variable and probably depends on the relative size of the nerves going into the lumbar plexus. This is well seen in Frog No. 43, where both fibres and cells were counted. An unusually large 10th nerve was found and the maximum of cells is unusually far back. In general the maximum lies near the exit of the 8th nerve.

4. It may be inferred that the nerve fibres do not go far in the cord before uniting with a cell.

5. There is a long string of scattered cells at the posterior end often ½ mm. long.

The exact relation of the maxima of cells to the points of exit of the nerves is not easy to determine on cross sections which alone I have studied. The third nerve passes as already said, forward, and the roots of the posterior nerves overlap. Longitudinal sections prepared by other methods will give conclusions on this point.

A word may be said on the relation of length of cord and number of cells, though no proportional relation was found.

TABLE XVIII.

Frog, No.	49	18	36	25	42
Length of cord, mm	4.1	7.6	11.6	13.9	14.7
No. of cells	4871	6758	8539	11131	11517
Cells per mm	1189	905	636	800	783

It is plain that the length increases more rapidly than the number of the cells. The length is necessarily taken from the imbedded cord. Proportional results are probably not impaired by this fact, although the exception to the series seen in No. 36 may rest on some irregularity in shrinking during imbedding.

A comparison of cells per mm. in brachial and lumbar regions may be interesting.

TABLE XIX.

Frog, No.	49	36	42
Weight of frog, grammes	1½	67	111
Cells, per mm. brachial	1730	1160	1063
Cells, per mm. lumbar	1352	791	784

The cells lie more closely than in the brachial region, and the number of cells decreases per mm. with the growth of the frog more rapidly in the lumbar than in the brachial region. This fact is plain also in the outer form of the cord which gradually changes from a conical to a cylindrical form. The change is also more rapid in youth than later.

III. Relation of Motor Cells and Fibres.

In frog No. 42, the motor fibres of the right side and the cells were both counted as given in the preceding pages.

The number of motor fibres in the ten nerves on the right side was 5,734.

The number of ganglion cells was, right, 5,777; left, 5,740. The correspondence is so close that we can well conclude that for each motor nerve fibre there is present a ganglion cell in the anterior horn of the cord, and that all ganglion cells therein contained are connected with motor nerve fibres.

Other countings gave the following result:

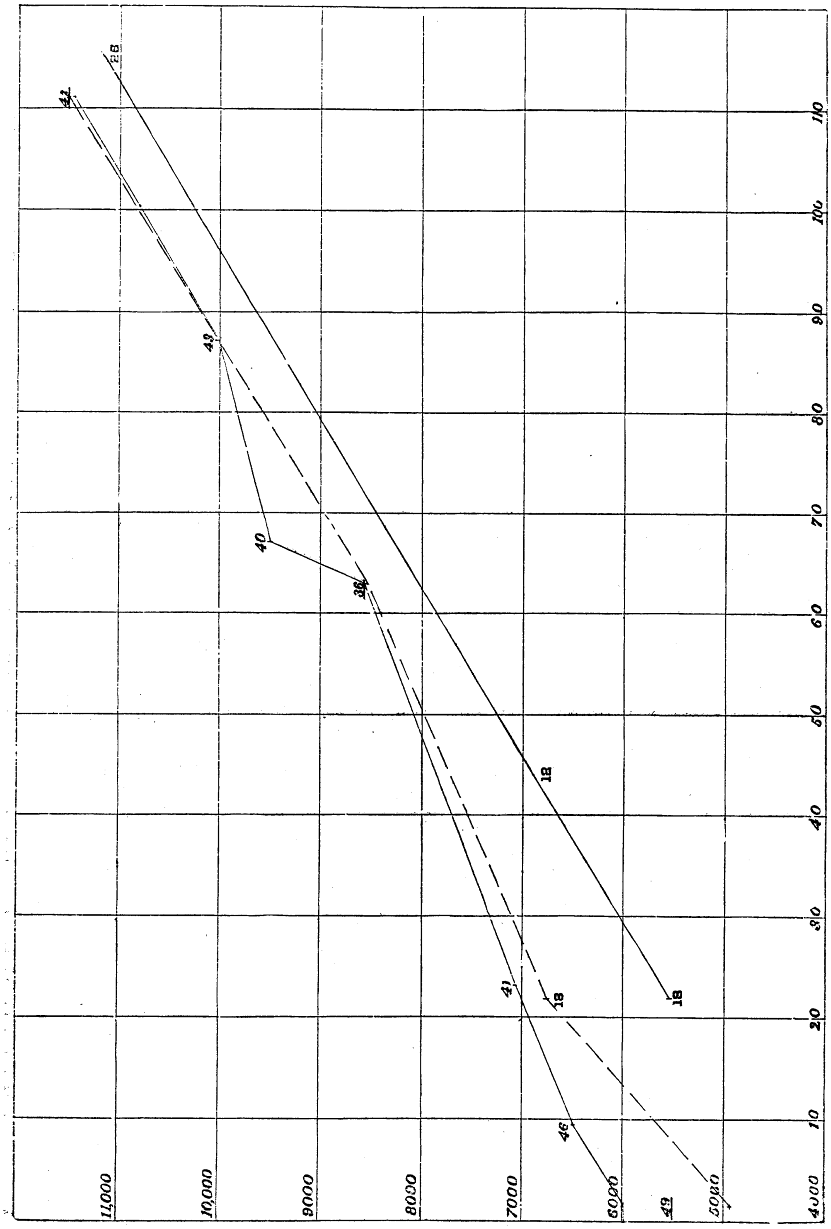
TABLE XX.

No. of Frog	49	36	42
Motor Fibres of one side	2,992	4,283	5,734
Ganglion Cells of right side	2,457	4272	5,777
Difference	+535	+43	−43

The great difference between the fibres and cells of frog 49, was a surprise to me. It is, however, easily explained. As already said, the nervous elements in a small frog are smaller than in the larger ones. There are thus a larger number proportionately of small cells and fibers. But while osmic acid discriminates easily from the smallest fibres, the corresponding cells are hardly distinguishable from the large embryonic cells found in great numbers in the cord of developing frogs, like the one in question. I therefore suppose that the number given for the fibres is probably the true number for the cells.

I append a figure in which the weight of the frog serves as the axis of abscissas, and the number of ganglion cells and nerve fibres as that of ordinates. It will be seen that there is quite a close correspondence between the lines of cells and and fibres, but that the former shows a too cupid decline in the region of the smaller frogs. The lines should probably run parallel and would do so were the methods for discriminating cells as good as those for fibres.

In Fig. 1 the figures on the lower side of the cut represent the weight of the frogs in grammes; those on the right of the cut, the number of cells or fibres. The broken line represents the curve of the ganglion cells. The upper line shows the nerve fibres, and the lower line the large ganglion cells in those frogs where only those cells were counted. The numbers in the cut refer to those of the frogs examined.



11,000
10,000
9000
8000
7000
6000
5000
4000
10
20
30
40
50
60
70
80
90
100
110

Fig. 1.

It remains to briefly consider the relation of the fibres and cells of different regions.

TABLE XXI.

Frog No.	36	42
Fibres, Nerves 1–3	4578	6122
Cells of brachial region	4061	5104
Difference	—517	—1018
Fibres, Nerves 4–10	4088	5346
Cells of dorso-lumbar region	4478	6423
Difference	+390	—1067

The table shows that we have too many cells in the dorso-lumbar region, too few in the brachial. The latter must therefore draw on the former, and, as already remarked, there are ascending fibres from the middle region of the cord.

We can also determine the point where the supply for the lumbar plexus begins.

The first six nerves contain in Frog 36, 5236 fibres, in 42, 7040. In figures II and III this point is marked with *d*, a point in the middle region just above the lumbar enlargement. This confirms previously advanced views.

IV. Number of Sensory Fibres.

The following table gives the facts so far as I have investigated them.

TABLE XXII.

	No. 41, ♂ Wt. 23 Gr.				No. 36. ♀ Wt. 63 Gr.			
Nerve.	Motor.	Sensory.	Sum.	Trunk.	Motor.	Sensory.	Sum.	Trunk.
I.	652	78	720	718	783	124	907	908
II.	1098	1230	2328	2563	975	1649	2624	3041*
III.	226	143	369	370	481	264	745	749
IV.	119	185	304	301	106	193	299	297
V.	92	188	280	279	114	224	338	339
VI.	137	176	313	314	159	184	343	341
VII.	137	470	608	607	142	562	704	703
VIII.	501	737	1238	1243	870	1101	1971	1955
IX.	450	547	997	1001	441	993	1434	1633*
X.	112	27	139	141	212	41	253	253
Sum.	3524	3781	7295	7325	4283	5335	9618	

It will be seen that except in two cases there is a close agreement between the sum of the roots and the trunks. In those two cases the nerve was so large as to be unstained near its exit from the spinal column, and sections were taken lower down, where the nerve may have been joined by other nerves.

It is plain, (1) that the number of motor fibres is smaller than that of the sensory; and (2), if these two frogs may be taken as examples, that the number varies with the weight of the frog, but not according to the same law as do the motor fibres.

V. Functions of the Motor Ganglion Cells.

Experiments were made with a view of directly determining the function of the group of cells whose numbers were counted. The frog's brain was destroyed and the spinal cord exposed. It was then fastened on a plate like the mechanical stage of a microscope, and its tendo achillis was connected with a registering drum in the usual way. A very fine needle was plunged into the cord by means of a rack-and-pinion movement. It was first inserted into the center of the cord, then withdrawn, the frog was moved one-tenth mm. and the cord again pierced, the needle withdrawn, and the operation was repeated until the whole breadth of cord was passed below the needle. The usual effect of the prick was either nothing or a twitch of the muscle; at one point, however, a tetanus was produced. To determine this point the cord was hardened, imbedded, and a section made at the point experimented upon; a drawing of the section was then divided into as many equal spaces as there had been needle pricks, and it was found that *those pricks which caused a tetanus passed through or close to the group of large ganglion cells.* This was the case whether the cord was pierced from the side or from above. We may then conclude that these ganglion cells have the power of converting into a tetanus, a stimulus which, if applied to the nerve would cause merely a single twitch.

EXPLANATION OF PLATES.

Plates I and II are a graphic representation of the tables X–XV., and show the number of cells for each one-tenth mm. of length of spinal cord. The vertical line marked O serves as the axis of abscissas and contains as many units of length as does the given cord one-tenth mm. On each side are ordinates erected whose length corresponds to the number of cells at the given horizon. Each space on this axis stands for ten ganglion cells. The figures are placed vertically so as better to show the right and left, anterior and posterior directions of the cord. In Fig. IV. the points of exit of the nerves are marked.

One source of error in the plates should be noted. It is assumed that the sections were cut at right angles to the spinal cord. Since this is never exactly true it happens that a small bilateral asymmetry exists in the figure which may not be found in the cord.

Fig. I. see Table X., page 67.
Fig. II. see Table XI., page 68.
Fig. III. see Table XII., page 69.
Fig. IV. see Table XIII., page 70.
Fig. V. see Table XIV., page 72.

Fig. I

Number of Cells in $\frac{1}{10}$ mm.

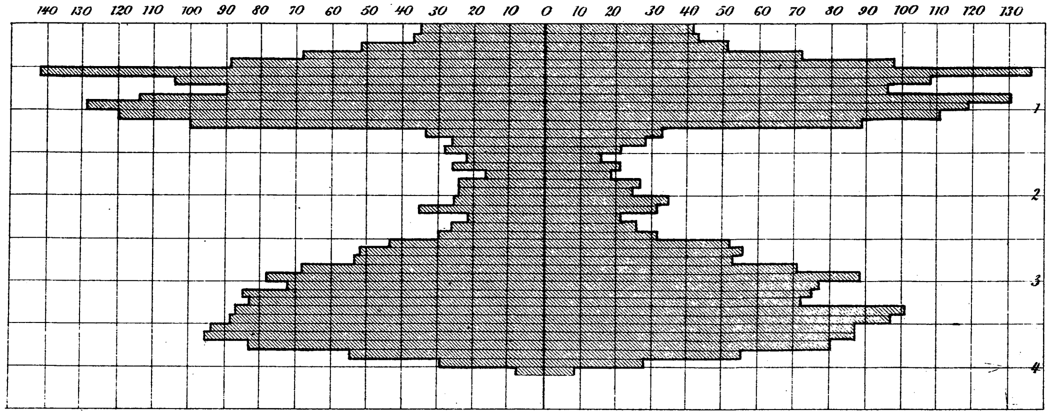


Fig. II

Number of Cells in $\frac{1}{10}$ mm.

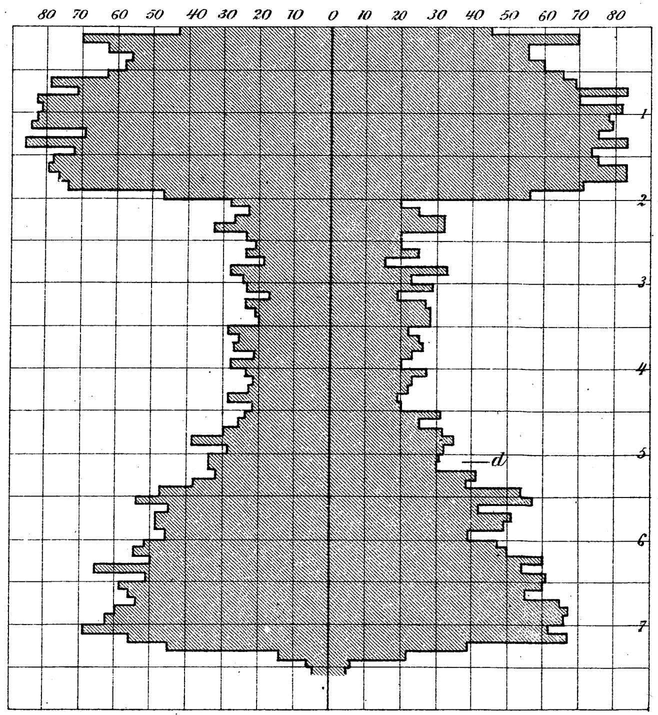


Fig. III.

Number of Cells in $\frac{1}{10}$ mm.

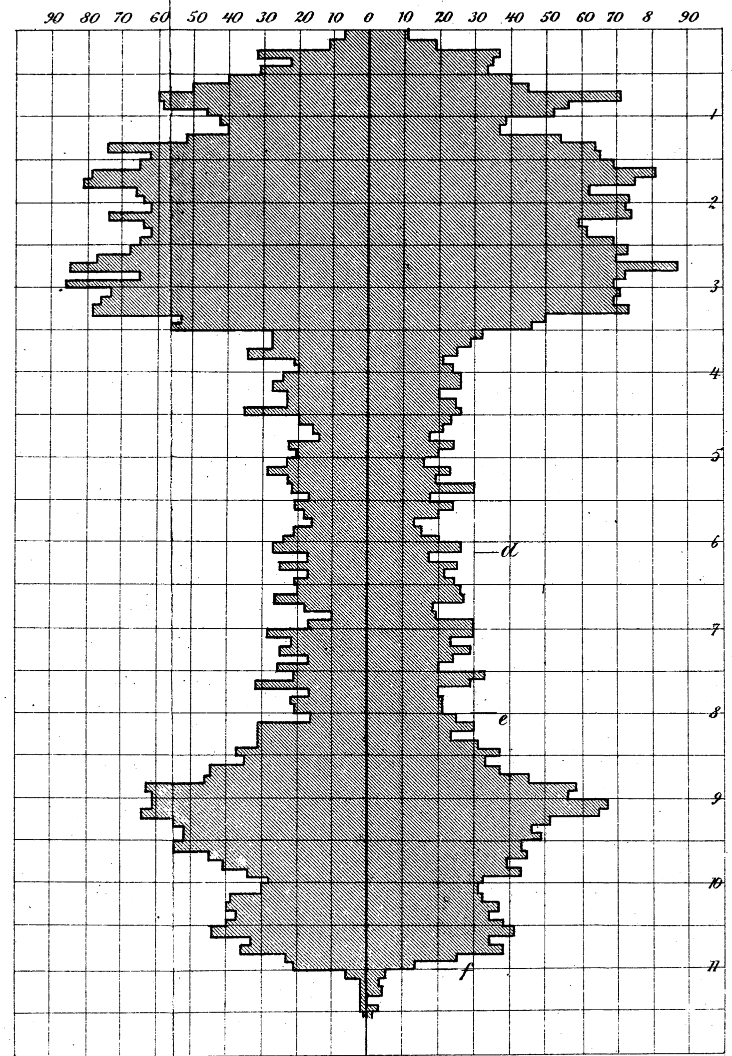


Fig. IV.

Number of Cells in 1/10 mm.

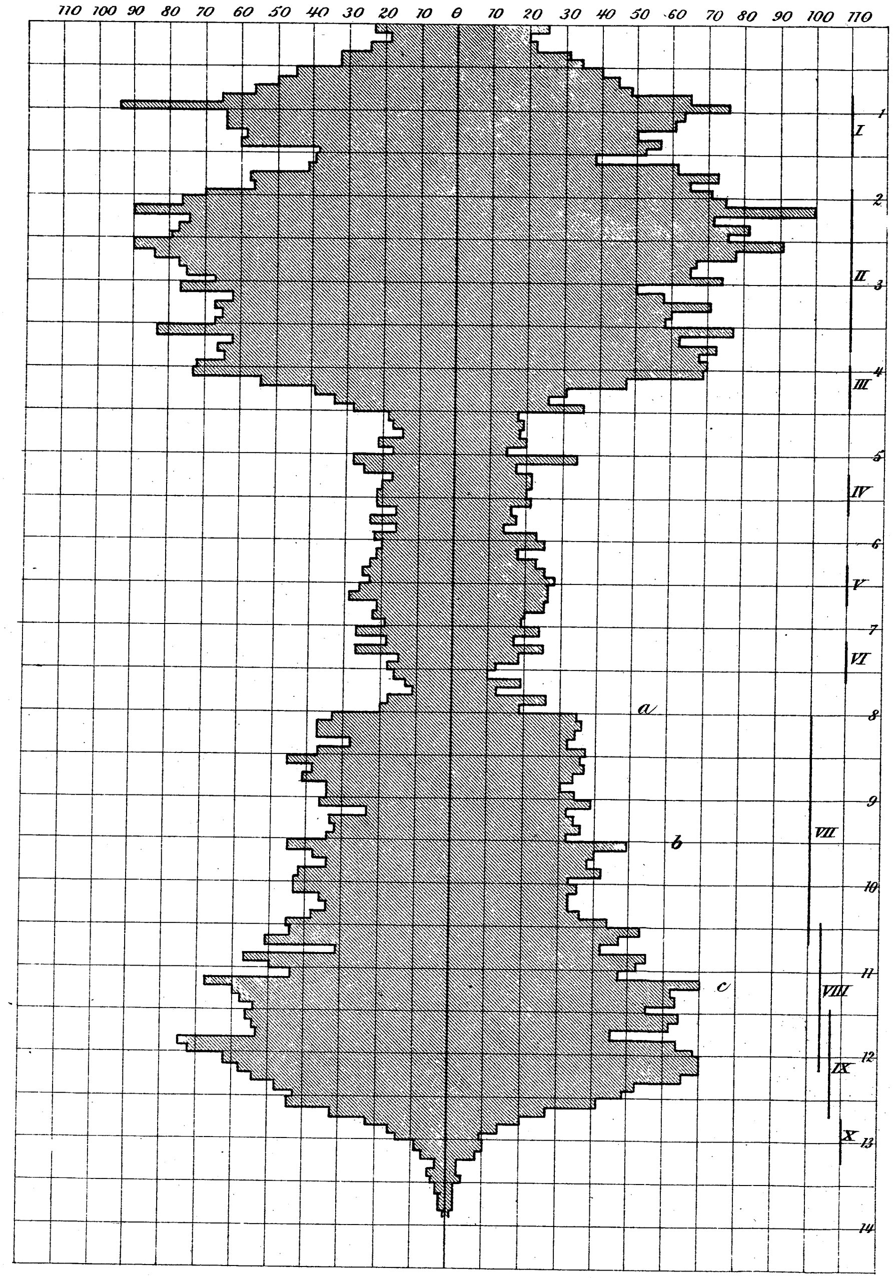
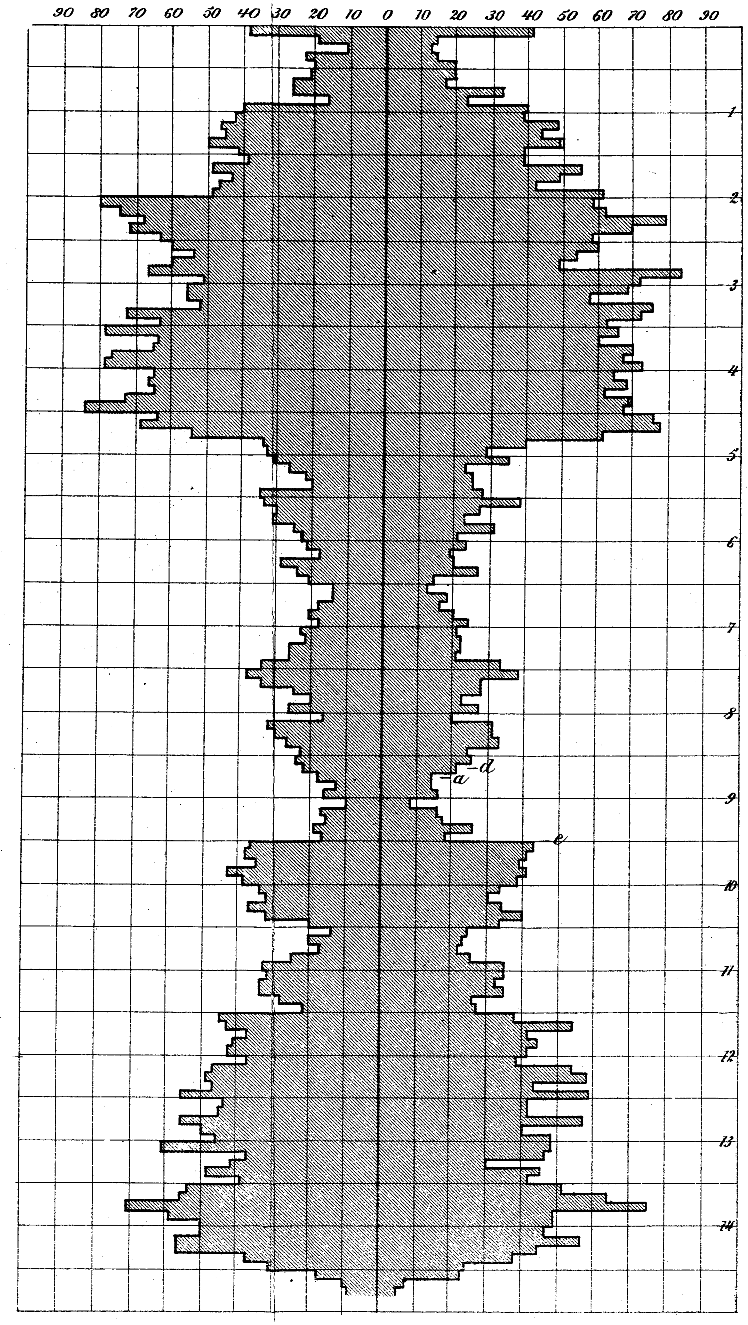


Fig. V

Number of Cells in 1/10 mm.



THIRTEENTH ANNUAL MEETING.

DECEMBER 26, 27 AND 28, 1882.

PROGRAMME.

TUESDAY, DEC. 26, 7:30 P. M.

Business Meeting — Reports of Officers.

WEDNESDAY, DEC. 27, 9:30 A. M.

Unfinished Business.
Paper: "Who built the Mounds."— Dr. P. R. HOY, Racine.
Paper: "Who made the Copper tools"— Dr. P. R. HOY, Racine.
Paper: "Greek Religion."— Prof. J. EMERSON, Beloit.

AFTERNOON SESSION, 2:30 P. M.

Paper: "Portraits of Columbus."— J. D. BUTLER, L.L. D., Madison.
Paper: "List of Fungi collected in Wisconsin." — WM. TRELEASE, Madison.
Paper: "Insanity."— A. O. WRIGHT, A. M., Madison.
Paper: "Our knowledge of Stellar Motion."— Prof. T. H. SAFFORD, Williamstown, Mass.

EVENING SESSION, 7:30 P. M.

Paper: (Institute of Christian Philosophy.) "The Unity of Moral Ideas." Rev. C. CAVERNO. Lombard, Ills.

THURSDAY, DEC. 28th, 9:30 A. M.

Paper: "The effect of local attractions on the Plumb line and Sea level." — Prof. J. E. DAVIES, Madison.
Paper: "Nature and Freedom."— Prof. J. J. ELMENDORF, Racine.
Paper: "Sorghum Sugar."— M. SWENSON, M. S., Madison.

AFTERNOON SESSION, 2:30 P. M.

Paper: (Institute of Christian Philosophy.) "The Ideal Man."— Prof. J. J. ELMENDORF, Racine.
Paper; "The Sochemanni."— PROF. W. F. ALLEN, Madison.

EVENING SESSION, 7:30 P. M.

Unfinished Business.
Paper: (Institute of Christian Philosophy.) "The Universality of Law."— Pres. JOHN BASCOM, Madison.

WHO BUILT THE MOUNDS?

By Dr. P. R. Hoy, Racine.

This question is often asked and variously answered. I purpose to treat the subject with due candor, offering such evidence only, as I consider authentic. Let us have the truth, though it should undermine the fanciful poetic fictions that have, from time to time, been advanced as the true solution of this mooted question. We read in papers and books on this subject, that the great antiquity of works is proven by the trees on or near them that a mound or fortification must be of great age for the trees were from three to four feet in diameter, or the very indefinite expression, there were *large trees* growing in such and such a locality.

Aside from the love of exaggeration, I am persuaded that there is a large margin for error in counting three or four inches of the outer margin of trees and thereupon estimating the age by multiplying the semi-diameter by this partial count.

The giant trees of California have been over and over again declared to be from three to four thousand years of age. In 1875, J. G. Lemmons was sent to ascertain the exact truth and report at the Centennial. On repeatedly counting the rings of at least a dozen trees, he found that their ages were from 1,000 to 1,500 years.

The celebrated tree, the stump of which is used as a floor for a ball room, is just 1,260 years old. Lemmons, during these investigations ascertained that by counting the rings on the outer foot and then, by this, estimating the age, the years would be doubled, for the growths varied from one-third of an inch in the interior, to the thickness of paper on the outside. So after repeated trials, he found that by counting a section one-third of the distance from the inside of the bark toward the centre, the age thus ascertained would correspond with the entire count. This rule was of great value to him in ascertaining the ages of the old prostrate trees. (Botanical Gazette, Vol. 3, Nos. 10 and 11.)

I have measured and counted the rings of many trees and find that in most forest trees Lemmons' rule is equally applicable.

Observation proves that forest trees acquire considerable size in comparatively few years. It is a rule in forestry to cut off the timber in 100 years from the planting, as it is then sufficiently large for all purposes, and after the expiration of one century the waste, decay, etc., equals the increase by growth. The fine shade trees that line our streets in Racine, more especially in the Second ward, are a source of pride and comfort to the citizens. I was one of the earliest settlers in this ward. In 1846–7 an organization for the purpose, planted trees some of which, by this time, have attained somewhat remarkable size. I have recently measured some of the largest. The white elms, *Ulmus Americana,* are from six to eight feet in circumference two feet from the ground. Maples from four to five feet; black and golden willows, eight feet; poplars, *Populus Candicans* eight and a half to nine feet. Not long since I had an opportunity of counting the rings and accurately measuring one of these street elms, finding the diameter two feet from the ground, inside of the bark, twenty-four inches, rings forty-eight,—an average of just one-fourth of an inch to a ring, giving an increase in diameter each year of one-half an inch.

Benjamin Bones, living four miles from Racine, cut down in 1870, a large white elm and on splitting it discovered, four inches from the centre, a blaze which included a hack evidently made by a sharp ax. He brought me a section of the tree including the blaze. There were one hundred and eighty-eight rings outside of the hack, measuring twenty-two and a half inches from inside of the bark to the blaze. Counting back and adding two years for the growths to cover the scar, we found that the period corresponded with Hennepin's first voyage along the west coast of Lake Michigan. A few years before this discovery Dr. Lapham and I amused ourselves tracing Father Hennepin's voyage. We located the spot where he halted and spent several days to recuperate. He says: "At this station the natives and voigeures we had with us killed plenty of stags, wild goats and many turkeys, big and fat." The point where we located this halt is not over one-half a mile from this famous historic tree, which was fully four feet in diameter. It is probable that 203 years ago some of Hennepin's party blazed an elm sapling as a guide, and now the marks of that hatchet are revealed as sharp and distinct as when first made.

At the time Dr. Lapham and I surveyed the large group of mounds, near Racine, in September, 1850, there was a pin oak sapling growing on the centre of a small mound situated near the house of William Bull. That sapling is now fifty-six inches in diameter although that species of tree is ordinarily not a rapid grower.

Trees that are planted on the mounds, in Mound Cemetery have made a rapid growth being much larger than those planted at the same time in the adjacent grounds.

It has been asserted over and over again, without fear of contradiction, that the "Mound builders were an agricultural people and the Indians not." The truth is that the Indians well deserved the name agricultural.

When white men came to America they found corn in cultivation from latitude forty degrees south, to the St. Lawrence river of the north. Corn must have originated in a warm country, probably in Mexico. How it could have been adapted to the short summers of the regions so far north, is a matter of interesting inquiry. Without other agricultural education than that derived from their own unrecorded and necessarily imperfect observations, the Indians pushed the production of corn from the Gulf of Mexico to the St. Lawrence, Canada, ages before the white man visited them, and it was to the natives that the early settlers were indebted, not only for the seed corn, but for instruction as to planting and cultivation. An annual like corn may extend itself east or west along the same isothermal line by accidental causes, but it could not have moved into a much colder climate without skillful cultivation and careful attention to the selection and improvement of variety. It must have required ages to change it to such a degree as to fit it to grow and ripen in Canada.

When the Pilgrims first came among the Indians they bought great stores of venison and eight hogsheads of corn and beans. (Mourt's Relations. Drake, p. 79.) King Philip, *Metacomet,* was surprised and driven from his home on Mount Hope. The Pilgrims took "what he had worth taking, and spoiled the rest, and also took possession of one thousand acres of corn, which was harvested by the English and disposed of according to their directions." (Old Indian Chronicle. Drake, p. 209.) In the history of the Pequod war it is recorded that the Pequods had "two plantations three miles in sunder, and above 200 acres of corn, which the English destroyed." [Mourt's Relations. Drake, p. 116.) At Philip's Fort, in Rhode Island, there were 500 bushels of corn, stored in sections of hollow trees, each holding about one barrel. These "gums" were so placed as to afford a formidable breastwork. (Dr. I. Mather. Drake, p. 218.)

In the war between the Narragansets and the combined forces of the Mowhegans and Pequots, the latter "committed extensive robberies and destroyed twenty-three fields of corn." This occurred in 1637, so says Roger Williams. (Drake, p. 123.)

In Wisconsin, the Winnebagoes, Menomonies and Pottawatomies raised more corn than they required for their own use Clark says: "Gen Atkinson purchased, he thinks it was 6,000 bushels of corn of the Winnebagoes. In 1848, when my brother and I traveled extensively through Wisconsin, we drove in several instances over old Indian corn-fields, one of which in Columbia county, extended over half a mile. An old pioneer living near by told us the Winnebagoes had cultivaed this large corn-field. The Mandans and Riccarees of the west cultivate corn not only for their own use, but also enough to make it a prominent article of trade." (Antiquiites of Wisconsin, page 90.)

Gen. Wayne in his official report of a battle with the Indians of Northwestern Ohio in 1783, says: "A vast destruction of Indian property took place during the expedition. The very extensive and highly cultivated fields and gardens show the work of many hands. The margins of the beautiful rivers appeared like one continuous village for many miles, nor have I ever before beheld such immense fields of corn. All were laid waste for twenty miles on each side of the rivers." In Western New York there were large fields of corn according to Champlain and Kirtland. In Eastern New York, Hudson mentions there being in several places extensive fields of corn. Marquis De Nouville in his celebrated expedition against the Seneca Indians says: "On the 14th of July, 1685, we marched to one of the large villages of Senecas where we encamped. We remained at the four Seneca villages for ten days. All the time we spent in destroying the corn which, including the old corn that was in *cache,* which we burned, was in such great abundance that the loss was computed at 400,000 minots or 1,200,000 bushels of Indian corn!" This was in Ontario county, New York. (Aboriginal Monuments in the State of New York, pp. 63 and 66.) Newport went up the Powhatan River to visit Powhatan in 1607. He states that Powhatan had extensive fields that came down to the river in which he cultivated corn, beans, peas, pumpkins, tobacco and flax. (Churchill and Holmes, Pickering p. 926.) De Soto speaks frequently of Indian villages that contained from 150 to 600 dwellings constructed of wood; sometimes walled in with stone and protected with tall palisades driven into the ground and surrounded by extensive fields of maize, beans, peas, pumpkins and other vegetables. In one instance he relates that his army passed through continuous fields of maize for two leagues—not a small field of corn even at the present time.

De Soto subsisted his army of one thousand men and two hundred and thirteen horses on the Indians' produce. At one place he took corn enough to feed his entire army for five days. He writes, "on Oct. 18 we came to Mobile, a walled city. which we captured and where we rested forty days. Found great stores of bear's fat, oil of walnuts and honey of bees stored in gourds. On March 3d, departed north with maize enough for sixty leagues."

De Soto's army wandered among and lived on the Indian four and a half years. It certainly took no small amount of corn and other provisions to subsist such an army for so long a period. The Seminoles, Cherokees, Chicasaws, Choctaws and Creeks were certainly a well-to-do people in an agricultural sense, at that early day, 350 years since, before the introduction of whiskey, which has well-nigh paralyzed their energies.

It is not uncommon for authors to assert confidently that the mounds were erected by a different race of people from the modern Indians, for the latter have no tradition of the mounds, by whom and for what purpose they were built. Let us consider the subject of *Indian Tradition.* Bartram, the zoologist and botanist, traveled in Georgia, Tennessee, Florida and South Carolina a little over one hundred years ago. He says: "At the Cherokee town of Cowe, on the Tennessee river, which contains one hundred houses, he noticed that the council house, a large rotunda, capable of accommodating several hundred people, stood on the top of an ancient artificial mound of earth, of about twenty feet in perpendicular elevation. The Cherokees themselves could give no account when or by whom the mound was built." At another important Cherokee town, Bartram saw a most remarkable column. It stood adjacent to the town, in the center of an oblique square, and was about forty feet high, and only from two to three feet thick at the base, and tapered gradually to a point at the top. What is remarkable about this pillar is, that notwithstanding it is formed of a single piece of pine timber, the Indians or white traders could give no account for what purpose or at what time it was erected. All the Indians that Bartram asked gave the same answer, which was that the ancient Indians found it there, and that their fathers knew nothing about it. This fact, says Bartram, is not singular, when reference is had to the mound of earth, but when the same answer is given concerning a perishable material, there is at least some slight ground for suspicion.

Another singular circumstance is that no pine trees grew nearer than twelve miles from this point. (Drake's Indians of North America, p. 63.)

None of the Indians at the present time have traditions running back as far as Allouez and Marquette, or even to the more recent time of John Carver. Is it not strange that they have no knowledge of these men? The Winnebagoes and Menomonees assert positively that they never made flint arrowheads, stone axes or pottery, and that these things must have been made by some one else. White Snake, a chief of the Winnebagoes, said in all sincerity, they were never made by the Indians. (Antiquities of Wisconsin, p. 90, Smithsonian Report of 1879, p. 430.)

In view of these facts what weight has the lack of tradition respecting the mounds? Just none at all.

Jefferson, speaking of the barrows or mounds of Virginia, says: "But on whatsoever occasion they may have been made, they are of considerable notoriety among the Indians. About thirty years ago a party of Indians passing through that part of the country where a mound was situated, went through the woods directly to it, without instruction or inquiry, and staid about it for some time with expressions which were considered those of sorrow. They returned directly to the high road and pursued their journey after spending one half of a day in visiting the mound." (Drake's Indians, p. 56.)

Dr. Samuel Drake studied many of the mounds of Ohio. After describing stone axes, copper implements, flint arrowheads, teeth of carnivorous animals, mica and bone implements, shell beads, and various patterns of pottery, etc., he remarks, "this pottery was made of the same materials employed by the Louisiana Indians within my own recollection, namely, powdered muscle and other river shells, sand and clay."

Dr. Drake, in speaking of the rough stone walls found in several localities in Ohio, said that they were similar to those constructed by the Cherokee Indians of the south. (Drake's Indians, p. 57.)

Atwater, in 1819, surveyed and studied a large number of the ancient works of Ohio. He says: "What the true height of these ruined works was, cannot be very well ascertained, as it is almost impossible to know the rate of their diminution even were the space of time given. But there can be no doubt that most of them are much diminished by the action of the tempests which have swept over them for ages. That they were the work of a different race from the present Indians, has been pretty confidently asserted; but, as yet, proof is entirely wanting to support such a conclusion. In a few instances European articles have been found in and about some of these works. But few persons of intelligence pronounced these works older than others of the same kind found occupied by the Indians at the time of the French wars." (Drake, p. 60).

Bartram in his travels in Florida relates: "The Indians collected the bones of the tribe and proceeded in a solemn manner to excavate a hole in the ground in which they deposited the bones, and after covering them up they elevated a *circular mound of earth over the spot.*" (Bartram's Travels, p. 514. New York Aboriginal Monuments, p. 68.) When Gen. Oglethrop landed in Georgia, in 1732, he communicated to the Indians the contents of the journal of Sir Walter Raleigh. They pointed out to Oglethrop a place near Yamacran bluff on which there was a large mound in which was buried, they said, a chief who had talked with Sir Walter Raleigh upon that spot. The chief had requested his people to bury him there. (Commissioners' Report on Georgia Affairs, p. 119. Drake's Indians, p. 369.)

A mound opened by Jefferson on the Ravenna river was attributed by him to recent Indians. (Jefferson's Notes on Virginia.)

A document accompanying the President's message of 1806 describes a mound of considerable size erected by the Natchez Indians when they were expelled from Louisiana (President Jefferson's Documents). Forbes was of the opinion that the mounds, thirty miles south of Natchez were erected by the Cherokee Indians. He states that the trees growing on the mounds were decidedly smaller than those growing on the adjacent grounds.

La Salle and his companions visited, two hundred years ago, the Natchez Indians. The town was surrounded by strong earthworks defended by tall stakes. They kept a perpetual fire burning on a mound which was forty-five feet high.

Bartram says in his Antiquities of Southern Indians that in his day the Choctaws erected mounds over the bones of the dead. The chief, *Tomachechi,* pointed out a large mound in which were the bones of a chief who had entertained a great white man with a red beard who came into the Savanna river in ships.

Walker describes many of the Florida mounds in the Smithsonian report of 1879. He excavated systematically a mound at the mouth of the Kootre river. A skull taken from the centre and base of the mound was broken in and inside of the head he found a *rusty iron spike* about three inches in length and a broken arrowhead. Excepting some highly ornamental fragments of pottery, these were all the relics he obtained in this mound. Walker also opened a mound on the south side of Alligator creek. This mound was circular in shape, forty-six feet in diameter, and about three feet in height.

He found many strings of colored glass beads, copper and brass ornaments. Among other curious objects was a pair of scissors and a fragment of a looking glass. By patience and care he obtained many strings of beads in the order they were worn by the owner. In two cases fragments of strings were preserved, seemingly by the copper. Many of the cut glass beads were very beautiful. Walker remarks that this mound could not be older than three hundred and forty years, probably much less. These trinkets may have been derived from De Soto, for tradition points out Phillips point, eight miles north of this mound as the spot where the Spaniards landed. (Smithsonian report 1879, p. 410.)

Dr. S. P. Hildreth opened a mound in Marietta, Ohio, and the circumstances were detailed by the accurate pen of the doctor. He relates: On removing the earth composing an ancient mound in a street of Marietta, the articles found were those belonging to the person over whom the mound was originally made. The articles were silver plated buckles and sword mountings; a streak of rust was all that remained of the blade. The name of Dr. Hildreth is sufficient guarantee that the statements are correct.

This mound must have been erected within a little over three hundred years at most. (Aboriginal Monuments of New York p. 187.)

Several silver crosses, a number of small bags of vermilion and other articles of European origin were discovered by C. A. Vaughn, of Cincinnati, in excavating several mounds in the vicinity of Beardstown, Ill. These articles were found within the skeleton at the base of the mounds. (Ancient Monuments of Mass., p. 146.) A small mound was opened near Chilicothe, Ohio, which was found to contain the skeleton of a girl enveloped in bark. (Ancient Mounds of Mississippi Valley, p. 171.)

In the year 1827, while constructing the Ohio canal a mound was removed under the supervision of William H. Price, at that time a member of board of Public Works. At the base of this mound with the skeleton, was a dial plate and other articles of European origin. (Ancient Mounds of Miss. Valley, p. 146.)

In Benton Township, Cuyahoga County, it became necessary to remove a small mound while excavating the Ohio canal. The remains of one or more human skeletons were found, also a gun barrel and some mountings of the stock. (Ancient Mounds of Miss. Valley, p. 146.)

In Green township, Chenango county, N. Y., there was a mound four feet high situated near Chenango creek, which was opened in 1829.

The mound had a pine stump standing on the top. Great numbers of human bones were found. These skeletons were lying without order, much decayed,and they crumbled on exposure. There were two heaps of flint arrowheads, one of which contained 200 of the usual pattern, color, black and yellow. At another point of the base of the mound, there were more than half as many of a smaller size. In the same mound a silver band or ring two inches in diameter, a number of stone gouges or chisels of different shapes and a piece of mica, heart-shaped and much decayed. (New York Aboriginal Monuments, p. 34.)

A remarkable work situated in Oneida county, N. Y., described by M. B. Clark, was inclosed with two rows of cedar palisades, they being twelve feet apart and inclosing ten acres. When the ground was first plowed the burnt stumps of these palisades were turned up. In this fort there were six mounds, the largest of which was opened.

Near the base there was a layer of ashes beneath which were human bones, many trinkets made of red pipe stone (catlinite) and a great store of old iron articles consisting of axes, files, knives, etc. (N. Y. Aboriginal Monuments, p. 171.)

Lewis and Clark speaks of a mound in which a great chief of the Omahas had been interred. He was buried upon a hill and a mound six feet in height and twelve feet in diameter was erected over him. (Lewis and Clark Travels West of the Mississippi, New York Monuments, p. 107.)

Beck mentions a large mound on the Osage river which had been erected within the last thirty years by the Osages in honor of a dead chief. (Missouri Gazette, p. 308.)

James, in 1816, upon what he deemed good authority, gives an account of the discovery of a new-made mound which, when opened, disclosed the body of a white officer placed in a sitting position on a mat. (James' Expedition, Vol. 2, p. 38.)

Lapham discovered a mound situated in the town of Oak Creek, Milwaukee County, Wis.

This isolated mound was six feet in height. The sides were much steeper than any he had seen, which indicated that the mound was comparatively recent. Time sufficient to level down or spread out the mound had not elapsed. (Antiquities of Wisconsin, p. 10.)

The mounds near Lake Koshkonong, Jefferson county, Wisconsin, are of a recent construction, as proved by the bones being well preserved and containing considerable animal matter. The numerous bone implements and shell beads, wampun are alike well preserved.

I have studied carefully the large group of mounds situated near Racine, and have excavated fifty of the original one hundred and thirty-eight, which Dr. Lapham and I surveyed in 1850. These Racine mounds being of the oldest type, the bones are entirely destitute of animal matter. I asserted that the specimens exhibited at a meeting of the

Wisconsin Academy of Science, Arts and Letters from Koshkonong were of secondary interment, notwithstanding I was assured they were taken below the center of the mounds, under a stratum of cement, composed of burnt-fresh water shells. In order to prove or disprove Mr. Clark's investigation, a party of scientific men went from Milwaukee and opened one of these Koshkonong mounds. They ran a wide excavation through the center of the mound, starting two feet below the surface of the ground. They were rewarded and fully confirmed Clark's statement, and proved that these mounds are of no great age.

Dr. Sternberger, of the U. S. Army, critically examined certain mounds near Pensacola, Florida. These mounds proved to have been constructed by Indians, as blue glass beads were found in several of them.

Catlin observed a conical mound ten feet in height, erected over the body of a young chief of the Sioux tribe who had been accidentally killed on that spot. (N. A. Indians, vol. 2, p. 107.) James Mathew, a brother of Rev. Father Mathew, of Racine, settled on Zumbro River, in Olmstead county, Minnesota, in 1860. When he first plowed the land there was a mound six feet high and twenty feet in breadth, and so situated that it was in the way of properly cultivating the land, so he made the attempt to plow it down. He sank the plow to the beam repeatedly, but succeeded in reducing the height about two feet. The next year he procured a scraper, and went to work systematically to remove the entire mound. After scraping down the eminence to within about two feet of the base he came to some rotten wood. On carefully removing the top he discovered a kind of cage built of large stakes driven into the ground, as close together as possible, and covered with a split log, finished by plastering the outside thickly with clay, thus forming a rude lodge which was about three feet long and a little less in breadth. In this pen he found one skeleton of an adult in a good state of preservation and with the bones were found two iron hatchets, a dozen flint arrow heads, a copper ring two inches in diameter, a lot of shell beads and a red stone pipe of rather large size and ingeniously ornamented with lead.

Father Mathew visited his brother a few days after this find. On his return he brought the entire lot of implements with him.

George A West, an intelligent and thoroughly reliable gentleman, wrote me an accurate description of a mound opened, and of the interesting relics obtained. His letter is as follows:

RACINE, WISCONSIN, Jan. 15, 1881.

DR. HOY, SR.:

Dear Sir — Knowing that for years, the works of the mound-builders have been closely studied by you, allow me the pleasure of describing to you a few particulars in regard to a mound opened by me in the year 1870.

When an uncle of mine by the name of Davis, was trapping on Root river, in the town of Raymond, Racine Co., he discovered two small mounds on the northwest quarter of section 15. The mounds were situated on the east bank of the river, above highwater mark, yet very near to the stream, on a sand bank. One was partly eaten away by the stream, and the other, situated a few rods away, was covered with hazel brush, with a few large trees standing near by. The mounds were each about ten feet across and two and a half feet above the level of the surrounding ground.

We concluded to open the remaining mound; so after removing the hazel brush and digging about three feet through sand and roots, we came to a bed of hard blue clay, which we threw out in chunks; beneath the clay we came to a sort of a cavity containing fragments of bone and dark streaks of earth, which marked the location of what was at one time a human form.

From the appearance of what remained we concluded that the person must have been buried in a sitting posture; for we found a tooth or two where apparently the pelvis was located, which must have dropped from the jaw above. By exercising care we might have preserved a complete cast of the interred, in the hard clay surrounding him.

Near the center of the mound we found a copper kettle, with a hole in its bottom; within the kettle there was a quantity of dark earth, which was composed mostly of vegetable matter; being such a shapeless mass we were unable to determine just what it might have been. The kettle was about six inches across, with straight sides; it had ears and no bale, and in one place on its side where there had been a hole, there was a rivet inserted, made of copper. The kettle was badly rust-eaten, and when new must have been very thin; Mr. Davis either disposed of it or took it away with him, and where it is remains a mystery. We also found a copper spear head and two irregular pieces of copper. The spear head was about three inches long, with a rivet hole in the shank. The pieces of copper show marks of pounding; they contain particles of silver and quartz, which show that they were never smelted. I am in possession of them. We, before restoring the mound, dug a foot or two in each direction, but found nothing more.

Very truly yours, GEO. H. WEST.

About fifteen years ago, John Elkins, a jeweler of Racine, told me that he had bought a lot of silver trinkets, ear-rings, belt-slides, and a fine double cross. These, he said, were found in a mound situated in a street in Burlington. Supposing these things to have been a secondary deposit, I made no especial inquiry at the time. However, when I received the report from Mr. West of the Raymond mounds, I determined to investigate the Burlington mounds. With this object in view I attended a meeting of the old settlers association, held in a grove near the village of Burlington, Racine Co., Wis. I called upon F. S. Perkins, who accompanied me to the grove to assist in finding the old Burlington pioneers. We found many who knew that a mound had been removed and that there were lots of silver trinkets and some brass kettles found, but they could give me no further information. They all, however, told me to write to Nathaniel Dickinson, of Elkhorn, Wis., and that I would get a prompt reply, and he would give me all the facts as accurately as if the event was of last week, being a man of extraordinary memory. I wrote to him, and on the third day received a reply as follows :

ELKHORN, WISCONSIN, June 26, 1881.

DR. P. R. HOY:

Dear Sir — There were originally three mounds situated near the junction of the White and Fox rivers. In seasons of freshets the locality of these mounds was covered with water. They occupied an irregular triangle, four to six rods apart.

The mounds in shape were each a section of a sphere. The two smaller ones were three feet in height and fifteen feet in diameter at the base. The remaining one was much larger, being six feet in elevation by twenty in diameter. They were composed of the surface sandy loam and apparently built without extended intermission of time.

In the fall of 1852, I was road commissioner and built a wooden bridge over White river, near where it joins the Fox. This bridge has since given place to one of iron. Requiring some earth for filling the approach I removed one of the small mounds that stood on the street.

When we came to the original surface, we found the shape of four persons, two adults and two children. Each was covered with a thick stratum of compact clay thus forming a rude kind of sarcophagus. On breaking open these clay cases we found human bones partly decayed and three copper kettles, one of which had some nuts in it, perhaps Pecans; another had what are supposed to be the bones of a rabbit; also, there were many silver ear-rings breast pins and one beautiful double armed, ringed, silver cross, with R. C. in roman capitals engraved in the centre of the upper arm of the cross, also a large quantity of blue glass beads. The remaining small mound we opened out of curiosity. We sank a wide shaft over the centre; when we came to the original surface of the soil and found one clay covered skeleton in a fine state of preservation. There was one copper kettle of rather large size and a small fur-covered, brass-nailed trunk, ten by twelve inches, and eight inches in height. In this trunk we discovered a lot of cheap silver trinkets. In the kettle there was some brown substance which we could not determine and over this brown substance were two or three folds of a woolen blanket.

I might have said, in its proper place that the clay was obtained on the opposite shore of White river, the only locality where this kind of clay could be procured in this vicinity.

A Mr. Stowell built a house over the large mound and when they dug the cellar they removed a part of this mound but nothing was found; still it may be that the centre of the mound was not disturbed. Kettles, silver and crania were scattered, some by gift, others loaned without exacting a return, so that at this time I cannot direct you where you can obtain any of the relics.

Should you require further information in addition to the above commonplace recital you can make any inquiry that you may wish and I will answer.

Yours truly,

NATHANIEL DICKINSON.

In answer to further inquiry, I received the following:

The clay-covered skeletons were central, and on a level with the original undisturbed soil, the second mound opened we did not sink below the base of the mound, as it would be of no use, as we fully proved in the case of the one removed, that the soil below was not disturbed, and in the second opened, the water from White river was within two feet of its base, as this mound was at a lower level than the other two mounds.

These two Dickinson mounds, the West mound, on Raymond, and the Mathew mound, in Minnesota, were certainly not older than 300 years, and in all probability not over seventy-five years, judging from the fur-covered trunk and wooden cage.

Mounds are usually found in groups of from three to thirty. In these groups one is almost always much larger than those placed irregularly about the patriarch of this mound family. In the large mounds it is not uncommon to find secondary burials, which are mostly near the surface. On the other hand, the small mounds are never interfered with, so far as I can ascertain from personal inspection and extensive inquiry. Mounds are not usually opened with sufficient care. In most cases, when the report is that there was a confused heap of bones, critical investigation would prove that the skeletons were originally placed in a sitting position, and that the apparent confusion is caused by the skeletons falling over at various angles, the legs alone retaining their original position.

The Wisconsin mounds are all sepulchral, with the exception of the so-called *animal mounds.*

Squier, after a thorough investigation of the earthworks, mounds and fortifications of New York says:

"In full view of the facts before presented I am driven to the conclusion little anticipated when I started on my trip of exploration, that these earthworks were erected by Iroquois and Senecas or their western neighbors; that the tribes that inhabited New York were to a degree fixed and agricultural in habit." (Aboriginal Monuments of New York, p. 83.)

Further on he says the light thrown upon the Ohio works by those situated in western New York has led to an entire modification of his former views regarding the Ohio works, and to the conviction that they are all of a comparatively late date and probably of common origin.

The flint arrow and spear points, the stone axes, pipes and ornaments, as well as various forms of pottery, are identical in shape, material and workmanship with those known to be used and manufactured by the Indians, when the Europeans first came among them. No one can tell by inspecting these articles whether they were taken from a mound or picked up on the site of a known Indian village. Shell beads found so commonly in mounds and Indian graves were their money — wampum — just such as the Indians living along the New England coast used to make continually. They gathered great quantities of small univalve sea shells in summer that they could continue the money making during the winter. They managed to bore a hole in these shells with a flint, before the whites furnished them with awls and drills. (Drake's Indians, page 229; Pickering's Chronological History, page 955.)

The various species of large univalve shells, "conchs," so often found in mounds and Indian graves, are yet preserved in the Omaha wigwams as sacred. The sound heard when one of these shells is placed to the ear is supposed to be the voice of departed spirits. (Paper read by Miss Fletcher at Montreal meeting of A. A. A. S.)

Then the mode of burial is still the same, mostly in a sitting posture, surrounded by their worldly wealth and supplied with a sufficiency of food to feed the hungry soul while on the long road to the happy hunting ground. I should like to see that anatomist who can distinguish the crania taken from mounds from those procured from Indian graves. The skulls from mounds differ just as much and just as little as do those of the present tribes of Indians. I obtained a skull of a Pottawatomie chief (it is now in the U. S. A. medical museum at Washington), which is one of the largest known. It is very symmetrical also, the capacity being 1785 cubic centimeters; maximum length, 188.9; maximum breadth, 163.5. circumference, 555.6; facial angle, 75; measured and photographed by order of the surgeon general. I had a second Pottawatomie cranium that is as unlike the above as possible, the capacity being 40 cubic inches less, facial angle 70. In view of the foregoing evidence, the legitimate conclusion must follow that the "mound builders" were Indians and nothing but Indians, the immediate ancestors of the present tribes as well as many other Indians that formerly were scattered over this country. Differing in habits of life and language just as the Indians of the several tribes did before the white man changed them, they continued to build mounds after they had communication with Europeans, since which time mound building, together with many of the arts of the red man, such as making wampum, flint, stone and copper implements, pottery, etc., have declined and finally nearly or quite ceased.

WHO MADE THE ANCIENT COPPER IMPLEMENTS.

By Dr. P. R. Hoy, Racine.

Elsewhere I have considered how the ancient copper implements were fabricated. This paper will be devoted to the answer of the question who made the ancient copper implements, that the plow and spade reveal so abundantly over Wisconsin and sparingly over most of the other states and Canada.

The early explorers upon the St. Lawrence in Canada, on the coast of New England, New York, Virginia, the Carolinas and Florida (among whom we will mention Cartier, Alfonse, Varanzano, Raleigh, Heriot, Ribauld, Newport, Allouez, Champlain and De Soto), all concur in saying that the Indians had implements and ornaments made of copper. Alexander Henry, who penetrated to Lake Superior at the time of the French war, assures us that the Indians obtained copper here which they made into bracelets, beads, spoons and other articles. (Henry's Travels p. 195.)

Dr. Jackson, of Boston, who spent several years on Lake Superior during the early period of the copper excitement, told me (in the summer of 1844, which I spent in the copper region) that "it was undoubtedly the Chippewas that mined, and probably the French half-breeds assisted in these old mines. The fresh condition of the wood work, skids and ladders, and the evidence that sharp axes were used in fitting the timbers is evidence that they are not of great antiquity." Dr. Jackson has published since similar views regarding these old mines.

Charles Whittlesey, U. S. Geologist, in the course of the geological survey of the Lake Superior district, writes: "In the old works on the Minnesota location near the forks of the Ontonogan river there was found at the depth of eighteen feet, a mass of copper weighing eleven thousand five hundred and eighty-eight pounds, which had been taken out of the vein by the ancients. It had been raised a few feet along the slope of the vein by means of wedges and cob-work made of logs laid up in the form of the body of a small log house. I had a piece of one of these logs which was cut from a black oak tree about six inches in diameter, showing distinctly the marks of a narrow axe, one and three-quarter inches wide, and *very sharp*. The marks of the instrument by which it was cut off were as plain and as perfect as they were on the log and stump recently cut in the vicinity.

Directly over the mass and over the timber which supported it, there stood on the rubbish which covered the mass about twelve feet in depth, a hemlock tree that had two hundred and eighty rings. There was a part of a wooden bowl and a wooden paddle taken from this old mine.

There were a number of wooden paddles found by Doctor Blake, in an old mine, at the Copper Falls mine, all of which were made of white cedar, which is abundant on Lake Superior. Most of these paddles were six feet in length, and resembled those used by the Chippewas in size, shape and material. The handles of these paddles used in the old mines were shaved with a knife or some other sharp cutting tool. In these old mines (Copper Falls), there was a skid with marks showing that it was cut with a sharp ax. There was also a bark spout for conveying the water from the locality. There was a birch tree growing over this debris which was two feet in diameter. The only implements found there which are made of copper, found in the rubbish of the old works, at a depth of from five to fifteen feet below the present surface, were one chisel, five inches long and an inch wide, a gad or wedge and one spear head of the ordinary pattern, four and one-half inches in length, with a socket for a handle." (Annals of Science, edited by Hamilton L. Smith, pages 28–30.)

It was reported by Singaba W'orsa (the head Chippewa chief), that when the Chippewas assembled at their councils from many points of the Lake Superior region, they had abundance of copper which led the council to the conclusion that copper abounded in many locations. In 1826, this intelligent chief piloted the U. S. Indian Commissioner, Gen. McKenny and party, to a celebrated mass of copper which had been long known by the Chippewas.

The commissioners went prepared to remove the mass, with a view of sending it to Washington. "We found it thirty-five miles above the mouth of the Ontanogan river, Lake Superior, on the west bank of the river, a few paces above low water mark. It consisted of pure copper, ramified in every direction through by a mass of stone (mostly serpentine, with calcareous spar), in veins of from one to three inches in diameter, and in some parts exhibiting masses of pure copper of over one hundred pounds. The entire weight of the mass was estimated at from three to five thousand pounds. It was found impossible, owing to the channel of the river being intercepted by ridges of sandstone, forming three cataracts with a descent in all of about seventy feet, to remove this great national curiosity. Evidence was discovered in prying the rock of copper from its position, confirming the history of the past, which recorded the efforts of other parties to extract wealth from this mass. These evidences consisted in chisels, axes and various implements, which are used in mining. This copper mass must have been much larger in dimensions, as no doubt those formerly working it removed much of the copper." (History of Indian Tribes of North America, by Gen. McKinney, Vol. I, p. 159.) This minute account is proof positive that long before 1826 persons operated on this mass of copper with sharp tools.

An extensive find of copper implements near the Sault Ste. Marie has recently been made. It contained twenty-three pieces, consisting of six awls, the largest six inches in length, the smallest three inches, five knives of various sizes and thirteen pieces composed of axes, hammers and chisels. They were found lying piled compactly together, surmounted by a little pile of stones. (*American Antiquarian* Vol. 5, No. 1, p. 89.)

The French penetrated to the Lake Superior region about three hundred and fifty years since — a time quite sufficient to account for all the old mining operations yet discovered.

Newport was told by Powhatan with whom he banqueted April, 1607, that the copper they had "was got in the bites of rocks between cliffs in certain veins a great distance north." (Dr. Pickering's Chronological History, p. 926.)

Granville speaks of copper among the Indians of Virginia which was said to have been obtained of the Shawnees. It was of the color of our copper, but much softer. (Granville's voyages in 1685. Vol. 12, p. 580.)

William N. Rogers, for several years connected with the Indian agency at Keshena, Wisconsin, told me that he frequently saw copper implements in the hands of the Chippeways and Winnebagoes. Many of their pipes were ornamented with copper.

One celebrated calumet which formerly belonged to Black Hawk, now owned by a Winnebago chief, has a broad rim of copper with great blotches of native silver.

The following is a copy of a letter of the Hon. Saterlee Clark, former Indian agent for the Winnebagoes from 1828 to 1830:

HORICON, WIS., May 9th, 1881.

DR. P. R. HOY:

My Dear Sir— In answer to your communication, Feb., 27th, * * *

When I first came among the Winnebagoes many of them had copper-headed weapons.

Many of them carried lances headed with copper, and it was quite common to see arrows headed with copper. Masses of virgin copper both large and small were often found scattered about, but particularly in the sand on the beach of the Wisconsin. This was so pure and soft that it was no trouble to shape it to suit them.

I have never seen any native copper vessels among them of any description, of their own manufacture. Very respectfully,

[Signed.] SAT. CLARK.

The original is in my possession.

I have a perfect copper implement eight inches in length, tapering to a fine point at one end and to a blunt point at the other, form square, each side at the center three-eighths of an inch wide. It was ploughed up with a few Indian bones by William Hass in the town of Caledonia. This grave was situated on a high bank overlooking the Root river. I inspected the grave.

John Trasen, living near the river, told me that there were Indian bones sticking out of the river bank. On visiting the spot we found three graves partially uncovered by the washing away of the bank. Two of the skeletons were of adults and the third proved to be that of a child. The adult graves were situated ten feet apart and sixteen inches below the surface from above.

On carefully digging we found in each several copper implements, nearly all of which were badly oxidized, while some articles had nearly disappeared. There was a succession of small rounded articles which we took to be copper beads. There were several small cylindrical articles of copper which were three to four inches in length.

In each of these three graves were remnants of pottery. In one of these pots there was a yellow paint that I could not determine. In the second adult grave was a red paint that proved to be vermilion. In connection with the child's grave I found two blue cut glass beads. The balance no doubt were appropriated by the river. In each adult grave there were the leg bones of a deer. The dead were supplied with venison while they lingered on the road to the blessed hunting grounds. A copper lance head was found by George West in Raymond, the description of which is given in West's letter in "On the Mounds."

There were also two pieces of copper, one of which had never been float-copper, but had been mined, as all the deep angles and ridges were sharp and not in the least rounded. The other specimen had been pounded out and a portion cut off had specks of silver associated with the copper.

Prof. Butler exhibited to me a spear head which had been plowed up by Sanford Marsh, in Waukesha county. The hole was filled with what appeared to be iron rust; on scraping he found a small fragment of the rivet. On applying the magnet it proved to be iron.

There can be no doubt that this spear head was manufactured after the Indians traded with the whites. (Since this was written Prof. Butler has published a description of this article in the *American Antiquarian.*)

F. S. Perkins, of Burlington, has collected nearly 400 copper implements, not counting beads, and not one single specimen was taken from a mound. Nearly all were plowed up or picked up from the surface. Mr. Perkins sold his original collection, consisting of 143 copper implements, to the

Wisconsin Historical Society, and has since devoted much energy to the collecting of a second cabinet of copper. He has now about two hundred specimens, many of which are unsurpassed. There are eight axes ranging from two to five pounds in weight. The largest implement weighs ten pounds two ounces. Among this magnificent collection he has ninety spear heads alone.

Near Racine there has been at least one hundred mounds either opened or entirely removed concerning fifty of which I have personal knowledge, and not one single specimen of copper has been discovered in these mounds and as this group is of the oldest type, and as they are situated in the region of abundance of copper, the fact leads to the inference that they were built before copper became of common use among the Indians. This is the more likely as the later mounds have not infrequently articles manufactured from nativecopper. The conclusion follows that the Indians living at no great distance from the copper regions of Lake Superior did mine copper and make various ornaments and implements, not only for their own use, but extensively for the purpose of barter with distant tribes and nations of Indians.

PRELIMINARY LIST OF WISCONSIN PARASITIC FUNGI.

By WILLIAM TRELEASE, S. D., Professor of Botany, University of Wisconsin.

The following provisional list of the parasitic fungi of the state includes only species which have been examined by myself. With one or two exceptions, specimens of all have been preserved in my herbarium.[1] Most of the species were collected about Madison, by myself; although I have received much valuable assistance from Mr. L. H. Pammel, a special student in my laboratory, and a most excellent collector,

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[1] Dr. Bundy informs me that none of the fungi enumerated in his list in the first volume of the Report on the Geological Survey were saved, so that I have been unable to refer to them.

who has also contributed many interesting forms from La Crosse and elsewhere. A few species have been received from correspondents, whose contributions are acknowledged in each instance.

Professor W. G. Farlow, of Harvard University, has aided me very materially in the determination of doubtful species. My thanks are also due Dr. M. C. Cooke, Prof. C. H. Peck and Mr. J. B. Ellis for similar assistance.

Where names different from those in common use have been employed, in deference to European authority, the synonym most frequently used is added in parenthesis.

As the list now stands it includes about 270 species on approximately the same number of hosts, most of which are phaenogamic plants. This number will probably be nearly doubled by a few years' collecting, especially through the addition of imperfect forms belonging to *Cercospora*, *Septoria*, and related form-genera. To this end, I shall be grateful for specimens from any part of the state, and will gladly render any assistance in my power in their identification.

CHYTRIDINEAE.

1. SYNCHYTRIUM FULGENS Schroeter, var. DECIPIENS Farlow.

Very common, on *Amphicarpaea monoica* Nutt. Madison, Ithaca; La Crosse, Pammel.

2. SYNCHYTRIUM ANEMONES (D C.).

Common, on *Anemone nemorosa* L. Madison.

SAPROLEGNIEAE.

3. SAPROLEGNIA FERAX (Gruithus), form THURETII De Bary. (*S. dioica* Auct.).

On dead flies thrown in water. Madison.

This species has not been found occurring parasitically with us, but it is frequently known to attack living aquatic animals, especially fish, and is the chief cause of the destructive salmon disease of England. It was obtained on some cultures started with cistern water in the spring of 1882, and again, in the fall of 1883, in water taken from a ditch. Antheridia have not been observed. A small percentage of the oogonia show a pseudo-pollinodium projecting into the base of the cell from below.

PERONOSPOREAE.

4. Cystopus candidus (P.).

Common, through the open season, on various crucifers,—*Capella bursa pastoris* Moench, *Sisymbrium officinale* Scop., etc. Madison, Syene; Kirkland, La Crosse, Pammel.

5. Cystopus cubicus (Strauss).

On *Ambrosia artemisiaefolia* L., *Cnicus lanceolatus* Hoffm. and *Artemisia biennis* Willd. Madison; La Crosse, Pammel.

6. Cystopus bliti Biv. (*C. amaranthi*, S.).

On *Amarantus retroflexus* L. Syene, Madison; La Crosse, Pammel.

7. Cystopus portulacae (D C.).

On *Portulaca oleracea* L. Madison; La Crosse, Pammel; Sauk City, Lüders.

8. Phytophthora infestans (Mont.) (*Peronospora infestans*, Mont.).

Common, in wet summers, on *Solanum tuberosum* L. Madison; and received from many parts of the state.

In some years the loss from the potato rot is estimated at many thousands of dollars in Wisconsin.

9. Peronospora viticola (B. & C.).

On various cultivated and wild grapes, and on *Ampelopsis quinquefolia* Michx. Madison, Syene, Ithaca; La Crosse, Devil's Lake, Pammel; also reported from every part of the state.

This certainly causes very much of the dry rot of grapes, as pointed out by Prillieux (Comptes Rendus, Oct. 2, 1882), who has more recently succeeded in observing the germination of the oospores by the direct emission of a mycelial thread, without the intervention of zoospores. I have collected it once producing conidiophores on the fruit.

10. Peronospora halstedii Farlow.

On *Bidens frondosa* L., *Ambrosia artemisiaefolia* L., *A. trifida* L., *Eupatorium ageratoides* L., *Rudbeckia laciniata* L., *Silphium terebinthinaceum* L., *S. integrifolium* Mx., *S. trifoliatum* L., *S. perfoliatum* L., *Helianthus strumosus* L., *H. occidentalis* Ridd., *H. tuberosus* L. and *Solidago riddellii* Frank. Madison; La Crosse, Pammel.

11. Peronospora obducens Schr.

On cotyledons and young leaves of *Impatiens fulva* Nutt. Madison; La Crosse, Pammel. Also found on *Impatiens pallida* Nutt., at Hokah, Minn., by Mr. Pammel.

12. PERONOSPORA GERANII Peck.
On *Geranium maculatum* L. Madison, Stoughton; Kirkland, Pammel.

13. PERONOSPORA ENTOSPORA (Roze & Cornu) (*P. simplex* Peck).
On *Aster novae angliae* L. and several unidentified species of *Solidago.* Syene; Stoughton; La Crosse, Pammel.

14. PERONOSPORA PYGMAEA Unger.
On leaves of *Anemone nemorosa* L., in May. Madison.

15. PERONOSPORA GANGLIFORMIS (Berk.).
On *Lactuca sativa* L. and *L. canadensis* L. Madison and Syene; La Crosse, Pammel.

16. PERONOSPORA PARASITICA (Pers.).
Common, on *Capsella bursa pastoris* Moench, *Lepidium virginicum* L., *Nasturtium armoracia* Fr. and *Brassica* sp. Madison, Syene; Baraboo, La Crosse, Pammel.

17. PERONOSPORA POTENTILLAE De Bary.
On *Potentilla norvegica* L. Madison; La Crosse, Pammel.

18. PERONOSPORA ARTHURI Farlow.
On *Oenothera biennis* L. Stoughton; La Crosse, Pammel.

19. PERONOSPORA VICIAE (Berk.).
On *Vicia faba* L. and *V. americana* Muhl. La Crosse, Baraboo, Pammel.

20. PERONOSPORA EFFUSA (Grev.).
Common on *Chenopodium album* L., in summer. Madison; La Crosse, Baraboo, Pammel.

21. PERONOSPORA ALTA Fckl.
On *Plantago major* L. Madison; La Crosse, Pammel.

22. PERONOSPORA CALOTHECA DeBary.
On *Galium boreale* L. and *G. triflorum* Michx. La Crosse, Pammel.

23. PERONOSPORA URTICAE (Lib.).
On *Urtica gracilis* Ait. Kirkland, La Crosse, Pammel.

24. PERONOSPORA CORYDALIS DeBary.
On leaves of *Dicentra cucullaria* D C. Madison.

Locally abundant, covering the entire lower surface of the leaf with a matted, gray felt.

24*a*. PERONOSPORA LEPTOSPERMA DeBary.
On *Artemisia* sp. La Crosse, Pammel.

25. PERONOSPORA AUSTRALIS Spegaz. (*P. sicyicola* Trelease, *Botrytis cubensis* B. & C. ?).

Very abundant in summer and fall, on *Sicyos angulatus* L. Madison, Stoughton.

This species was first found in the summer of 1882. Its presence is indicated by pale spots on the upper surface of the leaf, opposite which the fruiting hyphae emerge in dense white tufts 1-3 mm. in diameter, with angular contour, limited by the veinlets of the leaf. Later these spots become dead and white, resembling those caused by *Ramularia, Septoria,* etc.

Berkeley and Curtis describe a *Peronospora cubensis* on a West Indian cucurbitaceous plant (Journ. Linn. Soc., Bot., X., 363), but their description, like many of Berkeley's, is unsatisfactory and does not well apply to our plant. Through the courtesy of Dr. Farlow, I have made a thorough examination of the leaf said to bear *Botrytis cubensis,* in the Curtis herbarium, but whatever it may have once contained has entirely disappeared; and a careful search on the Wright duplicates at Cambridge, which Dr. Farlow was kind enough to make, does not show any *Peronospora.* The species was, therefore, named *P. sicyicola* in my herbarium and in this paper as first presented, and a description was given by Dr. Farlow, in the Botanical Gazette for 1883, p. 331. Since that was published the description of a South American species on *Cyclanthera,* discovered by Spegazzini, has reached this country. So far as can be made out, this is identical with the Wisconsin form, and the name of Spegazzini has the right of priority, dating from 1881. His description is as follows: "Hypophylla; maculae amphigenae, magnitudine ludentes, primo parvulae, dein saepe totum folium occupantes, pallescentes v. fusco-pellucidescentes, angulosae; hyphae mycelii crassae, subtorulosae; haustoria subsphaeroidea v. subclavata, numerosa, saepe totam cellulam plantae hospitalis implectantia; hyphae fertiles hinc inde erumpentes v. e stomatibus exsurgentes, rectae-cylindraceae, longiusculae (250—500$\times$14—15 μ), hinc inde glomerulatae, usque ad verticem continuae, inferne saepe incrassatulae, sed mox breviter ac abrupte coarctato-attenuate, apice subverticillatim 5—12 ramosae; rami 3—6-ies trichotomi, gradatim alternati, ac abbreviati; ramuli ultimi apice incrassatuli, 3—5 sterigmata (3.5$\times$1.5—2 μ) hyalina, subampulliformia, inter se angulo-recto divergentia, saepe 2-3 denticulato-lobata gerentia; conidia obovato-sphaeroidea, sursum obtuse rotundata, saepeque apiculata (15$\times$10—12μ), hyalina."—Ann. de la Sociedad Cientif. Argentina, 1881, XII., p. 81.

In our form the conidial branches are hyaline, tufted from the stomata, often .5 mm. high, with a diameter of 12 μ. 3–4 times branched below. Primary branches alternate, ascending. Ultimate and often penultimate twigs spreading, the lateral ones in pairs, forming crosses with the branch which bears them. Conidia hyaline, subspherical or broadly ellipsoidal, variable in size, averaging 13$\times$16 μ; with an apical papilla, hence probably germinating by zoospores. Oospores not seen.

26. PERONOSPORA LOPHANTHI Farlow.
On *Lophanthus scrophulariaefolius* Benth. La Crosse, Pammel.

27. PERONOSPORA SCHLEIDENIANA DeBary.
On leaves of *Allium cepa* L.
Called "onion-rust," and very destructive.

28. PERONOSPORA GRAMINICOLA (Sacc.) (*Protomyces graminicola* Sacc., *Peronospora setariae* Pass.).
On leaves of *Setaria viridis* Beauv. and *S. italica* Kunth. La Crosse, and Hokah, Minn., Pammel.
The oospores give some leaves a decided brown color. Conidial branches sparingly produced.

ASCOMYCETES.

GYMNOASCI.

29. EXOASCUS PRUNI Fckl.
On the fruit of *Prunus*, causing "plum pockets" or "bladder plums." Stoughton; Ahnapee, Swaty; Ithaca, Hatch.

30. ASCOMYCES COERULESCENS Mont.
On leaves of *Quercus coccinea* Wang. and *Q. rubra* L. Stoughton; Kirkland, La Crosse, Pammel.

PERISPORIACEAE.

31. UNCINULA ADUNCA (Wall.) (*U. heliciformis* Howe).
Common, in fall, on species of *Salix*, and on *Populus balsamifera* L., var. *candicans* Gray.

32. UNCINULA SUBFUSCA B. & C. (*U. ampelopsidis* Peck).
On *Ampelopsis quinquefolia* Mich. Madison; LaCrosse, Pammel.
This is given the name of Berkeley and Curtis on the authority of Cooke—Journ. Roy. Hort. Soc., 1878, p. 72.

33. UNCINULA AMERICANA Howe (*U. spiralis* B. & C.).
On leaves of cultivated grape, in the fall. Syene.

34. UNCINULA CIRCINATA C. & P.
On leaves of *Acer rubrum* L. Ithaca.

35. MICROSPHAERA EUPHORBIAE B. & C.
On *Euphorbia corollata* L. Madison; La Crosse, Pammel.

36. MICROSPHAERA FRIESII Lév.
On *Syringa vulgaris* L., very common, disfiguring the lilacs in summer and fall. Madison.

37. MICROSPHAERA DIFFUSA C. & P.

On *Desmodium canescens* D C, *Lathyrus ochroleucus* Hook. and *Lespedeza violacea* Pers. Madison; Delton, Devil's Lake, La-Crosse, Pammel.

The form on *Lathyrus* has the 8–12 hyaline appendagas 4–5 times forked, the ultimate divisions unequal, some of them straight, others recurved, closely resembling those of *M. ravenelii* B., which occurs on *Gleditschia.* They are also absolutely indistinguishable from those of *M. pulchra* C. & P., in my collection. Mr. Ellis writes, however, that this form does not differ more from Peck's specimens of *M. diffusa* than the latter do from those of Ravenel distributed by Cooke in Ravenel's Fung. Amer.; in the latter of which they are merely dichotomous and spreading as in my specimens on *Desmodium*, whereas in the former they are only a little less ornate than in my specimen on *Lathyrus.* Professor Peck also regards this as a form of his species.

38. MICROSPHAERA PULCHRA C. & P.

On *Lonicera flava* Sims. and *L. parviflora* Lam. Madison; La-Crosse, Pammel.

39. MICROSPHAERA VAN BRUNTIANA Gerard.

On *Sambucus canadensis* L. Madison.

40. MICROSPHAERA PENICILLATA (Wall.).

On *Corylus americana* Walt. and *C. rostrata* Ait. Very common in the fall. Madison.

41. MICROSPHAERA EXTENSA C. & P.

On leave of *Quercus rubra* L. Madison.

42. MICROSPHAERA RUSSELII Clinton.

On *Oxalis stricta* L. La Crosse, Pammel.

43. PODOSPHAERA TRIDACTYLA (Wall.) (*P. kunzei* Lév., *P. oxyacanthae,* D C.).

Common, on leaves of cultivated cherry and plum, and on *Prunus virginiana* L., causing the leaves to fold lengthwise. Madison, Ithaca; La Crosse, Pammel.

44. PHYLLACTINIA SUFFULTA (Reb.) (*P. guttata,* Wall.).

On *Celastrus scandens* L., *Carpinus americana* Michx., *Corylus americana* Walt. and species of *Cornus* and *Fraxinus.* Madison.

45. SPHAEROTHECA CASTAGNEI Lév.

Common, on *Bidens frondosa* L., *Nabalus* sp., *Taraxacum dens-leonis* Desf., *Veronica virginica* L., *Rubus triflorus* Rich., *Brunella vulgaris* L. and *Agrimonia eupatoria* L. Madison; La Crosse, Pammel.

46. SPHAEROTHECA PANNOSA (Wall.).

On *Rosa parviflora* Ehr., and on cultivated roses.

The mildew, or mycelium bearing conidia, is very common through the summer and fall, injuring some of the moss-roses very greatly. The perithecial fruit, on the contrary, is uncommon, and seems to form preferably on wild roses, rather late in the fall.

47. ERYSIPHE TORTILIS (Wall.).

On leaves of *Clematis virginiana* L., in summer and fall. Madison; Devil's Lake, Pammel.

No. 558 of Ellis' North American Fungi, on the same host, distributed under the name of *Erysiphe communis* Schl., seems to belong to this species.

48. ERYSIPHE LAMPROCARPA (Wall.).

Very common, on *Ambrosia artemisiaefolia* L., *Helianthus strumosus* L., *Aster miser* L., *A. laevis* L., *Xanthium strumarium* L., *Cnicus discolor* Muhl., *Diplopappus umbellatus* T. & G., *Eupatorium perfoliatum* L., *E. purpureum* L., *Phlox paniculata* L., *P. drummondii* Hook., *Teucrium canadense* L., *Hydrophyllum virginicum* L., *Echinospermum virginicum* Lehm. and *Verbena urticifolia* L.

49. ERYSIPHE COMMUNIS (Wall.).

On *Ranunculus abortivus* L., *Lathyrus venosus* Muhl. and *Amphicarpaea monoica* Nutt. Madison.

Conidia, apparently of this species, are also very common on *Thalictrum dioicum* L.

50. ERYSIPHE GRAMINIS D C.

On *Poa pratensis* L. Madison. Common, through the season, in shaded places.

Only the conidia (*Oidium monilioides* Lk.) have been found, but there can be little doubt that they belong to this species, the perithecial fruit of which forms most frequently on the old leaves.

PYRENOMYCETES.

51. PHYLLACHORA LESPEDEZAE (Schw.) (*Dothidea lespedezae*, Schw.).

On leaves of *Lespedeza capitata* Michx., in summer. La Crosse, and Hokah, Minn., Pammel.

52. PHYLLACHORA PTERIDIS (Reb.) (*Dothidea pteridis* Fr.).

The Pycnidia occur on fronds of *Pteris aquilina* L., from Milwaukee, in the Lapham herbarium.

53. PHYLLACHORA ULMI (Duv.) (*Dothidea ulmi* Fr.).
Very common on leaves of *Ulmus americana* L., in fall and winter, the ascospores forming on the fallen leaves; the spermogonia (*Septoria ulmi* Fr.) on the same host.

54. PHYLLACHORA TRIFOLII (Pers.) (*Dothidea trifolii* Fr.).
With its conidia (*Polythrincium trifolii* Kze.), on *Trifolium repens* L. and *T. pratense* L. Common, in summer and fall. Madison, Ithaca; La Crosse, Pammel; Sauk City, Lüders.

55. PHYLLACHORA GRAMINIS (Pers.) (*Dothidea graminis* Fr.).
Common, on *Asprella hystrix* Willd., *Dactylis glomerata* L., *Elymus canadensis* L., *Panicum latifolium* L. and other grasses, in fall and winter. Madison, Ithaca; La Crosse, Pammel.

56. MONTAGNELLA HELIOPSIDIS (Schw.) (*Dothidea heliopsidis* Schw.).
What appears to be this species was found on the dead stems of species of *Helianthus* and *Aster*, but sterile, as usual.

57. PARODIELLA PERISPORIOIDES (B. & C.) (*Dothidea perisporioides* B. & C.)?
On leaves of *Desmodium acuminatum* D C. La Crosse, Pammel.

What I have referred to this species appears as numerous minute olive-brown or black dots, .5 mm. or less in diameter, on the upper surface of the leaves. These perithecia are smaller than those of any form of *P. perisporioides* in my herbarium, and are pycnidial, containing numerous hyaline round-oblong stylospores, each measuring 3–5μ, and with 1–2 oil globules.

58. HYPOMYCES LACTIFLUORUM (Schw.).
Very common on one or more species of agaric, deforming the infested plants, which are ultimately covered closely by the bright cinnabar-red perithecia.

59. GNOMONIELLA FIMBRIATA (Pers.) (*Sphaeria fimbriata* Pers.).
On leaves of *Carpinus americana* Michx., in August. Pycnidia (*Glaeosporium carpini* Desm.) and ascosporic fruit.

60. GNOMONIELLA CORYLI (Batsch) (*Sphaeria coryli* Batsch).
On leaves of *Corylus americana* Walt. and *C. rostrata* Ait., in summer. La Crosse, Kirkland, and Hokah, Minn., Pammel.

61. PLOWRIGHTIA MORBOSA (Schw.) (*Sphaeria morbosa* Schw.).
Common, on stems of *Prunus virginiana* L., *P. americana* Marshall, *P. pennsylvanica* L. and *P. serotina* Ehrh. Madison; Sauk City, La Crosse, Pammel.

In May, when conidia are abundant on the forming knots, those of the preceding year commonly have the protoplasm of their asci still undifferentiated into spores. A considerable number of specimens show that the species winters very largely by its perennial mycelium rather than by ascospores, and new knots are usually formed close below the old ones by the same mycelium. The "black knot" undoubtedly also occurs on cultivated species of *Prunus*, though I have not yet collected it on them.

62. NECTRIA CINNABARINA (Tode).

On branches of *Robinia pseudacacia* L. Madison.

This with its conidia, *Tubercularia vulgaris* Tode, has been collected only on dead branches; but it has been shown by Dr. Heinrich Mayr (Part 3 of Hartig's Untersuchungen aus dem forstbotan. Institut zu München), that the species sometimes lives as a true parasite on maple, box-elder, etc.

63. CRYPTOSPORELLA ANOMALA (Pk.) (*Diatrype anomala* Peck).

Forming knots on branches of *Corylus americana* Walt. Madison.

64. EPICHLOE TYPHINA (Pers.).

On sheaths of an *Elymus*, *Andropogon furcatus* Muhl. and one other undetermined grass. Madison, Stoughton, Ithaca; La Crosse, Pammel.

65. CLAVICEPS PURPUREA (Fr.)?

Common on *Secale cereale* L., and *Triticum vulgare* Vill. Syene; La Crosse, Pammel.

The sclerotia were not subjected to cultures, and consequently no perithecia were obtained, but there can be little doubt as to the species.

66. CLAVICEPS, sp.

On *Zizania aquatica* L. Milwaukee, Lapham.

The sclerotia are stout, ovoid, oblong, averaging 5×9 mm. Their color is pinkish, brown. I have seen the same thing in the herbarium of Dr. Farlow, but do not know that it has ever been made to fruit.

67. CLAVICEPS, sp.

Small sclerotia have been found in abundance on *Elymus striatus* Willd., *E. canadensis* L., *Koeleria cristata* Pers., *Glyceria nervata* Trin., *Agrostis scabra* Willd., *Deyeuxia canadensis* Beauv., *Poa compressa* L. and *Phleum pratense* L., at Madison, Ithaca, La Crosse and Kilbourn City, by Mr. Pammel and myself. No cultures having been undertaken, however, the species is undetermined.

68. CORDYCEPS MILITARIS (L.) (*Torrubia militaris*, Fr.)?

Conidia on "white grubs" in fall. Madison.

Only the *Isaria* stage was seen, although a number of cultures were undertaken.

69. ——.

On leaves of *Eupatorium ageratoides* L. and *Podophyllum peltatum* L.

Stroma sessile, 3 mm. in diameter, hemispherical, waxy, pale flesh-colored Perithecia superficial. Asci and spores as in *Epichloe typhina* (P.).

A curious fungus, related to *Cordyceps* and *Epichloe*, apparently growing on clusters of spiders' eggs. Possibly connected with *Isaria arachnophila*, No. 76.

PHACIDIACEAE.

70. PHACIDIUM RANUNCULI Desmaz.

On leaves of *Ranunculus pennsylvanicus* L. and *R. sceleratus* L. Madison; La Crosse, Pammel.

Flesh-colored; not dark like English specimens, but otherwise similar to them.

71. PHACIDIUM TRIFOLII (Bernh.).

On leaves of *Trifolium pratense* L. Madison.

72. RHYTISMA SALICINUM Fr.

On leaves of *Salix*. Madison.

73. RHYTISMA ASTERIS Schw.

On leaves of *Solidago*. Sauk City, Lüders. Also found on one or more species of *Aster*, at Brownsville, Minn., by Mr. Pammel.

The compound nature of these galls is discussed in volume IV. of "Psyche."

74. RHYTISMA ILICIS CANADENSIS Schw.?

On leaves of *Ilex verticillata* Gray. Milwaukee, Lapham; Devil's Lake, La Crosse, Pammel.

Forming round or somewhat irregular black spots, about 2 mm. in diameter, surrounded by a brown border, on the upper surface of the leaf—whitish below. The same form occurs on leaves of *I. laevigata* Gray, collected at Ovid, N. Y., by Brewer and Chickering; but all of my specimens are immature.

DISCOMYCETES.

75. PEZIZA DEHNII Rabh.

On petioles and leaves of *Potentilla norvegica* L., in spring and summer. Madison; La Crosse, Pammel.

ISOLATED IMPERFECT FORMS.

76. ISARIA ARACHNOPHILA Ditm.

On spiders, in autumn. Madison. (*Cf.* No. 69).

77. MICROSTROMA LEUCOSPORUM Mont.

Forming white spots on the under surface of leaves of *Juglans cinerea* L. Represented from just across the line in Minnesota and Illinois, and hence certain to be found in Wisconsin. It should also occur on *Carya*.

78. DIDYMARIA UNGERI Cda. (*Ramularia didyma* Ung.).

On *Ranunculus fascicularis* Muhl., *R. recurvatus* Poir. and *Anemone dichotoma* L. Madison: Kirkland, La Crosse, Pammel.

79. RAMULARIA CELASTRI Ell. & Martin. (*R. celastri* Pk.).

On leaves of *Celastrus scandens* L., in fall. Madison.

Spores 1-4 celled. Described under the same name by Peck (33 Report, p. 30).

80. RAMULARIA PLANTAGINIS Ell. & Martin.

On leaves of *Plantago major* L. Madison, Syene; Kirkland, Pammel.

81. RAMULARIA TULASNEI Sacc. (*R. fragariae* Pk.).

On leaves of *Fragaria vesca* L. and *F. virginiana* Ehr., wild and cultivated. Madison; Milwaukee, Trowbridge; Janesville, Kellogg.

Known pretty generally over the country as "Strawberry Rust."

With us this species appears to pass the winter in black, stromatoid sclerotia, which protrude from the surface of the leaf. In the spring conidial threads grow out from these bodies and quickly fruit.

82. RAMULARIA ARVENSIS Sacc.

On leaves of *Potentilla norvegica* L. Madison, Syene; La Crosse, Pammel.

83. RAMULARIA MACROSPORA Fres., var. SENECIONIS Sacc.

On leaves of *Aster novae angliae* L. Syene.

To the naked eye resembling the conidia of *Entyloma compositarum* Farl. Spores colorless, 1–4 celled, usually 2–celled; oblong-ovoid, slightly truncate at the pointed extremities, sometimes narrowed gradually to the septum; $5–6 \times 20–40\ \mu$.

84. RAMULARIA ARMORACIAE Fckl.

Common on leaves of *Nasturtium armoracia* Fr., wild and cultivated. Madison.

The common leaf disease of the horseradish, very destructive to the old leaves in summer and fall. Presumably occurring on other Cruciferae in Wisconsin, as it does elsewhere.

85. RAMULARIA URTICAE Ces.

On *Urtica gracilis* Ait., in spring. Madison.

Agrees closely with Berlin specimens from Magnus.

86. OVULARIA OBLIQUA (Cke.) (*Ramularia obovata* Fckl., *Peronospora obliqua* Cke.).

Common, in spring, on leaves of *Rumex.* Madison.

87. OVULARIA IRREGULARE (Pk.) (*O. isarioides* Sacc., *Oidium irregulare* Pk.).

On the fruit of *Staphylea trifolia* L. La Crosse, Pammel.

88. OVULARIA PYROLAE, n. sp.

On leaves of *Pyrola rotundifolia* L. Stoughton.

Spots circular, dark. Spores colorless, round-oval to oblong, frequently acute at one end, unicellular. Usually $4 \times 12\ \mu$; extremes noted: $3.5–6 \times 6–17\ \mu$.

89. FUSIDIUM RAVENELIANUM Thuem. (*Ramularia desmodii* Cke., *Fusisporium pubescens* B. & C.).

On leaves of a species of *Desmodium* and an *Astragalus.* Madison; La-Crosse, Pammel.

90. FUSIDIUM PTERIDIS Kalchbr.

On fronds of *Aspidium marginale* Sw. Kirkland, Pammel.

91. CERCOSPORELLA CANA (Pass.) (*Fusidium canum* Pass.).

Common, on leaves of *Erigeron canadense* L., in summer and fall. Madison.

What appears to be the same thing was found at La Crosse on the radical leaves of some *Solidago.*

92. CERCOSPORELLA APOCYNI E. & K.

On leaves of *Apocynum cannabinum* L. La Crosse, Pammel.

93. CERCOSPORA APII Fres., var. PASTINACAE Farlow, *in herb.*

Common, on leaves of *Pastinaca sativa* L. Madison; La Crosse, Pammel.

Perhaps from *Cercosporella pastinacae* Karst., as described in Hedwigia, 1884, p. 63, is not distinct.

94. CERCOSPORA BETAECOLA Sacc.

On *Beta vulgaris* L. Ithaca.

Very destructive to beet leaves, in fall.

95. CERCOSPORA CHENOPODII Fres.

Very abundant, on leaves of *Chenopodium album* L., in midsummer and later. Madison; La Crosse, Pammel.

96. CERCOSPORA RACEMOSA Ell. and Mart., *ined.*

On *Teucrium canadense* L. La Crosse, Pammel.

Scarcely a good *Cercospora.* I am indebted to Dr. Farlow for the determination.

97. CERCOSPORA PHYSALIDIS Ell.

On leaves of two species of *Physalis.* La Crosse, Pammel.

98. CERCOSPORA PYRI Farlow.

On leaves of *Pyrus arbutifolia* L. Kilbourn City, Pammel.

99. CERCOSPORA GRANULIFORMIS Ell. & Holway.

On leaves of *Viola cucullata* Ait. Madison; La Crosse, and Hokah, Minn., Pammel.

Polythrincium trifolii Kze.—See Phyllachora trifolii, No. 54.

99*a*. CLADOSPORIUM TRIOSTEI Pk., n. sp.

On leaves of *Triosteum perfoliatum* L. La Crosse, Pammel.

Spots indefinite, pale, becoming brown at the center with age; 2–5 mm. in diameter. Conidiophores tufted, slightly wavy, hypophyllous, 125–150μ long, 3.5μ in diameter, deep brown. Spores dark brown, sometimes slightly paler than the threads; lemon-shaped, with strongly pronounced papillae at either end; 2-celled; 5–7$\times$15–20μ. Septum usually central, sometimes near one end.

100. PASSALORA DEPRESSA (B. & Br.) (*Cladosporium depressum* B. & Br.).

On leaves of *Zizia integerrima* D C. and *Archangelica atropurpurea* Hoffm.? La Crosse, Pammel.

101. FUSICLADIUM DENDRITICUM (Wall.) (*Cladosporium dendriticum* Wall.).

On leaves and fruit of *Pyrus malus* L., *P. coronaria* L. and *P. prunifolia* L. Madison, Ithaca; Baraboo, Johnson; La Crosse, Pammel; and reported all over the state.

The cause of "leaf-blight" and "scab" of apples, and very destructive.

102. PYRICULARIA GRISEA (Cke.) (*Trichothecium griseum* Cke.).

On the leaves of *Panicum sanguinale* L. Syene, Madison.

Causing gray spots; common, in the fall.

103. TRICHOTHECIUM ROSEUM Fr.

On a living puff-ball in August. Madison.

Very possibly growing as a saprophyte on an injured part of the fungus, as it occurs the year round on firewood, old black-knots of cherry, etc.

104. SEPEDONIUM CHRYSOSPERMUM Link.

On a species of *Boletus.* Madison.

Although the host was almost entirely replaced by the conidia, as usual, there was no indication of ascosporic fruit.

105. ASTERINA, sp. (?).

On leaves of *Salix*, in fall. Syene.

Forming dendritic black spots several millimeters in diameter. Too immature for determination.

106. SPHAERONEMA PERSICAE (Schw.).

On *Plowrightia morbosa* Schw., and on branches of *Prunus americana* Marsh. Madison.

Perhaps growing on the honey-dew of Aphides.

107. GLAEOSPORIUM LINDEMUTHIANUM Sacc. & Magn.

On pods of *Phaseolus*, sp. Madison.

Causing the common and destructive spotting of wax beans.

108. GLAEOSPORIUM (MARSONIA) MELILOTI, n. sp.

On the stems of *Melilotus alba* Lam. Madison.

Perithecia minute, inconspicuous, occurring in longitudinal rows 2–5 mm. long, on the stem. Spores oozing out in pale, flesh-colored tendrils, under the microscope appearing colorless; oblong, straight or slightly curved, 2-celled. 5–6×13–20 μ. In the smaller spores the septum is nearly central; in the larger ones it occurs nearer one end.

109. GLAEOSPORIUM (MARSONIA) JUGLANDIS (Lib.).

On brown spots on leaves of *Juglans nigra* L. and *J. cinerea* L. Madison; La Crosse, and Hokah, Minn., Pammel.

Almost entirely defoliating some trees in August.

109*a*. GLAEOSPORIUM (MARSONIA) CASTAGNEI (Desm. & Mont.).

On leaves of *Populus alba* L. Madison.

Glaeosporium carpini Desmaz.— See Gnomoniella fimbriata, No. 59.

110. PHOMA UVICOLA B. & C.

On cultivated species of *Vitis*. Syene; Ithaca, Hatch.

The apparant cause of much of the "dry rot" of grapes. The form sent by Mr. Hatch is reported as very destructive to the young twigs of some varieties, and appears to be identical with that distributed in Erb. Critt. Ital., No. 747.

111. PHYLLOSTICTA SPHAEROPSOIDEA Ell. & Everh.

On leaves of *Aesculus hippocastanum* L. Madison.

112. PHYLLOSTICTA VITICOLA (Cke.).

On leaves of cultivated grape and *Ampelopsis quinquefolia* Mich. Madison, Ithaca.

113. PHYLLOSTICTA DODECATHEI, n. sp.

On leaves of *Dodecatheon meadia* L. Stoughton.

Spots circular, brown, about 3 mm. in diameter. Spores hyaline, ovoid to oblong, sometimes nearly spherical, eguttulate, 2–5×3.5–7 μ, unicellular.

114. PHYLLOSTICTA QUERCUS Sacc. & Sp.

On leaves of *Quercus macrocarpa* Michx. and *Q. alba* L. Kirkland, La Crosse, Pammel.

115. PHYLLOSTICTA APOCYNI, n. sp.

On leaves of *Apocynum cannabinum* L. La Crosse, Pammel.

Spots circular, brown, about 3 mm. in diameter. Perithecia small, black. Spores colorless, oblong, 3.5–4×5–7 μ, unicellular.

116. PHYLLOSTICTA PYRINA Sacc.

On apple leaves, Madison.

117. PHYLLOSTICTA, sp.

On leaves of *Prunus serotina* Ehrh. Madison.

Spots rounded or oblong, 3–8 mm. in diameter, brownish-red. Perithecia small, black. Spores ellipsoidal, hyaline, 2–4×7–8 μ, unicellular.

Perhaps *P. serotina* Cke., of which I have not been able to examine specimens.

118. ASCOCHYTA, sp.

On leaves of *Silphium integrifolium* Mich. and *Vernonia noveboracensis* Willd. Stoughton; La Crosse, Pammel.

Spots brown, circular, about 3 mm. in diameter. Perithecia brown, 100–120μ, slightly carbonized about the round orifice. Spores colorless; ovoid, oblong or reniform, frequently constricted at the middle; 3–5×7–14μ, with 2–4 oil drops; when mature 2-celled.

Resembles *Phyllosticta sonchi* Sacc. (Michelia, I., 141), except in the septate spores.

119. ASCOCHYTA OXYBAPHI, n. sp.

On leaves of *Oxybaphus nyctagineus* Sweet. Stoughton.

Spots dark brown, roundish, 1–2 mm. Perithecia on the upper surface of the leaf, small, brown, carbonized about the orifice. Spores colorless, 2-celled, 4×10–17μ; sometimes constricted at the middle.

120. ASCOCHYTA VIOLAE Sacc. and Sp.

On leaves of *Viola pubescens* Ait. Madison.

121. ASCOCHYTA QUERCUS Sacc. & Sp.

On leaves of species of *Quercus*; on round, white spots. Madison.

121*a*. ASCOCHYTA AMPELINA Sacc.

On small brown spots, on leaves of *Vitis cordifolia* Mx. Madison.

122. ASCOCHYTA SPARTINAE, n. sp.

On leaves of *Spartina cynosuroides* Willd., in autumn. Madison; La Crosse, Pammel.

This species was found in small quantity, in company with *Uromyces acuminatus* Arthur, and causes small rounded pale yellow spots on the leaves. The spores ooze out in flesh-colored masses, and are colorless, straight or slightly curved, usually a little narrower at one end than the other. They average 3×35 μ. As a rule they are two-celled, but in a few instances two or even three septa were distinguished. Perhaps identical with some of the numerous described Septoriae or Ascochytae of grasses; but I have been unable to place it.

123. Ascochyta salicifoliae, n. sp.

On leaves of *Spiraea salicifolia* L. La Crosse, Pammel.

Spots numerous, rounded, about 1 mm. in diameter, deep flesh colored. Perithecia large, similarly colored. Spores oozing out; hyaline, fusiform, usually a little curved in form of a crescent, 1-septate, with several (3-4) oil drops; 2-3.5×30-50 μ.

Referred at first to *Septoria ascochytoides* Sacc., but differs in the absence of a darker border to the spots, while the spores are twice as long as in that species, where they are said to measure 18-20×2.5-3 μ. Perhaps, like the last, more properly a Septoria than an Ascochyta.

124. Septoria ravenelii Thuem.

On leaves of *Prunus serotina* Ehrh. La Crosse, Pammel.

This occurs in the Curtis herbarium under the name *S. sanguinea* Desm.

125. Septoria noli tangeris Gerard.

Forming small black spots on cotyledons of *Impatiens fulva* Nutt. Madison.

126. Septoria sisymbrii Ellis.

On leaves of *Dentaria laciniata* Muhl., in spring. Madison.

127. Septoria alliorum Westd. (*S. viride tingens* Curtis).

On leaves of *Allium tricoccum* Ait., in spring. Madison.

With more distinct spots than the specimens described in Peck's 23d Report, p. 55.

128. Septoria ribis Desmaz.

On leaves of *Ribes cynosbati* L. and *R. floridum* L. Madison; La-Crosse, Pammel.

129. Septoria violae West.

On leaves of *Viola pubescens* Ait. Madison.

130. Septoria erigerontis B. & C., *in herb.* Curtis (*S. erigerontis* Peck).

On radical leaves of some *Erigeron*, in early spring. Madison.

131. Septoria oenotherae West.

On leaves of *Oenothera biennis* L. Madison.

132. Septoria scrophulariae Peck.

On leaves of *Scrophularia nodosa* L. Madison; La Crosse, Pammel.

133. Septoria heterochroa Desmaz.

On leaves of *Malva rotundifolia* L. Common, Madison.

Also frequently referred to *S. destruens* Desm., by authors.

134. SEPTORIA CANNABINA West.

On leaves of *Cannabis sativa* L., in autumn, Madison. Sometimes accompanied by a *Phoma*.

The diseased hemp leaves were marked by discolored spots very early in the season, but little fruit was formed.

135. SEPTORIA ACERIS (Libert).

On leaves of *Acer dasycarpum* Ehrh. Madison.

A comparison with the original *Ascoxyta aceris* Lib. (Crypt. Ard., No. 54), for which I am indebted to Dr. Farlow, shows very little difference between our plant and the European form. The spores, after their escape, lie loosely over the lower surface of the leaves. In both forms they are straight or more commonly somewhat curved, usually 4-celled, and decidedly constricted at the septa, which, like the external walls, are very thin. The average size is 4×40–$50\ \mu$. Spots very small, yellow.

136. SEPTORIA ASTRAGALI Desmaz.

On leaves of *Vicia americana* Muhl. Stoughton.

137. SEPTORIA, sp.

On leaves of *Aquilegia canadensis* L. La Crosse, Pammel.

Spots blackish, elongated. Spores filiform, $1 \times 25\ \mu$ Differs from *S. anemones* Desm. chiefly in the spots. Penzig and Saccardo (Atti R. Inst. Veneto, Ser. 6, v. 2.) describe a species under the name *S. aquilegiae*, which produces large black spots on leaves of *Aquilegia atrata*, which is possibly the same, though I have seen only the abstract of their paper in the Bot. Centralblatt, where spore-measurements are not given.

138. SEPTORIA COPTIDIS B & C.

On leaves of *Coptis trifolia* Salisb. Wisconsin, Lapham. *In herb.* Curtis.

139. SEPTORIA PHLOCIS Sacc. & Sp.

On leaves of *Phlox divaricata* L. Madison.

Differs from the typical form in causing larger yellowish or dirty white spots 5 mm. in diameter, which are often confluent. Perithecia numerous. Spores colorless, filiform, 2×30–$40\ \mu$, usually 2-septate.

140. SEPTORIA GRAMINUM Desm.

On leaves of *Setaria viridis* Beauv. and on *Poa annua* L. Ithaca, Syene, Stoughton.

The variety on *Poa* is quite destructive in spring, occurring on the rachis of the panicle and on the floral envelopes, which are uniformly brown. Perithecia round, black, about 80 μ in diameter, prominent. Spores hyaline, slightly clavate, obscurely septate; average size, $2.5 \times 40\ \mu$.

141. SEPTORIA RUBI (Duby).

On leaves of *Rubus strigosus* Mich. Madison, Syene.

142. SEPTORIA CONVOLVULI Desmaz. (*S. flagellaris* Ell. & Everh.)
On leaves of *Convolvulus sepium* L. Madison.

Spots brown or nearly white, round, 1–3 mm. in diameter. Perithecia small, one or a few on each spot. Spores nearly filiform, colorless, usually 2×40 μ. Not certainly distinguishable from forms of *S. convolvuli*, which varies much on different hosts.

143. SEPTORIA, sp.
On leaves of *Silphium integrifolium* Mich. Stoughton.

Spots angular, blackish-brown, 1–3 mm. in diameter. Perithecia inconspicuous, 60–70 μ. Spores colorless, filiform, about 5-septate, 1.5–2×30–35 μ.

144. SEPTORIA, sp.
On stem of *Ribes*. "Wisconsin, Lapham." *In herb.* Curtis.

145. SEPTORIA POLYGONORUM Desmaz.
On *Polygonum hydropiper* L. Ithaca, Madison; Baraboo, Pammel.

Septoria ulmi Fr.—See Phyllachora ulmi, No. 53.

146. DARLUCA FILUM Cast.
On various Uredineae; e. g., *Puccinia polygoni amphibii*, on *Polygonum amphibium*, *P. asteris* on *Aster*, *Uromyces junci*, on *Juncus*, *U. acuminatus*, on *Spartina*, *Puccinia tomipara*, on *Bromus*, *Phragmidium*, on *Potentilla*, *Uredo iridis*, on *Iris versicolor* and *Puccinia menthae*, on *Pycnanthemum*.

BASIDIOMYCETES.

UREDINEAE.

147. UROMYCES TEREBINTHI (D C.) (*Pileolaria brevipes* B. & Rav.).
Uredo and teleutospores on *Rhus toxicodendron* L. Madison; La-Crosse, Pammel.

I have not compared this with the European form, but Shroeter has shown that they are identical (Hedwigia, 1875, p. 170).

148. UROMYCES POLYGONI (Pers.).
Uredo and teleutospores on *Polygonum aviculare* L. and *P. erectum* L., in summer and fall; the uredo especially abundant. Madison; La Crosse, Pammel.

149. UROMYCES PHASEOLI (Pers.) (*U. appendiculatus* Lév.).
Uredo and teleutospores on leaves of cultivated beans (*Phaseolus*) and *Amphicarpaea monoica* Nutt. The aecidium on the latter host.

150. Uromyces orobi (Pers.).

Aecidium on *Lathyrus venosus* Muhl., *L. palustris* L. and *Desmodium acuminatum* D C. Uredo and teleutospores on *L. venosus* Muhl. Madison; Baraboo, La Crosse, Pammel. The aecidium on *Desmodium*, from Brownsville, Minn.

151. Uromyces lespedezae (Schw.) (*U. macrosporus* B. & C.).

Aecidium, uredo and teleutospores on *Lespedeza capitata* Michx Madison; Kilbourn City, La Crosse, Pammel.

152. Uromyces trifolii (A. & S.) (*U. apiculatus* Strauss).

Aecidium, uredo and teleutospores on *Trifolium repens* L. and *T. incarnatum* L. Madison; La Crosse, Pammel.

152*a*. Uromyces euphorbiae C. & P.

Aecidium, uredo and teleutospores on *Euphorbia maculata* L. and *E. hypericifolia* L., very common in late summer and fall. Madison; La Crescent, Minn., Pammel.

The aecidium has been distributed by Cooke, on the same host plant, as *A. euphorbiae* Pers. (Ravenel's Fung. Amer., No. 484).

153. Uromyces erythronii (D C.) (*U. liliacearum* Ung.).

Aecidium, uredo and teleutospores on *Lilium canadense* L. Madison; La Crosse, Pammel.

The uredo corresponds in every respect with that described by Dr. Farlow in the Proceedings of the American Academy, XVIII., p. 79.

154. Uromyces junci (Desmaz.).

Uredo and teleutospores on a small *Juncus*. Madison, Syene.

155. Uromyces hedysari paniculati Schw.

Uredo and teleutospores on a species of *Desmodium*. Madison.

156. Uromyces pyriformis Cke.

Uredo and teleutospores on *Acorus calamus* L. La Crosse, Pammel.

157. Uromyces caladii (Schw.).

Aecidium, uredo and teleutospores on leaves of *Arisaema triphyllum* Torr. Madison; Kirkland, Pammel.

Peck has given the synonymy of this species in full in the 29th Report on the New York Cabinet of Natural History, p. 67.

158. Uromyces hyperici (Schw.).

Aecidium on *Elodes virginica* Nutt. Teleutospores on *Hypericum pyramidatum* Ait. La Crosse, Pammel.

159. Uromyces solidaginis Niessl.

Teleutospores on *Rudbeckia laciniata* L. La Crosse, Pammel.

160. UROMYCES ACUMINATUS Arthur.

Uredo and teleutospores on *Spartina cynosuroides* Willd. Madison; La Crosse, Pammel.

A very variable species, which in some of its forms can scarcely be distinguished from a species on several grasses from other parts of the country, which may be a form of the variable *U. dactylidis* Otth.

161. PUCCINIA CIRCAEAE Pers.

Teleutospores very abundant on leaves of *Circaea lutetiana* L. Madison; La Crosse, Pammel; also collected at Hokah, Minn., by Mr. Pammel.

162. PUCCINIA ANEMONES VIRGINIANAE Schw. (*P. solida* Schw.).

Teleutospores on *Anemone virginiana* L. and *A. cylindrica* Gray, in August. Madison; La Crosse, and Hokah, Minn., Pammel.

163. PUCCINIA THALICTRI Chevall.

Teleutospores on *Thalictrum dioicum* L. and *T. cornuti* L. Madison; Kirkland, La Crosse, Pammel.

I do not see how this can be distinguished morphologically from *P. anemones* Pers. It is usually marked with larger and more obtuse warts than our specimens of the latter, but European specimens of *P. anemones* sometimes have quite as coarse granulations as our *P. thalictri*.

164. PUCCINIA HYDROPHYLLI Peck & Clinton.

Teleutospores on *Hydrophyllum virginicum* L. Madison.

165. PUCCINIA LOBELIAE Ger. (*P. microsperma* B. & C.).

Teleutospores on *Lobelia syphilitica* L., in August. Madison.

166. PUCCINIA VERRUCOSA (Schultz). (*P. hyssopi* Schw.).

Teleutospores on *Lophanthus scrophulariaefolius* Benth. La Crosse, Pammel.

167. PUCCINIA SILPHII Schw.

Teleutospores on *Silphium perfoliatum* L. and *S. integrifolium* Mich. Stoughton; La Crosse, Pammel.

On the latter host sometimes accompanied by the spermogonia of an aecidium, in June. (*cf.* No. 242.)

168. PUCCINIA ASTERIS Duby. (*P. asteris* Schw.).

Teleutospores on *Aster corymbosus* Ait., *A. cordifolius* L. and *A. tradescanti* L. La Crosse, Dells of the Wisconsin, Pammel.

169. PUCCINIA SOLIDAGINIS Pk.

On leaves of *Solidago nemoralis* Ait. (?) La Crosse, Pammel.

Paler than the type, which it otherwise resembles, according to Professor Peck.

The teleutospores are often forked; in some cases the division extends merely through the terminal papilla; in others the lower cell is produced into a thickened papilla just below the septum.

170. PUCCINIA TOMIPARA, n. sp.

Uredo and teleutospores on a species of *Bromus*, apparently *B. ciliatus* L. La Crosse, Pammel.

II. Sori small, round, or little elongated, on the upper surface of the leaf. Spores commonly round, somewhat roughened with blunt, inconspicuous warts; pale yellow, 22–26 μ.

III. Sori compact, black, long covered by the epidermis; round or slightly elongated, usually about .2 mm. in diameter. Spores pale chestnut-brown, thin walled, without apical thickening; irregularly oblong, sessile; 2–5-celled, often tomiparous; 13–22×35–43 μ.

The species is remarkable from the fact that the spores are commonly 3–4-celled, with the uppermost septum oblique or not infrequently parallel to the axis of the spore, which is thus made to consist of more than one row of cells. It somewhat resembles *P. triarticulata* B. & C., which occurs on *Elymus*, and which has 3-celled spores; but these are longer and differently shaped.

171. PUCCINIA BARYI (B. & Br.) (*P. striatula* Thuem., *P. linearis* Pk.).

Uredo and teleutospores on some dead grass, possibly *Andropogon scoparius* Michx. Madison.

Well marked by the strongly clubbed paraphyses.

172. PUCCINIA ANDROPOGI Schw. (*P. ellisiana* Thuem.).

Teleutospores on *Andropogon scoparius* Mx. Madison; Milwaukee, Lapham; La Crosse, Pammel.

This has been compared with Schweinitzian specimens, by Dr. Farlow. The teleutospores are not unlike those of *P. cesati* Schr., as described by Winter.

173. PUCCINIA ARUNDINARIAE Schw.

Teleutospores on dead leaves of *Spartina cynosuroides* Willd., in winter and spring. Madison.

174. PUCCINIA EMACULATA Schw. (*P. graminis* P., var. *brevicarpa* Peck).

Teleutospores on *Panicum capillare* L. Madison; La Crosse, Pammel.

175. PUCCINIA VEXANS Farlow.

The form described by Peck as *Uromyces brandegeei*, but now held to be the uredo or mesosporic form of this species, was found once on *Bouteloua racemosa* Lag., at La Crosse, by Mr. Pammel. The quantity examined was small, and no teleutospores were seen.

176. PUCCINIA PHRAGMITIS (Schum.) (*P. arundinacea* Hedw.).

Uredo and teleutospores on *Phragmites communis* Trin. Milwaukee, Lapham; La Crosse, Pammel. Also collected at Hokah, Minn., by Mr. Pammel.

177. PUCCINIA MAYDIS Carrad. (*P. sorghi* Schw.).

Uredo and teleutospores on the leaves of *Zea mays* L., common, in summer and fall. Madison.

Cooke has described an Asiatic species on Indian Corn, under the name of *P. purpurea*, the teleutospores of which do not appear distinct from ours. The purplish discoloration of the leaves which it induces, and from which it derives its specific name, is not characteristic, for some of the Wisconsin specimens of *P. maydis* occur on decidedly purplish spots, and Dr. Farlow informs me that Italian specimens of the same species are often purple. An examination of Indian specimens of *P. purpurea*, for which I am indebted to Dr. Farlow, shows, however, that the uredo spores are rather larger and more oblong than those of our plant; and they are accompanied by nearly colorless, thick-walled, clavate paraphyses, which are wanting in our species.

178. PUCCINIA POLYGONI AMPHIBII Pers. (*P. polygonorum* Lk., *P. amphibii* Fckl.).

Uredo and teleutospores on *Polygonum amphibium* L. Madison; La-Crosse, Pammel. Also collected at Brownsville, Minn., by Mr. Pammel.

The parasite is very commonly attacked and greatly deformed by *Darluca filum* Cast.

179. PUCCINIA PRUNI SPINOSI (P.) (*P. prunorum* Link).

Uredo and teleutospores on leaves of seedling *Prunus americana* Marsh. and on those of older plants of the same species and of *P. virginiana* L., in late summer and fall. Madison.

180. PUCCINIA ARGENTATA (Schultz) (*P. noli tangeris* Cda.).

Uredo and teleutospores on *Impatiens fulva* Nutt., in fall. Madison.

As no aecidium accompanies this species in Europe, our *Aecidium impatientatum* Schw. must be considered as probably belonging to some heteroecismal species, although it occasionally occurs on the same leaves with the *Puccinia.*

P. argentata has also been found on *Impatiens pallida* Nutt., at Hokah, Minnesota, by Mr. Pammel.

181. PUCCINIA AMORPHAE Curtis.

Uredo and teleutospores on leaves of *Amorpha canescens* Nutt. and *A. fruticosa* L., common. Madison; La Crosse, Pammel. Also collected at Hokah, Minn., by Mr. Pammel.

182. PUCCINIA PETALOSTEMONIS Farlow, *in litt.*

Uredo and teleutospores on *Petalostemon.* La Crosse, Pammel.

II. Sori round, brown, surrounded by the ruptured epidermis, which is elevated so as to form a false-peridium. Spores pale brown, ovoid, nearly smooth or somewhat granular on the surface. Average size, 20×22 μ.

III. Sori similar to those containing uredo spores, black. Spores medium brown, broadly ellipsoidal, slightly constricted, thin-walled, without apical thickening, surrounded by a smooth gelatinous sheath; average 20×33 μ.

The species is related to *P. amorphae* Curt., but readily distinguished by the paler and more transparent teleutospores, and the thinner, smooth envelope. Pale-amber paraphyses, frequently hooked at the tip, accompany both uredo and teleutospores.

183. PUCCINIA ZYGADENI, n. sp.

Teleutospores on *Zygadenus glaucus* Nutt. La Crosse, Pammel.

Sori small, rounded; on both sides of the leaf. Spores amber-brown, darker at the apex, on thin walled colorless pedicels; oblong or sometimes clavate; but slightly constricted. Apex thickened, usually rounded or truncate, rarely acute. 16–20×33–56 μ; commonly about 17×43 μ.

This resembles a specimen in the Curtis herbarium, on *Amianthium,* which is labeled *P, asphodeli* Duby. "It corresponds closely to a specimen from France, bearing the same name, but evidently incorrectly named, as other specimens from France and Italy, with the same name, are quite different." (Farlow, *in litt*).

184. PUCCINIA ALETRIDIS B. & C.

Uredo and teleutospores on *Aletris farinosa* L. Kilbourn City, Pammel.

The uredo sori are small; their spores pale yellow, round-ellipoidal, thin walled and sparsely granulated. Their usual size is about 20 μ.

185. PUCCINIA KUHNIAE Schw.

Teleutospores on *Kuhnia eupatorioides* L., in the fall. Madison; La Crosse, Pammel.

186. PUCCINIA PODOPHYLLI Schw. (*P. aculeata* Schw.).

Teleutospores common on *Podophyllum peltatum* L., in June. Madison, Kilbourn City; La Crosse, Pammel.

Sometimes accompanying or preceded by *Aecidium podophylli* Schw., but frequently found where there is no trace of the latter.

187. PUCCINIA XANTHII Schw.

Teleutospores on *Xanthium strumarium* L. and *Ambrosia trifida* L. Madison; La Crosse, Pammel. Also collected ot Hokah, Minn., by Mr. Pammel.

In New England, this is often preceded by an aecidium, according to Dr. Farlow.

188. PUCCINIA FUSCA (Relhan) (*P. anemones* P.).

Teleutospores very abundant, in spring, on *Anemone nemorosa* L. Madison.

The aecidium occurring simultaneously on the same species is *A. punctatum* Pers., and not *A. leucospermum* D C., which is said by European authorities to be a stage of this species. It is frequently associated with *Peronospora pygmaea* Ung. and *Urocystis anemones* (Pers.), but I have never seen it on the same leaf with the brown aecidium.

189. PUCCINIA CONVOLVULI (P.).

Aecidium (*A. dubium* Clinton, *A. calystegiae* Cast., *A. convolvuli* Ces.), uredo and teleutospores on *Convolvulus sepium* L. La-Crosse, Pammel.

190. PUCCINIA GALII (Pers.).

Spermogonia on *Galium aparine* L., in May. Uredo and teleutospores on *G. triflorum* Michx., in summer and fall. Madison; La-Crosse, Pammel.

The teleutospores are uniformly more thickened at the apex, and more clavate in general outline than those of *P. valantiae* Pers., to which the American form has sometimes been referred. The presence of uredospores is also characteristic, and the occurrence of spermogonia indicates that the aecidium will ultimately be found, although I am not aware that it has yet been recorded in this country.

191. PUCCINIA PIMPINELLAE (Strauss) (*P. myrrhis* Schw.).

Aecidium, uredo and teleutospores on *Osmorrhiza brevistylis* D C. Madison; Kirkland, Pammel.

192. PUCCINIA MENTHAE Pers.

Aecidium on *Monarda fistulosa* L. and *Lycopus europaeus* L. Uredo and teleutospores on *Mentha canadensis* L., *Pycnanthemum lanceolatum* Pursh, *Monarda fistulosa* L. and *M. punctata* L. Madison; Sauk City, Lüders; La Crosse, and Hokah, Minn., Pammel.

193. PUCCINIA GENTIANAE (Strauss).

Uredo and teleutospores on *Gentiana andrewsii* Griseb., in autumn. Madison.

194. PUCCINIA FLOSCULOSORUM (A. & S.) (*P. compositarum* Schl., *P. variabilis* Grev., *P. hieracii* Mart.).

Uredo and teleutospores on *Taraxacum dens-leonis* Desf., *Hieracium canadense* Mx., *H. scabrum* Mx., *Cnicus altissimus* Willd., *C. lanceolatus* Hoffm. and *C. discolor* Muhl. Madison; Devil's Lake, Pammel.

Probably several of the aecidia referred to *Aecidium compositarum* Winter belong to this species.

195. PUCCINIA HELIOPSIDIS Schw.

Uredo and teleutospores on *Vernonia fasciculata* Michx. La Crosse, Pammel.

Scarcely distinct.

196. PUCCINIA TANACETI D C.

Uredo and teleutospores on *Artemisia dracunculoides* Pursh. Madison.

197. PUCCINIA HELIANTHI Schw.

Aecidium (*A. helianthi* Schw.) on *Helianthus strumosus* L. Uredo and teleutospores common on *H. grosse-serratus* Mart., *H. annuus* L. and *H. strumosus* L. Madison, Syene; La Crosse, Pammel.

The broader uredospores and the paler apex of the teleutospores distinguish this from the forms of *P. tanaceti*, with which Winter unites it, that I have been able to examine.

198. PUCCINIA VIOLAE (Schum).

Aecidium on *Viola cucullata* Ait., *V. pubescens* Ait. and *V. canadensis* L. Uredo and teleutospores on *V. cucullata* Ait., *V. blanda* Willd. and *V. pubescens* Ait. Madison, Stoughton; Delton, Devil's Lake, Kirkland, Pammel.

199. PUCCINIA RUBIGO VERA (D C.) (*P. straminis* Fckl.).

Uredo and teleutospores common, on *Hordeum jubatum* L.

Aecidium asperifolii Pers., which is said to belong to this species, and which occurs on various Boragineae, has not been found yet.

200. PUCCINIA GRAMINIS Pers.

Aecidium (*Aecidium berberidis* Gmel.) very common in spring, on *Berberis vulgaris* L., wherever the barberry is cultivated. Uredo and teleutospores abounding on many grasses, of which the following have been collected: *Triticum vulgare* Vill., *Avena sativa* L., *Phleum pratense* L., *Hordeum jubatum* L., *Agrostis vulgaris* With., *A. scabra* Willd., *Briza maxima* L., and *Elymus*, sp. Ithaca, Madison, and reported from many other localities.

The uredo appears sparingly in the spring, before aecidia have developed on the barberry, and there is reason for believing that the mycelium hibernates in winter grain and perennial grasses. Although the barberry does not grow wild in the state, it is cultivated in sufficient abundance to stock the state with wheat rust in favorable seasons. The teleutospores are found in fall and winter, and are especially noticeable on the sheaths of grasses, after their death. Attempts made in my laboratory to infect the very young leaves of wheat seedlings with the sporidia from germinating teleutospores have thus far entirely failed, though Plowright claims to have succeeded. If this were possible it would entirely do away with the necessity for the intervention of the barberry, which, as has been said, is questionable, for other reasons.

201. PUCCINIA CORONATA Cda.

Uredo and teleutospores very common, on *Dactylis glomerata* L., *Avena sativa* L., etc. Madison. The common oat rust in this vicinity is the uredo of this species.

Aecidium rhamni Gmel., which is held to be a state of this species, has not yet been found. It should be looked for on species of *Rhamnus.*

202. PUCCINIA CARICIS (Schum.).

Aecidium (*Aecidium urticae* Schum.) common, in spring, on *Urtica gracilis* Ait. Uredo and teleutospores on *Cyperus schweinitzii* Torr., and other sedges, in fall and winter, common. Madison; La Crosse, Honey Creek, Pammel.

203. PHRAGMIDIUM SUBCORTICIUM (Shrank) (*P. mucronatum* Link).

Uredo and teleutospores on leaves of *Rosa parviflora* Ehrh., and on cultivated roses. Madison.

204. PHRAGMIDIUM SPECIOSUM Fries.

Teleutospores on petioles and stems of *Rosa parviflora* Ehrh., in fall and winter. Madison.

Uredo miniata P., or a form not to be distinguished from it, sometimes occurs on the same plant in spring under suspiciously similar circumstances, but a connection between the two species has not yet been traced.

205. PHRAGMIDIUM RUBI IDAEI (Pers.) (*P. effusum* Fckl., *P. gracile* Grev.).

Uredo and teleutospores on leaves of *Rubus occidentalis* L., in autumn. Madison.

This is the species distributed in Ellis' North American Fungi, No. 282, under the name of *P. incrassatum* Lk., var. *gracile.* The uredo which has been associated with it is very abundant, scattered over the lower surface of the leaves. It may prove to belong to *P. rubi* (Pers.) (*P. bulbosum* Strauss).

206. PHRAGMIDIUM FRAGARIAE (D C.) (*P. triarticulatum*, B. & C., *P. obtusum*, P.).

Uredo (*Uredo potentillarum* D C.) on leaves of *Potentilla canadensis* L. Madison; La Crosse, Pammel.

207. GYMNOSPORANGIUM MACROPUS Link.

Teleutospores common on cultivated *Juniperus virginiana* L., in May. Madison, Syene; Oconomowoc, Lapham; Sauk City, La-Crosse, Pammel.

GYMNOSPORANGIUM SABINAE (Dicks.), var GLOBOSUM Farlow (*G. fuscum*, D C., var. *globosum* Farlow).

Teleutospores on *Juniperus virginiana* L., common on certain trees in May. Madison; River Falls, King.

The galls of this species are less succulent than those of the last, which are commonly known as "Cedar Apples." Cornu records similar galls as caused by it in France (Bull. Soc. Bot. de Fr., v. 25, p. 123).

The common European cluster-cup of the pear (*Roestelia cancellata* Rebent.) is held to be a state of this species, but it does not occur with us, if, indeed, it is found in this country.

209. MELAMPSORA SALICIS CAPREAE (Pers.) (*M. salicina* Lév.).

Uredo and teleutospores common on species of *Salix*, the latter developing after the leaves have fallen. Madison; La Crosse, Pammel.

210. MELAMPSORA POPULINA (Jacq.).

Uredo very common in the fall, on leaves of *Populus monilifera* Ait., *P. tremuloides* Michx., *P. grandidentata* Michx. and *P. balsamifera* L., var. *candicans* Gray. Teleutospores on fading or fallen leaves of the same species. Madison.

211. COLEOSPORIUM SONCHI ARVENSIS (Pers.) (*C. compositarum* Lév., *C. solidaginis* Thuem.).

Uredo and teleutospores common on species of *Solidago* and *Aster*, in summer and fall, Madison; Dells of the Wisconsin, La Crosse, etc., Pammel.

ISOLATED UREDO FORMS.

212. UREDO MINIATA Pers. (*Coleosporium miniatum*, Pers.).

Very common on petioles and stems of *Rosa parviflora* Ehr., in spring. Madison; La Crosse, Pammel.

Precedes *Phragmidium speciosum* Fr., to which some of its forms bear a considerable resemblance in habit.

213. UREDO AGRIMONIAE EUPATORIAE (D C.) (*Coleosporium ochraceum* Bonord.).

Common, on leaves of *Agrimonia eupatoria* L. Madison.

214. UREDO IRIDIS Duby. (*Trichobasis iridicola* Pk!).

On *Iris versicolor* L., in fall. Madison.

215. UREDO PYROLAE (Gmel.).

On *Pyrola elliptica* Nutt., in spring. Madison.

216. UREDO, sp.

On *Mimulus ringens* L., in company with *Aecidium pentstemonis* Schw. La Crosse, Pammel.

Sori small, scattered loosely over both surfaces of the leaf; spores pale orange, very irregular, unevenly warted, 10×23— 15×16μ.

217. UREDO POLYPODII (P.) (*U. filicum* D C., *U. aspidiotus* Pk.?).

On *Cystopteris fragilis* Bernh., in May and June. Madison, Kilbourn City.

Spores obovate to pyriform, smooth, 13—20×23—26μ, usually, 13.5×25μ; thinner walled than European specimens on *Cystopteris* and *Phegopteris.*

218. CÆOMA NITENS Schw. (*C. luminatum* Schw.).

Common in spring, on wild and cultivated plants of *Rubus occidentalis* L. and *R. villosus* Ait. Syene, Stoughton, Madison; Baraboo, La Crosse, Pammel; Janesville, Kellogg.

The common red-rust of raspberries. The orange rust which occurs in autumn is referred to No. 205.

ISOLATED AECIDIAL FORMS.

219. AECIDIUM* PUSTULATUM Curt.

On *Comandra umbellata* Nutt., in spring. Madison; Columbus, Rockwell.

220. AECIDIUM POLEMONII Peck.

On *Phlox pilosa L.* and *Polemonium reptans* L. Common, in spring. Madison.

221. AECIDIUM PODOPHYLLI Schw.

On *Podophyllum peltatum* L., in June. Madison.

Sometimes associated with *Puccinia podophylli* Schw., which, however, more commonly occurs without any trace of the aecidium.

222. AECIDIUM OENOTHERAE Peck.

Very common in spring and summer, on *Oenothera biennis* L. Stoughton, Madison; Baraboo, Pammel; Sauk City, Lüders.

223. AECIDIUM LYSIMACHIAE Lk.

On *Steironema lanceolata* Raf. (?) La Crosse, Pammel.

224. AECIDIUM SOLANI Mont.

On *Physalis virginica* Mill. and *P. lanceolata* Michx. Sauk City, Lüders.

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* This name is sometimes written *Oecidium.* See Malinvaud, Bull. Soc. Bot. France, 1880, No. 5.

225. AECIDIUM PETERSII B. & C.

On *Viola delphinifolia* Nutt. Common, in spring. Madison.

Peridia longer than those of the aecidium of *Puccinia violae.*

226. AECIDIUM GERANII D C.

Very common, in spring, on leaves of *Geranium maculatum* L.

227. AECIDIUM GROSSULARIAE D C.

On leaves, pedicels and flowers of *Ribes rotundifolium* Mx., *R. floridum* L'Her., *R. cynosbati* L., *R. aureum* Pursh and *R. rubrum* L. Everywhere, in spring. Madison; La Crosse, Pammel.

This cannot be distinguished from the European species, which is called by Winter the aecidium of *Puccinia grossulariae* Gmel., with which he identifies the American *P. pulchella* Pk. Though the aecidium is one of the commonest of fungi everywhere east of the Mississippi, I am not aware that its assumed teleutosporic form has been recorded for any locality but the one given by Peck. Dr. Magnus, also, writing of this species as it occurs in Germany, says "*Aecidium grossulariae* certainly is an isolated aecidium, which belongs to a heteroecismal *Puccinia*, as I convinced myself some years since by observations on *Ribes nigrum, R. grossularia* and *R. alpinum*, in the vicinity of Berlin." *

Since the above was written, Plowright, discussing British Uredineae, says: "As no *Puccinia* occurs on gooseberry leaves in this country, it is clear *Aecidium grossulariae,* as we find it, is not a Pucciniopsis but is probably a heteroecismal species." (Grevillea, XII., 36). the same conclusion is reached in Denmark, by Rostrup (Rev. Mycolgique, October 1884, p. 211).

228. AECIDIUM POLYGALINUM Peck.

On *Polygala senega* L. Madison; La Crosse, Pammel.

229. AECIDIUM IMPATIENTATUM Schw.

On *Impatiens fulva* Nutt. and *I. pallida* Nutt. Madison; La Crosse, Pammel; Sauk City, Lüders. Also collected at Hokah, Minn., by Mr. Pammel.

230. AECIDIUM JAMESIANUM Peck.

On *Asclepias tuberosa* L., *A. cornuti* Dec., *A. ovalifolia* Dec. and *Acerates longifolia* Ell. Stoughton; La Crosse, Pammel; Sauk City, Lüders.

This is called the aecidium of *Uromyces howei* (Peck) by Mr. Arthur (Bull. Minn. Acad., XI., 25).

The bright orange-red spores contrast beautifully with the pure white peridia, much as in *Roestelia aurantiaca* Pk., and the thickening of their walls, mentioned by Mr. Arthur, is very characteristic.

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* (Verhandl. Bot. Verein, Prov. Brandenburg, v. 23, p. XXVII–XXVIII.)

231. AECIDIUM CONVALLARIAE Schum.

On *Polygonatum biflorum* Ell. and *P. giganteum* Dietr. La Crosse, Pammel. Spermogonia, probably of this species, on *Smilacina racemosa* Desf.

232. AECIDIUM SAMBUCI Schw.

On *Sambucus canadensis* L. La Crosse, Pammel.

233. AECIDIUM FRAXINI Schw.

On *Fraxinus sambucifolia* Lam. Kirkland, La Crosse, Pammel.

234. AECIDIUM RANUNCULACEARUM, D C.

On *Anemone dichotoma* L. La Crosse, Pammel.

This species includes, in part, the aecidium of *Uromyces dactylidis* Otth., which occurs on grasses, according to Schroeter and Plowright, while *Puccinia arundinacea* D C. also has its aecidium on *Ranunculus*, according to Cornu (Comptes Rendus, June 26, 1882).

To be distinguished is, perhaps —

235. AECIDIUM THALICTRI Grev.

On *Thalictrum dioicum* L. Madison; La Crosse, Pammel.

236. AECIDIUM RANUNCULI Schw.

On *Ranunculus abortivus* L. Madison, in spring.

Quite distinct in its habit from either of the preceding.

237. AECIDIUM PUNCTATUM Pers. (*A. quadrifidum* D C.).

Not uncommon on leaves of *Anemone nemorosa* L. Less abundant on *Anemone acutiloba* Lawson, in May. Madison.

The typical form with a wide 4-lobed margin is unusual, most of the specimens having a narrow border divided into small lobes. The form on *Hepatica acutiloba* is very distinct from *A. hepaticae* Beck, in its brown spores. I do not distinguish it from some forms on *A. nemorosa.*

238. AECIDIUM DICENTRAE, n. sp.

On leaves of *Dicentra cucullaria* D C., in company with *Peronospora corydalis* DeBary. Madison.

Hypophyllous, scattered. Spots none. Peridia short, pale yellow, irregularly torn or finely many-lobed, .3 mm. in diameter. Peridial cells granulated, polygonal, more or less isodiametric, averaging 13×15 μ. Spores deep orange, thin-walled, smooth, nearly spherical or somewhat polygonal; 13–20 μ, usually about 16 μ; wall colorless.

A beautiful species, collected by Mr. Pammel in May, 1884. The aecidia are accompanied by small violet or brown spermogonia, like those of *A. punctatum.*

239. AECIDIUM PAMMELII, n. sp.

On leaves of *Euphorbia corollata* L. La Crosse, Pammel.

Spots brown, little, if at all, thickened, slightly pustulate, with a central cluster of a few spermogonia. Cluster cups usually hypophyllous, concentrically arranged, rarely a few epiphyllous. Peridium short, whitish; border narrow, about 10-lobed. Peridial cells colorless, rugose, usually nearly isodiametric, 20–25 μ. Spores red-orange, polygonal, isodiametric or commonly somewhat elongated, 20—25 μ.

The spots are generally orbicular, or elliptical with the longer axis parallel to the midrib. When the spermogonia appear near the margin of the leaf, or near the midrib, the spot naturally develops in but one direction. The species differs from the aecidium of *Uromyces euphorbiae* C. & P. in the regular arrangement of the cluster cups on round spots, and from the other aecidia occurring on this genus in not deforming the host plant.

240. AECIDIUM PENTSTEMONIS Schw.

On *Castilleia sessiliflora* Pursh., *Pentstemon pubescens* Sol. and *Mimulus ringens* L., in summer. La Crosse, Pammel.

The aecidia occur most abundantly on the lower surface of the leaf, less frequently above. Spots rounded, slightly thickened, reddish-brown, often yellow-bordered; less evident on *Castilleia* than on the other hosts. Peridia white, short, scarcely bordered, crumbling into the rows of cell of which they are composed. Spores orange; smooth, 15—20 μ in diameter.

The form on *Pentstemon* seems to be *A. pentstemonis* Schw., and that on *Mimulus* is scarcely different from *A. gerardiae* Pk., but neither seems to be very distinct from *A. scrophularinarum* Lasch., on *Scrophularia,* in Rabenhorst, Herb. Mycol., Ed. 2, No. 374. A uredo (No. 216) occurs in company with the aecidium on *Mimulus,* but is not evidently connected with it.

241. AECIDIUM SII LATIFOLII (Fiedler).

On leaves of *Sium lineare* Michx. La Crosse, Pammel.

242. AECIDIUM COMPOSITARUM Winter.

On leaves of *Lactuca canadensis* L., *Nabalus*, sp., *Vernonia noveboracensis* Willd., *Eupatorium perfoliatum* L., *Aster sericeus* Vent. and several other species of *Aster* and *Solidago* (among the latter *S. latifolia* L. and *S. riddellii* Frank), *Silphium perfoliatum* L., *Erigeron annuum* Pers., *E. canadense* L., *E. strigosum* Muhl. and *Cynthia virginica* Don. Madison; Kirkland, La Crosse, Pammel.

In this conglomeration, which for convenience includes all aecidia found on Compositae and not connected with some teleutosporic form, are, perhaps, to be distinguished: *A. tenue* Schw. (*A. compositarum,* var. *eupatorii* Schw.), *A. erigeronatum* Schw. and *A. asteratum* Schw. Specimens found at Madison on *Taraxacum dens leonis* Desf. may prove to be *A. taraxaci* Schm. and Kze., the aecidium of *Puccinia silvatica* Schr., of which we have not detected the teleutospores.

243. ROESTELIA LACERATA (Sow.).

Very common in summer and fall, on leaves of *Crataegus tomentosa* L. and *C. coccinea* L. Madison, Ithaca.

This is considered by European authorities to be the aecidium of *Gymnosporangium clavariaeforme* D C., which grows on the Juniper, but has not yet been reported in Wisconsin. Although the *Roestelia* is very abundant about Madison, I have never seen the Juniper here, so that its teleutospores are necessarily wanting.

244. ROESTELIA PENICILLATA (Sow.).

Common on leaves of *Pyrus coronaria* L. and *Amelanchier canadensis* Torr. and Gray., the spermogonia in May and June, the cluster-cups later. Madison; Delton, La Crosse, Pammel.

Sometimes considered a variety of the last species.

245. ROESTELIA TRANSFORMANS, Ell.(?)

Spermogonia on leaves of *Pyrus arbutifolia* L. La Crosse, Pammel.

USTILAGINEAE.

246. USTILAGO PANICI GLAUCI (Wall.) (*U. neglecta* Niessl).

In ovaries of *Setaria glauca* Beauv. Very abundant in fall. Syene, Madison.

247. USTILAGO SORGHI (Link) (*U. tulasnei* Kuehn).

In ovaries of *Sorghum saccharatum* L., grown from imported Chinese seed. Madison.

The specimens are more elongated than the typical form, but hardly distinct. Dr. Farlow writes me that he has more typical forms from Washington, D. C. The introduction of the smut with Chinese seed is well shown by its occurrence in three distinct localities (District of Columbia, Farlow; New York, Sturtevant; and Wisconsin) on plants raised from imported seed. It does not seem to spread with us.

248. USTILAGO ZEAE MAYS (D C.) (*U. maydis* Lév.).

In various parts of *Zea mays* L. Very abundant everywhere; also on leaves of the Teosinte (*Euchlaena luxurians* Fourn.) at Madison, and Cambridge, Mass.

249. USTILAGO SEGETUM Pers.

In ovaries of *Avena sativa* L., *Triticum vulgare* Vill. and *Hordeum vulgare* L. Madison; Sauk City, La Crosse, Pammel; Milwaukee, Lapham.

Very abundant; the small-grain smut.

250. USTILAGO RABENHORSTIANA Kuehn.

In the inflorescence of *Panicum sanguinale* L. Madison; La Crosse, Pammel,

Spores smoother than the European form.

251. USTILAGO SPERMOPHORUS B. & C.

In ovaries of *Eragrostis poaeoides* Beauv., var. *megastachya* Gray. Madison; Sauk City, Lüders.

The affected ovaries are round or ellipsoidal, scarcely enlarged, and remain long unbroken, enclosed by the paleae. Spores thin-walled, brown, round or slightly elongated, finely echinulate, 6×8, 8×8— 10×8 μ.

The appearance of the ovaries recalls *Tilletia decipiens* (Pers.) as represented in Scandinavian specimens as *Agrostis*, from Professor Blytt, but the spores of that species measure 23 — 28 μ.

252. USTILAGO JUNCI Schw.

Pedicels and perianth of *Juncus tenuis* Willd. (?) in June. Stoughton.

Apparently referrible to Cornu's genus *Cintractia*.

253. USTILAGO SYNTHERISMAE Schw.

Inflorescence of *Cenchrus tribuloides* L. La Crosse, Pammel.

254. TILLETIA FOETENS (B. & C.) (*T. laevis* Kuehn).

In ovaries of *Triticum vulgare* Vill. La Crosse, Pammel.

The "bunt" or hard smut of wheat, published in 1860 as *Ustilago foetens* B. & C., in Ravenel's Fungi Carol. Exsicc., V., 100.

255. TILLETIA STRIAEFORMIS (West) ? (*Ustilago salveii* B. & Br!).

In leaves of *Phleum pratense* L. and *Elymus canadensis* L., var. *glaucifolius*. Stoughton, Madison; La Crosse, Pammel.

Referred here on the authority of Winter.

256. ENTYLOMA COMPOSITARUM Farlow. (*Protomyces polysporus* Peck).

In leaves of *Silphium integrifolium* Mx., *Ambrosia artemisiaefolia* L., *A. psilostachya* D C. and *Lepachys pinnata* Torr. & Gr. Madison, Ithaca; LaCrosse, Pammel.

Occurs also on *Aster puniceus* L., in the East, and has been described on *Ambrosia trifida* L., by Peck (34th Report, pp. 45–6).

257. ENTYLOMA LOBELIAE Farlow.

In leaves of *Lobelia inflata* L. Delton, Pammel.

258. ENTYLOMA CRASTOPHILUM Sacc. (?)

In sheaths of *Zizania aquatica* L. Madison.

This agrees well with the description in all respects save the thickening of the angles of the spores, which I have not noticed. I have not been able to compare it with authentic specimens.

259. ENTYLOMA LINARIAE Schroeter.

In leaves of *Veronica peregina* L. Madison.

This occurs in round, thickened portions of the leaf, similar to those on *Linaria*, in which it is found in Europe.

260. ENTYLOMA BESSEYI Farlow (*E. physalidis* Wint., *Protomyces physalidis* K. & C.?).

On *Physalis*, sp. Madison; La Crosse, Pammel,

The description does not allow it to be distinguished from the African species described by Kalchbrenner and Cooke (Grevillea, IX., 22).

261. ENTYLOMA MICROSPORUM (Ung.).

On leaf and petiole of *Ranunculus fascicularis* Muhl. Stoughton.

262. ENTYLOMA MENISPERMI Farlow and Trelease.

In leaves of *Menispermum canadense* L. Madison; Hokah, Minn., Pammel.

263. ENTYLOMA THALICTRI Schroeter (?).

In leaves of *Thalictrum dioicum* L. Common in the fall. Madison.

This seems to be distinct from *E. ranunculi* (Bonord.), to which it was doubtfully referred by Farlow (Botanical Gazette, August, 1883). Having seen no description of Schroeter's species, however, I can only assume that the two may be identical.

264. DOASSANSIA ALISMATIS (Fr.).

In leaves of *Alisma plantago* L., var. *americana* Gray, and *Sagittaria variabilis* Engelm. Madison.

The young spots in spring are white, and look like those of an *Entyloma*. The conidia on *Sagittaria* are hyaline, cylindrical or fusiform, 1-celled, and measure 2–3×12–20 μ.

265. UROCYSTIS ANEMONES (Pers.) (*U. pompholygodes* Schl.).

In stems and leaves of *Anemone nemorosa* L. and *A. dichotoma* L. Madison; La Crosse, Pammel.

266. UROCYSTIS OCCULTA (Wall.).

In leaves of *Elymus canadensis* L. Stoughton.

267. ENTOMOPHTHORA MUSCAE (Cohn).

Very common, on house flies, in fall. Madison, Syene.

The common fall disease of flies. The tarichium state of *E. calopteni* Busey will probably be found here in the larger grasshopper (*Caloptenus differentialis*).

THELEPHOREAE.

268. EXOBASIDIUM VACCINII Wor.

On *Gaylussacia resinosa* Torr. & Gray and *Vaccinium*, sp. Kirkland, La Crosse, Pammel. Also collected on the last-named host at Hokah, Minn., by Mr. Pammel.

Undoubtedly occurs on the cranberry and other Ericaceae here as elsewhere.

ALPHABETICAL INDEX TO HOSTS.*

A.

B.

C.

D.

* The fungi are referred to by their list numbers.

W.

X.

Z.

ON THE PRESENT STATE OF OUR KNOWLEDGE OF STELLAR MOTION.

By TRUMAN HENRY SAFFORD, Ph. D., Field Memorial Professor of Astronomy in Williams College.

The stellar motions, the so-called proper motions of the stars, which used to be thought fixed, seem to us very small, because the suns we call stars are so very far away.

Bodies which move at least as rapidly as our earth does about its sun, seem to move with velocities rarely exceeding one second a year; and this large stellar motion is only sufficient to produce a displacement equal to the moon's diameter as we see it in about eighteen centuries.

Under these circumstances another cause besides the apparent slowness makes the problem in question a troublesome one — the fact, namely, that accurate astronomical observation is a thing of less than two centuries past — and even Flamsteed, who commenced it, is now antiquated — and we are obliged to take Bradley's later observations— from 1750 on — as the real beginning.

Moreover, as years go by, it is found possible and necessary to re-reduce the older star-catalogues, in order to make use of the past records to the greatest possible extent.

Thus Bessel's Bradley's catalogue superseded in 1818 Bradley's own catalogue; and Professor Auwers has already published the chief results of a new reduction, which, using Bessel's principles and methods, supersedes Bessel's results.

Another element of difficulty in the problem lies in the comparative ease of making new observations upon the stars in a routine way, and the greater difficulty of selecting the fittest objects and observing those only. The practical astronomer who has learned simply how to observe, is far inferior to him, whose ability lies in a combination of the power to select well his working list, that to observe to the last degree of accuracy, and that to discuss results with skill and completeness. And the German school of astronomers, established by Bessel, Gauss and Struve, is at the same time the most perfect and the most regardful of all these matters.

At present star-catalogues are many; but complete discussions of their results are very scanty in comparison.

Three elements must then be considered in the present paper.

First, what old catalogues need re-reduction?

Second, what new observations need to be added to those now in progress.

Third, what discussions of stellar motion by the help of these materials are timely and needful.

Bradley's observations, as I have said before, have been re-reduced by Auwers; and his work is partly published; he has also taken care that new observations be made upon such of the stars as needed them; the resulting new catalogue by Dr. Becker of the Berlin observatory has been published, with proper motions discussed by Auwers; and Bradley's stars need not be observed any more for the present, except for purposes of the most refined accuracy. It will be an economy in by far the most cases simply to drop all Bradley stars from our working lists.

Flamsteed and Lacaille, from their want of precision, need hardly be considered in this connection; Lacaille's observations were, it is true, partly of some accuracy for his time; but *these* cases will mostly come up under other circumstances, as repetitions of Bradley; or else will be included in the Cape of Good Hope observations. Lacaille's far southern stars, whether well or ill observed by himself, are all continued in the new Cape catalogue.

T. Mayer (1756) observed zodiacal stars mainly. These are now in process of reobservation at Berlin.

Prof. Newcomb has lately prepared a catalogue of standard and zodiacal stars; so that the observer or computer who wishes to economize his labor had best avoid all stars within 6 degrees of the ecliptic; especially as the Greenwich observatory, and also that at Wilhelmshaven, so far as its means allow, are especially careful about stars near the moon's path from year to year.

The Lalande zones, including Fedorenko and D'Agelet, have been or are to be reobserved in the great zones now going on under the auspices of the Astronomische Gesellschaft, an international association having its seat at Leipzig. This reobservation is certainly sufficiently accurate to compare with Lalande, whose single observations were made with less accurate instruments than would now be employed; and whose mistakes are many. His zones have been fairly well reduced; and the lamented von Asten has computed new tables of reduction for most of them.

Piazzi's Palermo catalogue of 7,646 stars for 1800 needs a new reduction. This would, however, be an enormous labor; there are nearly 100,000 observations. Ten years' labor of a skillful computer would at least be needed; and probably this is a very low estimate. The stars do not now need reobservation owing to the great zones just mentioned.

Groombridge's catalogue for 1810 of 4,243 stars needs also a revision. But this would be much easier, as the original manuscript calculations are preserved; and are probably very free from mistakes. What is chiefly needed here is a careful study of the azimuth correction of Groombridge's meridian circle.

William von Struve published a catalogue of right ascensions for 1814 and 1815 in the first volume of the Dorpat observations. This, probably, needs some little revision, owing to its early date; and the same eminent observer continued this work during 1818 and 1819; but these latter observations are unreduced.

Years' work might readily be spent upon these right ascensions of Struve; and would be important for the revision of Groombridge, as the latter would be for that of Piazzi.

I have myself in progress a careful reobservation of the stars observed by Struve, especially for the difficult region within 10° of the north pole.

From the Greenwich observations of Bliss and Maskelyne, not much can be obtained for the stars' places. The planets, sun and moon, were the main subjects of Maskelyne's attention. S. Hertzsprung has reduced some of Maskelyne's work upon small stars, and I am myself calculating some more of it for another purpose.

But Pond, who was Astronomer Royal from 1811 to 1835, has left vast folios of observations; a good many of them need a new reduction and discussion. It may, perhaps, be hoped that the Greenwich authorities will accomplish this work at some future period; it is probably not immediately pressing.

Bessel, at Königsberg, accumulated a great store of observations. Among them is the material for a considerable catalogue of zodiacal stars, which a year's work would perhaps complete ready for press. It is all indexed and its mean epoch would be 1830 or 1835. The stars contained in it are also mostly in Piazzi and Mayer; but Bessel's observations are so much better than these as to make up for their comparative newness.

Something can also be made out of the same great astronomer's work between 1814 and 1819 although, his instruments were then very inferior to those employed later.

Another very useful, though very scattered, collection of older star-places, mainly declinations, could be made up by a careful study of the early latitude work of various astronomers from Mudge and Lambson, down to Bessel, Gauss and Struve.

Struve's great Dorpat catalogue, published in 1852, but containing results of observations back to 1822, has been, I believe, completely reobserved at Pulkova. So far as the other catalogues for epochs about 1830 are concerned, I fancy few of them need much reobservation; as they largely contain identical stars.

A few stars in the Abo catalogue (Argelander's of 1830) need reobservation as well as rediscussion. My own copy of this catalogue once belonged to the lamented Tiele, an assistant at Bonn; and contains manuscript notes of results — apparently calculated under Argelander's direction, which are nowhere else published as far as I know. The doubtful stars are in all cases such as were imperfectly observed before Argelander, and so mentioned in his notes.

There is a class of several hundred stars which, although visible to the naked eye, were only found in Lalande's and Bessel's zones when Argelander placed them in the Uranometria Nova. These were soon after observed by Henderson at Edinburgh, and by the Pulkova astronomers. They are much needed for field work in latitude and longitude. I have myself often missed accurate modern places for them, and hope to see them soon catalogued. The Edinburgh catalogue of Henderson is excellent in general plan, but is yet unfinished. The astronomer who shall put it together from the yearly volumes of 1834 to 1844 inclusive, will accomplish a considerable service at comparatively trifling cost. And these places begin to be old enough to serve as an old catalogue. The great Pulkova work of the same character is vigorously in progress, and will be soon completed.

The old catalogues, then, which need re-reduction or compilation, are these, with their epochs:

Piazzi, much the largest of all	1800
Mayer	1756
Groombridge (revision)	1810
Struve, circumpolar	1815
Pond (revision and recalculation)	1830
Bessel, zodiacal	1830
Miscellaneous latitude stars	1785–1830
Edinburgh (compilation)	1840

Of new star catalogues to be made I think the most important, next to the great zones several times mentioned, which are now nearly done for the northern hemisphere, is an accurate reobservation of all stars to the seventh magnitude inclusive, which are not now well known.

For the region south of the celestial equator there need be little solicitude in this matter, as the powerful observatories of the Cape, Melbourne and Cordoba have probably so nearly filled the gaps left at northern stations, that we can afford to wait till the results to date are completely published for the two latter ones. And the extension to the Tropic of Capricorn of the northern zones will show what farther is acking.

North of the equator, the stars of the first four magnitudes are nearly all Pulkova fundamentals, and thus well known, even where occasionally neglected at other places. Those of the fifth and sixth magnitudes have either been, or are about to be, carefully observed at Greenwich; our Coast Survey has requested a few specially neglected ones of these degrees of brightness to be attended to at three or four places.

It may then be said that those astronomers who wish to contribute to our knowledge of bright stars' places, have only to supply such observations as they themselves use for semi-fundamental purposes, and observe stars of the *seventh* magnitude; and a few brighter which may have been neglected.

I have not yet mentioned the British Association Catalogue. This was published in 1852; its places and proper motions were then inaccurate, and are now relatively much worse, as great improvements have since been made in precision of observation. But the stars of this catalogue have been greatly preferred in observatories, owing to its great convenience as a working list; so that the general result now is, that an astronomer who wishes to do anything not superfluous, or liable soon to become so, must be very wary in his work upon these stars.

I have myself long kept an index of them, showing where and when their positions have been lately determined; and have thus saved myself much labor. The index is not quite complete, even for the northern hemisphere; a considerable portion of it is virtually published in my catalogue of 2,018 stars (Washington, War Department, 1879), and my manuscripts of the remainder are in such condition that I can readily give authorities for any B. A. C. star north of the equator.

When the great zones are published (this is to be expected to take place in portions for the next ten years), they will contain comparisons with several old authorities, and will thus indicate many new stars whose proper motions are to be looked for. They will consequently be referred to for this purpose by every one interested in this subject.

Of least square discussions of this subject, published in full, we have principally Mädler's Bradley, vols. 14 and 16 of the Dorpat observations, and volume 7 of the Bonn observations, which contains two long memoirs by Argelander.

Mädler's Bradley is in the main superseded by Auwers' but is often convenient to refer to as an index and approximate check for such stars as were defectively or poorly observed by Bradley.

Argelander's papers are indispensable to any one who wishes to master the subject; they have been excelled in small details, hardly in general plan. The miscellaneous list of considerable proper motions which the great astronomer here gives deserves occasional reobservation, as many of the stars were poorly observed before him.

There are four large catalogues lately published by four departments of the United States government, viz.: Mr. Boss's declinations of 500 stars, by the State Department; my own catalogue of 2,018 stars, both right ascensions and declinations, by the War Department; Prof. Newcomb's, of 1,098 stars, by the Navy Department; and the Coast Survey list of 1,463, by the Treasury Department. The first is admirable in all respects; Prof. Boss took a great deal of pains and spent much time; but the right ascensions are lacking. My own work was for a practical end, which did not allow either the means or the time for so complete a discussion of four times as many stars; but I think a great many trustworthy proper motions were detected by its means. I hope by-and-by to observe the few stars in this catalogue which are now at all uncertain, owing to lack of older observations. Prof. Newcomb's catalogue is, for the smaller non-fundamental stars, much in the same condition as my own. The coast survey computers have contented themselves with the rather inaccurate proper motions of the B. A. catalogue, and with a rather defective collection of modern authorities; so that the present errors of their declinations are large. They do not add right ascensions more accurate than to whole seconds of time, which is, of course, entirely proper for their purpose. In order to completely utilize for theoretical purposes the three government catalogues first mentioned, Mr. Boss's needs to be completed by adding right ascensions, and the other two — in fact all three — by revisions wherever the material at hand was deficient.

In the southern hemisphere, and especially in the southern most half of it, there are valuable discoveries by the Melbourne observers and by Mr. Stone; and in the northern hemisphere, and part of the southern, we have Auwers' Bradley and the other compilations which have been just mentioned. I estimate that probably two thousand stars in the whole heavens have proper motions exceeding $0''.1$ (a tenth of a second) annually, which have already been calculated by least squares, or some similar process, and only need revision.

The field of investigation in this direction now open is, of course, boundless; what needs to be done for the next twenty years is mainly a critical study of the materials, their reduction to a fixed epoch and least square calculation therefrom, and adding (probably) a smaller amount of new observations than has been accumulating in a routine way, without much plan, for the last half century; to say nothing of the great catalogues which have been better planned. I have not mentioned these newer catalogues in detail as they are well known.

For the epoch 1900 it ought to be possible to construct a catalogue like that of the British Association for 1850 in general plan, but complete to the seventh magnitude, and of great accuracy both in its positions and proper motions, and before that time we ought to have a definitive settlement of the problem of the solar motion, which will go far to give us definite notions of the general structure of the universe. For I have long ago shown that, in this way only can we find much more about the average stellar distances.

FOURTEENTH ANNUAL MEETING.

DECEMBER 26, 27 AND 28, 1883.

PROGRAMME.

WEDNESDAY, DECEMBER 26th, 7:30 P. M.

Business Meeting — Reports of Officers.

THURSDAY, DECEMBER 27th, 9 :30 A. M.

Unfinished Business.

Paper: "On Ancient Villages among Emblematic Mounds."—Rev, S. D. PEET, Clinton.

Paper: "On Elephant Mounds."—Rev. S. D. PEET.

Paper: "Game Drives on the Mississippi River."—Rev. S. D. PEET.

Paper: "The Man Mounds."—Rev. S. D. PEET.

AFTERNOON SESSION, 2:30 P. M.

Paper: "On the Distribution and Migration of Birds in Outagamie and Brown Counties." — S. D. WILLARD, Depere.

Paper: "On the Principal of Duality." — Prof. C. A. VAN VELZER, Madison.

Paper: "Analysis of Water from Florence, Wis." PROF. W. W. DANIELLS, Madison.

Paper: "The Wisconsin Geological Survey on Upper Silurian Fossils." Dr. F. N. DAY, Wauwatosa.

Paper: "Variation in Attraction due to the form of Attracting Bodies." D. P. BLACKSTONE, Berlin.

EVENING SESSION, 7:30 P. M.

Unfinished Business.

FRIDAY, DECEMBER, 28th, 9:30 A. M.

Paper: "On the Driftless Area." — Prof. R. D. SALISBURY, Beloit.

Paper: "On Metamorphic Rocks." — Prof. R. D. IRVING, Madison.

Paper: "The Variation in Attraction due to the form of Attracting Bodies." D. P. BLACKSTONE, Berlin.

AFTERNOON SESSION, 2:30 P. M.

Paper: "On the Relation of Greek Art and Religion." — Prof. J. EMERSON, Beloit.

Paper: "The Democracy of the Ancient Germans." — Prof. W. F. ALLEN, Madison.

Paper: "The Results of the Caroline Id. Eclipse Expedition."— Prof. E. S. HOLDEN, Madison.

Paper; "The Genera of the Family Attidæ."— Prof. G. W., and ELIZABETH S. PECKHAM, Milwaukee.

ANCIENT VILLAGES AMONG EMBLEMATIC MOUNDS.

REV. S. D. PEET, Clinton, Wis.

The subject which the author has set before himself in the heading of this paper, is an important one and yet one which is attended with peculiar difficulties. It is not an easy task to take the silent monuments of the dead and to people them with a living race. Even historic scenes when once deserted and left in silent ruin are difficult to rehabilitate, but prehistoric scenes much more. Of all the prehistoric works none are more mysterious and difficult to explain than are the emblematic mounds. There is an obscurity about them which almost baffles investigation. The people who built them are shadowy and unfamiliar as ghosts. For one to enter into the study of their habits and ways and to describe their modes of life is almost presumptuous. The tokens are, however, before us. Other explorers have studied monuments and from them given descriptions of unknown people.

The villages of the emblematic mound-builders may, indeed, be different from the buried cities of the east and their village life may contrast with the civilized state; yet this is in accord with what is known concerning the mysterious people. We are not to consider them as a civilized race, but rather as a rude and almst savage people. Their villages are merely the habitations of a rude people and are to be studied as much in their connection with their surroundings, as in the works which are found upon their village sites. This point will be considered by the reader as he follows the line of thought, for there are many elements brought into the account and they are all to be as exponents of the one surrounding system. The treatment of the subject is mainly from an archaeological standpoint. The only object of comparison is the villages of the later Indians. These, however, differ so much in their tokens from the villages of the earlier race, that they become sources of confusion and close analysis is required to distinguish the two classes of works. The author has been careful to notice the differences between the two and to make the subject definite. Our investigation is to be among emblematic mounds and not other tokens and the villages of which we are to speak are the villages of this unknown people. There are several heads or divisions to the snbject:

I. The existence of village life among the emblematic mound-builders.

II. The probable characteristics of these villages.

III. The identification of these peculiarities or traits in certain localities.

IV. The comparison of different localities as exhibiting the same characteristics.

V. The contrasts which are presented by certain groups, concerning which there are doubts whether they contain village sites or not.

I. The existence of village life among the emblematic mound builders is a point which has very great interest, and which deserves especial attention. The proofs of this have been lacking hitherto, although there are many facts which have rendered it probable.

(1). In the first place it has been supposed that the mound builders were in that stage of culture which would render the village a necessity. They were passing out from the stage of savagery and from a purely hunter's life into the agricultural state. This is evident from the fact that garden beds are found associated with the mounds. These garden beds differ from the corn fields of the Indians as much as the elaborate works and effigies differ from the ordinary burial mounds, and show that the mound builders were superior to the later tribes.

Village life existed among the Indians. With them there was the custom of raising the cereals combined with the chasing of wild game and the subsistence upon fish. With the mound-builders the same modes of life may have prevailed, but village life would be more marked, inasmuch as their culture was more advanced. The relics which are found, as well as the works, indicate that a peaceable condition prevailed among the builders of the emblematic mounds. These relics have been discovered in various parts of the state, and show that the copper age had been reached by this unknown people. We do not say that the copper age and village life were identical, but there was an approximation to the bronze age, and we know that the bronze age was characterized by the prevalence of villages. Mining was probably known to the mound-builders, and this would render probable that village life had been reached.

(2). Again, the tradition and known customs of the later tribes would render it probable that the mound builders dwelt in villages. The remark of Miss Fletcher in reference to the Dakotas is that they have favorite places to which they resort for generation after generation, and, judging from the tokens furnished by the emblematic mounds, we should say that the same custom prevailed among them. Village life is known to have existed among the Indians of this very locality, where the animal mounds are found. There are many sites of villages which have been identified by history. These differ from the sites of the villages of the preceding race, but are often in the vicinity of extensive groups of emblematic mounds. The record of early explorers and travelers is that the natives dwelt in villages, and the early maps locate these villages.

(3). The succession of races betokened by the earthworks would show that village life had existed in the earliest period. It is sometimes the case that the village site of a later tribe will appear with a certain class of earthworks in the vicinity, which differ from the works which belong to the emblematic mound builders, yet render it probable that both people built their mounds near their villages. It is one point for the archæologists to decide while studying the mounds and earthworks, which works belong to the later Indians and which to earlier mound builders.

(4). The universality of village life among uncivilized races would prove that it existed among the emblematic mound builders. This is a point which we shall not stop to discuss, but shall take it for granted. The similarity of village life is the point which we are to examine. In reference to these there is, perhaps, more uncertainty than in reference to the existence of villages. The study of the native life of the wild tribes may furnish us some information in reference to their characteristics and from our knowledge of the later tribes we may ascertain what were the elements of the village condition, but it is mainly by analogy that we predicate that such elements existed among the mound builders. We carry with us information from the living races to the extinct and by one picture learn to interpret another filling up the outlines which have become obscure by the wear of time and interpreting many things which would otherwise be inexplicable.

Again, II. The characteristics of village life are exhibited or made known. These characteristics are as we have seen, the selection of a locality favorable to subsistence, the selection of a spot which would be convenient of access, well guarded by its natural surroundings, and which should be dry and favorable for the erection of houses. The tokens that a village was located would be found in the existence of mounds, earthworks and effigies around an enclosure, in such a position as to give the idea of defense. The additional discovery of caches, springs of water, and other signs of permanent residence, would be additional proof. The existence of burial mounds in the vicinity of outlooks which might serve as defenses and of altar mounds in the vicinity, would prove that the locality had been occupied as a place of residence. The existence of game drives and of trails and gardens would be still further evident. The early explorers and travelers all speak of villages. It is very seldom that Indians were met with outside of their villages, but there were many localities where villages were prevalent. The early maps have given the location of many of the villages. According to these maps the villages were situated on the water courses and lakes, and were connected to one another by trails. Several villages were situated on Green Bay, others on Lake Michigan, and still others on the Mississippi river.

The study of these villages may give to us some hints as to what constituted village life. We find striking analogies between the locations of the earlier and the later races, for the same places in which history describes villages to have existed contain many monuments, which were evidently works which belonged to the emblematic mound buildess. The centers of population were the same and the same spots were chosen for the residences of the two races. The exploration of the mounds reveals a striking similarity between the modes of life and in many places should seem that these modes were carried out in exactly the same places; the hunting grounds being the same, the village sites the same, the defenses by lookouts the same, the burial places in close proximity and all of the departments of life having been conducted in the same scenes and having been repeated by the two races. The only difference between them being in the emblematic character of the mounds which the earlier race erected. The characteristics of the villages of the earlier race we conclude will be learned from the description of those of the later races.

The early travelers and explorers found Indians dwelling in villages, and from their descriptions we learn the characteristics of village life. These characteristics are as follows: 1st. The selection of a locality favorable for hunting and fishing, and at the same time accessible by rivers and trails from other villages and from distant parts of the country. 2d. The selection of a favorable spot for residence and the erection of houses or huts on some rise of ground overlooking a stream or lake. 3d. The erection of certain defenses, either stockade or a lookout station. This was a general habit, although there were many villages in Wisconsin which had no stockade and no visible defense. As a substitute, however, the villages were placed on land somewhat remote from the water course, and so hidden by surrounding forests or hills that they could not be approached without due warning being given. 4th. There were generally near these villages burial places, either the rude structures or graves protected by logs or rude planks, and the hollow logs hung in trees near the stream or lake. 5th. There were generally near the villages garden beds or corn fields, and always springs of water. 6th. In certain localities there were arrangements or contrivances constructed from wooden stockades by which game were entrapped. This was not universal, but there are certain sketches in certain books, especially in Champlain's works, which illustrate the fact. The Indians of Wisconsin are not known to have constructed game drives, but the point is an interesting one. 7th. There are various traditions in reference to the attachments which the Indians had for the localities where the villages were situated, and in reference to the religious ceremonies which were observed in or near their villages. These seven particulars we have here mentioned, because they illustrate certain points which we have discovered in connection with the emblematic mounds. The identification of a village site surrounded by emblematic mounds, has led to the discovery of the same characteristics, and proves interesting on this account. The mere discovery of a village site would not avail much were there not some further information gained from it. In describing the villages of the emblematic mounds, we shall draw the comparison and speak of the specific items or elements which seem to have been common among the villages. We shall first refer to one particular village and then show what its characteristics were and then draw the comparison between this particular village and other supposed villages and from the aggregate draw conclusions in reference to what constituted village life.

The identification of a village site among the emblematic mounds is an interesting fact, and one worthy of notice in this connection. In the first place it proves that the mound builders dwelt in villages. This has indeed been rendered probable by other facts, but has not been hitherto proved for a certainty. In the second place it furnishes a clue to a certain class of works which have been supposed to mark village sites, but concerning which there has been also much uncertainty. These works have been discovered by the author in various localities and the conjecture has often arisen that they were village sites. The comparison between them and the works which are known to have surrounded a village now clears up the uncertainty.

The identification of certain village sites will next engage our attention. The method which we have pursued in identifying these sites is the one which we have already prescribed. We have fixed in our mind what was the probable characteristics of village life and then have studied the mounds to see if these characteristics could be found in them. We have, in fact, taken the picture of native society as we have ourselves painted it and then have sought a frame for the picture in the emblematic works. This is, in our opinion, the only way in which a village site could be identified. It was because we had framed some conception of the people who erected the mounds and from the study of their works had come to understand something of their mode of life that we have made the discoveries which we have.

The first place where a village site has been identified by the writer is at Great Bend, on the Fox river, thirty miles west of Milwaukee. Here is a series of works which Dr. Lapham has described, and which have proved to be interesting on many accounts. (1) A few words in reference to the locality will be in place. Great Bend is situated at the edge of the extensive forests which formerly stretched along the lake shore, throughout the whole length of the state. At a point where the extensive system of prairies which characterizes the scenery of the interior of the state intrudes upon the forests near this place is an extensive marsh, wherein are immense tracts of land filled with wild oats. There are upon one side of the stream forests which abound with game, especially with the beasts of prey and with the larger class of birds, such as the wild turkey, wild goose, hawks and eagles. On the other side are the prairies, where formerly abounded the grazing animals, such as the buffalo, elk, wild deer, and the great variety of prairie birds, the marsh and the river forming a favorite resort for ducks and wild geese, and water fowls of various kinds. There are in the vicinity many small streams and ponds where beaver and muskrat would be numerous. The locality is, then, a favorable one for the permanent residence of a people.

The character of the region can be learned from the map which we here present.

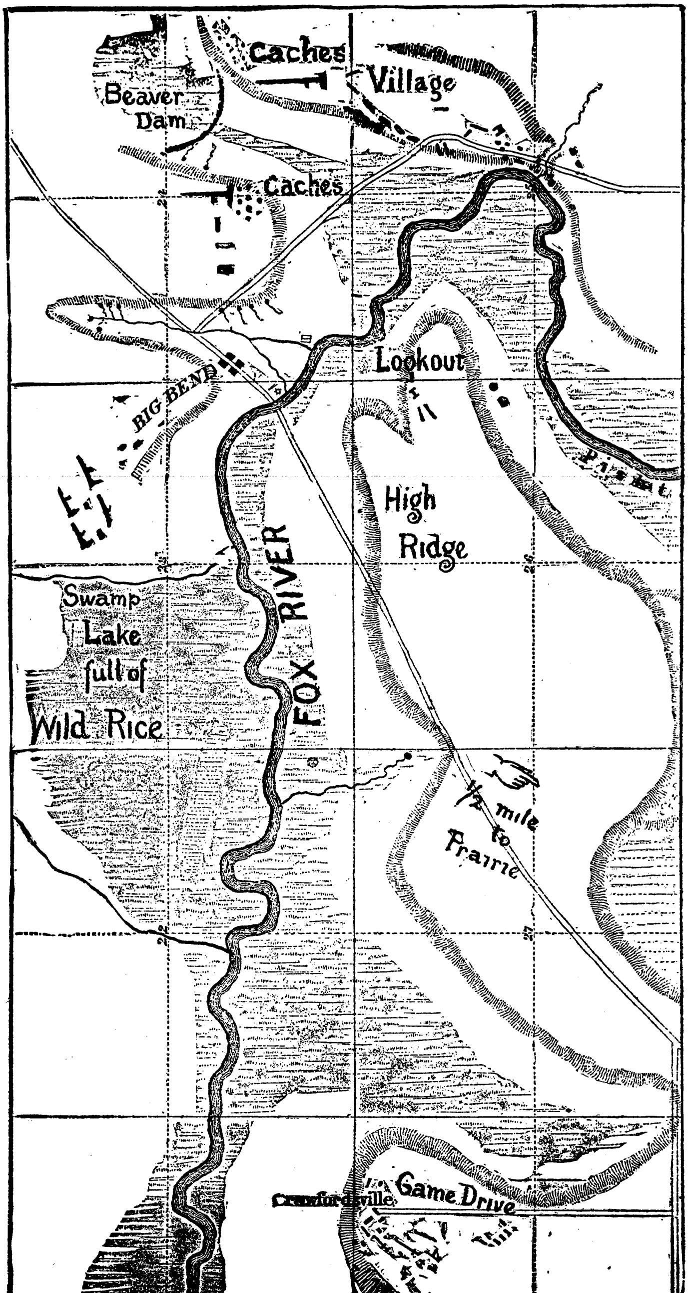
Caches
Village
Beaver Dam
Caches
BIG BEND
Lookout
High Ridge
Swamp Lake full of Wild Rice
FOX RIVER
½ mile to Prairie
Game Drive
Crawfordsville

Fig. 1.

Another point worthy of notice is that in the vicinity there are high lands which command extensive prospects. At this point there are extensive ridges which form prominent points from which extensive views could be gained. The geological formation is here noticeable. The Great Bend was caused by the damming up of the stream in the glacial period by great ridges of gravel which turned it from its course, deflecting it to the eastward, for six miles or more. At the point where the village is located the river bursts through the barriers, leaving a high knob of land upon the west side and gentle swells of ground upon the east, making an extensive lake, or reedy and marshy place to the north of the ridge, and throwing the region to the south open to the ravages of fire, so that the prairie crept up to the very edge of the stream at that side. On this ridge there are mounds and earthworks which correspond to altar mounds and outlooks which have been discovered elsewhere. In approaching the locality from the north one is impressed with the sightliness of this bluff or ridge, for at many intervals the ridge can be seen several miles away. It is singular that as the writer approached it there were open spots in the wooded hill top which attracted special notice, and that these spots proved to be the very localities where were outlooks and sacrificial mounds.

On reaching the locality the first thing which attracted attention was the discovery of a panther effigy of remarkable size and well defined shape. (See Fig. 2.) In following the outline of the effigy and reaching the head, it was discovered that the land was broken by a great number of pits, which proved to be the caches of the village. These were situated on the edge of a small pond, and near a beaver dam, but were hidden away in the forests and would not have been noticed except for the proximity of the effigy.

There are many effigies which seem to guard caches as this does, but none had so far been discovered near any village site. Dr. Lapham describes one as situated at Indian Prairie. Here the effigy is represented as guarding a low mound. In the mound was a pit and upon the surface of the soil were corn hills. The figure is given herewith for the

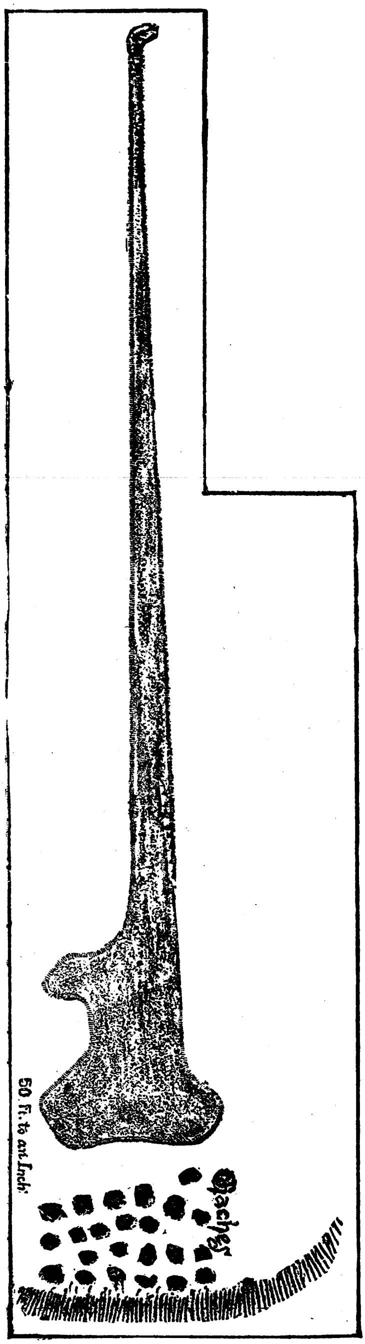

Fig. 2

sake of comparison. The effigy of a panther guarding the caches at Great Bend is much more symmetrical than that at Milwaukee. Dr. Lapham says that this ground is covered with a present race of Indians who occupied the land in this vicinity down to a very late period. The figure may be considered as a rude representation of a wolf or a fox guarding the sacred deposits before it. Both of these are of so little elevation as to be observed by the passer-by. The body of the animal is 44 feet and the tail 63 in length. The effigy which we discovered as guarding the caches near the beaver dam was accompanied by several large platforms o long mounds. One of them at right angles to the body of the effigy and another several rods distant to the west; these two having a parallel position. The caches were very observable. There were twenty or more of them scattered over the surface of the hill, but all of them in front of the effigy. Passing over the small stream where was formerly a beaver dam we came to other caches similarly situated, but without any effigy near them. These were more numerous than upon the other side, but were fully as well as guarded, as they were hidden in the forest and were in the rear of a rise of ground, on which we afterward discovered the site of the village itself. The existence of these caches was to us significant for it betokened permanent residence. We have previously noticed the advantages of the locality. The forest, and marsh, and prairie combined would lead one to expect a village somewhere in the vicinity. The fact that extensive works had been described also led to expectancy but the discovery of the caches put us on the alert.

(4) The situation of the village itself impressed us more than the caches. It was on a rise of ground from which the water flowed in every direction. The stream which we were crossing formed a barrier upon the north side. The swale and beaver dam and low land in which the stream headed formed also a barrier to the spot on the east, separating the village from the forests, making the approach to it inaccessible on that side. The river is some distance to the west, and flows at an angle toward the tongue of land on which the

village is situated. Between the village and the river the land is low, and so the spot is inaccessible except at one point. At the south of the village site was another small stream, which also heads in the swamp or springy land in the rear of the village. The low land adjoining is covered by a jungle of bushes and small trees, a fit place for the hiding of wild animals, but abounding with berries and wild fruit of various kinds. The situation of the village on this rise of ground was remarkable, because the spot was so favorable in every respect. The peculiarity of the site is that all the requisites of village life were furnished by it. It is well guarded and drained, is surrounded by forests and prairies, is well situated in relation to the river, the rice swamps, the beaver dam and springs of water, was in a locality where the means of subsistence were furnished in great abundance. Additional to these advantages was the fact that, on the opposite side of the river, less than a mile away, is the high bluff to which we have referred, and on this bluff there proved to be mounds which undoubtedly served as outlooks. The protection of the village was thus secured by the locality as well as the means of subsistence. The situation of the ground on which the village was located was in the midst of swamps and low lands, which also served for protection.

The evidence that this was a village site is as follows:

(*a.*) The selection of the locality with a view to subsistence. The place for storing grain was furnished by the hillside to which the approach was easy from the village itself, but was difficult from any other direction. The presence of springs near the village but in the rear of it secured to the inhabitants a supply of water from which they could not well be cut off. The presence of the game-drives shows that the inhabitants depended upon wild game as well as the products of the soil for their subsistence and the marshes in the vicinity abound in wild rice. There may have been the cultivation of maize, but no garden beds have been discovered in the vicinity. The means of subsistence were furnished by the forest, streams, lakes, and prairies.

(*b*.) The beauty of the spot and the advantages furnished by the well-drained and shaded ground would indicate that it had been used as a village site. Not all villages are as favorably situated as this, but the advantages were too manifest for any one to deny them in this case.

(5.) The artificial works of the locality impressed us. The first object which engaged attention was the effigy of a huge panther. This was situated on the edge of the hill at a point where the small stream breaks through into the valley of the Fox river. The effigy stretches along the brow of this hill overlooking the valley of the river, its immense body and tail forming a guard against approach to the caches on the banks of the stream above, and protecting the village site at this point. The effigy is a peculiar one; it represents the panther as standing with head erect, the legs straight, but the body extremely attenuated, as if the animal was in the last stage of starvation. The position of the effigy was also peculiar, while its immense body and tail stretched along the hillside toward the little stream at the north, and terminated at the very edge of the bluff in this direction. Its head fronted the opening to the village itself, and the attitude was as if the animal was looking directly into the village, and was there watching and waiting for some object that might satisfy its appetite. Such at least was the impression made upon the imagination by the figure. The contrast between this effigy and the one guarding the caches in the rear of the village was marked. In the first place the effigy was much longer and more definitely marked. Again, it was situated on the brow of the hill, overlooking the land adjoining. Its attitude and shape were peculiar. Our conclusion was that the effigy was stationed near the village site, with the head fronting the opening, in the attitude as if guarding the gateway.

At the entrance of the village site there was a series of oblong mounds. These mounds were arranged so as to make a double guard; two of them formed an angle toward the north, at the opening of which was the panther effigy two others formed an angle to the south, leaving openings at either end and between them, but so arranged as to form

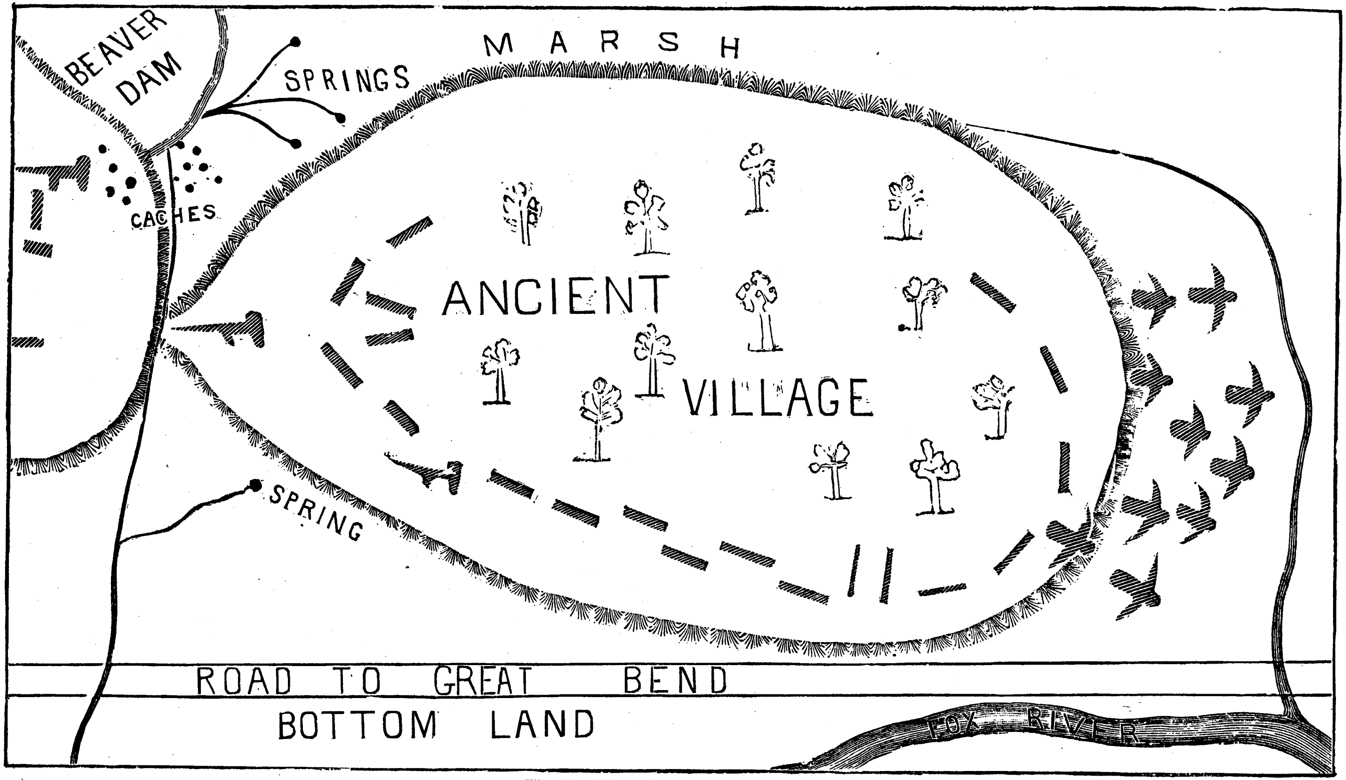

Fig. 3.—Mound Builders' Village.

a guard to the entrance; beyond this, following along the brow of a gentle slope of land were other oblong mounds. A little further on to the south and west was another panther effigy, the effigy this time situated at an opening between the oblong mounds, but with the body running parallel with the mounds, and thus forming, a guard across the opening on the other oblong mounds and effigy mounds. Here the effigy was that of an eagle or hawk which seemed to guard the village on this side, and formed the bend of the wall. Other oblong mounds were situated on the edge of the rise of ground, forming a quasi wall at the south of the enclosure, and turning back toward the north formed also a partial wall upon the east side. The situation of the village was on a rise of ground within the enclosure, which was formed by the oblong mounds. There was no evidence of a stockade, but the earth-works so surrounded the village and site that they may have served as a partial defense. The entrances to the village were also guarded by mounds which were peculiarly arranged. The one where the panther effigy was had a double line of oblong mounds; the middle entrance was also guarded by oblong mounds, but had no effigies near it.

The means used for defending the locality prove that it was a village. The enclosure covered an area of about one hundred and sixty acres. The mounds surround the edge of the enclosure forming a fragmentary wall. They needed only to be attended with stockades to form a splendid defense against approaching enemies on three sides, while on the other side the marsh and low land furnished a natural defense. There was a double advantage or use to these oblong mounds, while they furnished platforms from which warriors could shoot approaching enemies. They also furnished platforms on which the inhabitants could sit and watch the busy life of the village within the enclosure. The entrance and covered ways would indicate that there was a form of arrangement of the houses, possibly streets ran through the villages, and a square may have existed in the centre. Effigies guarded the village at either side and gave the village the sense of protection. (See Fig. 3.)

The spot where the village is located is a beautiful one. It is at present covered with a sturdy growth of oak trees and is a very attractive place. The shade of the trees protects the spot from the glaring heat of the sun during the warm seasons, end the surrounding forest would protect also the village from the sweeping winds and drifting snows during the cold season. The presence of the caches and of the effigies and oblong mounds show that it was a permanent dwelling place. As an additional protection to the village, there were at the south of the village site a large number of bird effigies. These are scattered over the surface of the hill at this end of the village forming an abatis which might serve both as a screen for hunters and as a guard against the approach of an enemy.

The discovery of burial mounds in the vicinity indicated also that it was a place of permanent residence. These burial mounds were on the lowland adjoining the river. They are so situated that they form an outlook along the valley of the stream, but are in close proximity to the village site itself. These mounds have not been excavated but their shape and size would indicate that they were burial mounds.

(6.) The outworks, or groups of mounds in the vicinity of the village are worthy of notice. There are mounds on land belonging to Mr. Rose, on section 25, one mile or more distant. These mounds are situated near the line of the bluff overlooking the valley of the river, just at the point where the stream and the marsh join. These mounds are nearly obliterated, and their design could not be ascertained. They were, however, so situated in relation to the river and marsh and land adjoining, as to give rise to the idea that they were used possibly for game drives. The effigies were in a wheat field and could not be identified. The out-works which most interested us were those situated on the edge of the same marsh or lake, three miles to the west. These have been described by Dr. Lapham;* he calls them the mounds at Crawfordsville, although there is no village there and never was. The peculiarity of these works is that they are

*See Lapham's Antiquities.

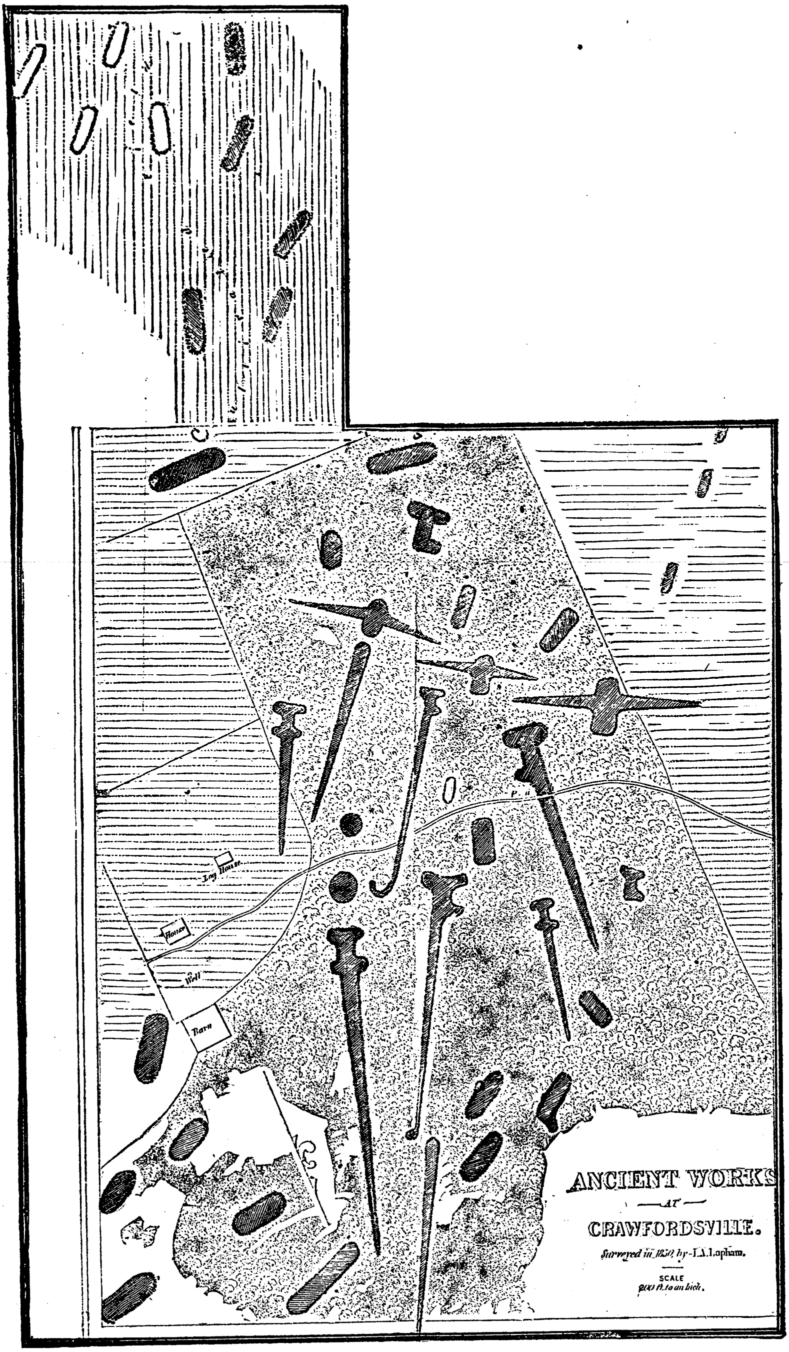

Fig. 4.—Effigies near Great Bend.

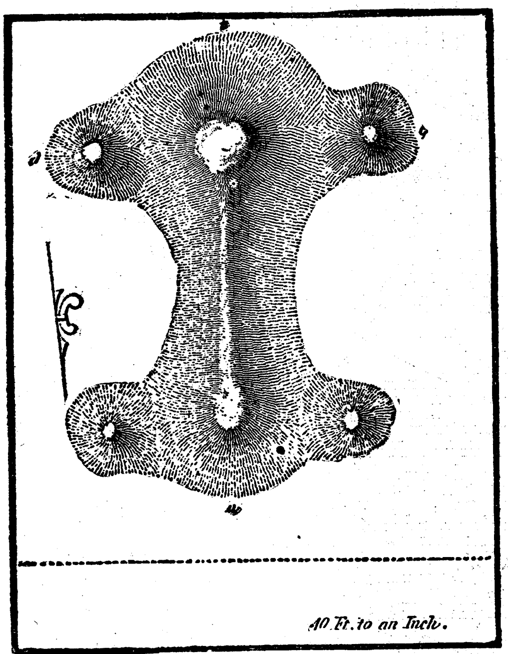

Fig. 5.—Altar Mound.

stretched along parallel with one another, and form a group resembling others which we have elsewhere identified as game drives. An illustration of the group is here given It will be noticed that the effigies are peculiarly situated and shaped; they are unnaturally prolonged, and so placed in reference to one another as to give the idea that they were intended as screens for hunters, and as traps for wild game. The arrangement of the ridges is not exactly in parallel lines, but at angles, each effigy serving to make a narrow place through which the animals would need to pass, and the oblong mounds forming guards to each opening, so that an additional opportunity for shooting the game might be furnished.

(7.) The most noticeable peculiarity of the region was the discovery of a so-called altar mound. We mention this last because it is the most suggestive and because it brings out the point of analogy between the village life of the mound builders and that of the Red Indians. There are no traditions connected with the locality but the religious significance of this group of works is apparent. On the summit of the hill overlooking the village itself is a small group of mounds, consisting of three oblong mounds and one effigy. The oblong mounds are situated on the brow of the bluff, and apparently were designed to serve as guards to the effigy. The effigy is what we have called an altar mound, as it has the same shape and situation with other mounds which have proved to contain altars, and is one which has been found in various particulars. The figures of it will illustrate the point. (See Fig. 5.) It is a mound formed by a combination of five mounds in one, the whole group making an effigy of an animal resembling the horned toad or frog. A ridge which connects two tumuli or conical mounds, forms the spine; four conical mounds situated at the corners formed the hips of the animals; the projections which represent legs are blunt and without particular resemblance to the animal formed. The distinguishing peculiarity of the effigy is that its form is an exact repetition of the shape of the bluff. The projections in the mounds imitate on a small scale the spurs on the side of the bluff itself, the two making a double effigy. As an additional feature proving the religious character of the works, we may mention the existence of two massive burial mounds. These are situated on the low land below the bluff and between the bluff and the river. They are massive, and may have been the place where the bones of those who had been residents of the villages were borne after death and deposited. The altar mound was so situated that it could be seen from a great distance. If there were fires lighted on it they would gleam not only upon the waters and the river below, but they could be seen for miles away. There is no doubt that this was the place where sacrifices were offered and where religious ceremonies were observed. The group furnishes a most distinguishing peculiarity of village life.

One point additional which we have not mentioned is the line of communication of their villages in the same region. The trails which communicated between the villages of the Indians may prove an additional feature. These trails are known, and have been identified and traced by the author. The situation of the village on a well known route is at least worthy of study.

It was situated on the line of the dividing ridge, which has been used from time immemorial for a route from Lake Michigan to the Mississippi river. The route leads from Milwaukee through Muskegon lake, on through the Great Bend, crossing the Fox river; then at this point passes across the prairies to the west until it reaches the Rock river. Here it divides, one route turning south towards Beloit and Rockton and another towards Lake Koshkonong and the Four lake region where Madison now is. Passing from here the route crosses the dividing ridge between the Wisconsin river and the western branches of the Rock river, until it reaches the Blue Mounds. From the Blue Mounds it crosses prairies to the Platte Mounds and reaches the Mississippi river among the bluffs somewhere about Cassville. At each of these localities there are extensive works, showing that the same population and the same thoroughfares prevailed in prehistoric times which prevailed in the historic, the modern villages and cities having been placed on the very same sites where the ancient villages were.

The ancient trail was supplanted first by the stage route. The railroad has now taken the place of both. This village site has not been reached by the railroad although it was a favorite project to connect the interior with the lake by this route. The first plank road through the Milwauke mounds was built from Great Bend and Muskegon to Milwaukee. The first railroad struck the site of another native village, that at Waukesha and then passed on to the west. Proof furnished by the thoroughfares of modern days may not seem to be in point, and yet we take the ground that the natural advantages of the country have led to the choice of the same localities for residences, the same routes for travel, and the same spots for centers of population throughout the whole series of changes which have occurred both in historic and prehistoric times.

The proofs that this was a village site do not need to be dwelt upon longer. We only recapitulate the points which have been illustrated in this case that we may understand what are the characteristics of village life among the emblematic mound builders generally. We have 1st, the situation of villages as regards the means of subsistance, (a) on the edge of a forest and near a prairie abounding in wild game; (b) in proximity to wild rice swamps and near streams and forests where fruits and grains were abundant, (c.) it was near rivers and lakes where fish could be procured, and may have been a favorable position for the raising of maize and horticultural products. 2d. The character of the ground on which the village was located. (a.) It was isolated from the river and from the surrounding country. (b.) It was a favorable place for drainage and furnished favorable places for hiding their stores of grain.

3rd. Provisions for defense: (a) fragmentary walls placed on the edge of a hill; (b) effigies placed at the openings between; (c) a covered way, protecting the entrance to the village.

4th. The outworks accompanying the village consisting of (*a*) burial mounds; (*b*) game drives; (*c*) effigies protecting it; (*d*) look-out mounds in a prominent position; (*e*) other works designed to protect and to furnish means of subsistence.

5th. The evidences of religious observance: (a) the presence of the effigies surrounding the enclosure; (b) the number of burial mounds in the vicinity; (c) the altar and place of cremation.

6th. The situation of the works as related to the surrounding country: (a) its connection by streams and trails with other centres of population; (b) its location on a lake or river; (c) the character of the country surrounding as furnish opportunity of changing signals with distant points.

7th. The last characteristic and the chief is the presence of the enclosure. In this case the enclosure was marked, and affords undoubted evidence that a village was located here.

III. These evidences of village life have been dwelt upon, for they are essential in fixing the points where other villages were located. The comparison between this village of the emblematic mound-builders and the known villages of the later tribes have given us certain characteristics, but the comparison is hereafter to be between one village of the unknown people and other villages which may be presumably fixed upon. It is a method of gradual approach.

IV. We proceed, now, to consider other village sites, and to compare these with the one which has been identified. The second locality where an ancient village has been identified is at Waukesha. The points of .resemblance between the two localities are as follows:

1st. The locality was favorable for the subsistence of a large population. The same forests which intervene between the Fox river and the lake stretch northward, and here forms a border line between wood land and prairie, and between one form of natural products and another, thus affording a double supply of wild game and of nature's cereals and fruits. The locality is similar to that at Great Bend, in that there was an extensive prairie bordering upon an extensive marsh, and similar surroundings of high hills, and the same variety of soil. At this place there were formerly extensive groups of emblematic mounds, some of them on the prairie itself and some of them in the openings surrounding, and some on the summit of hills in the vicinity. It is evident from the na-

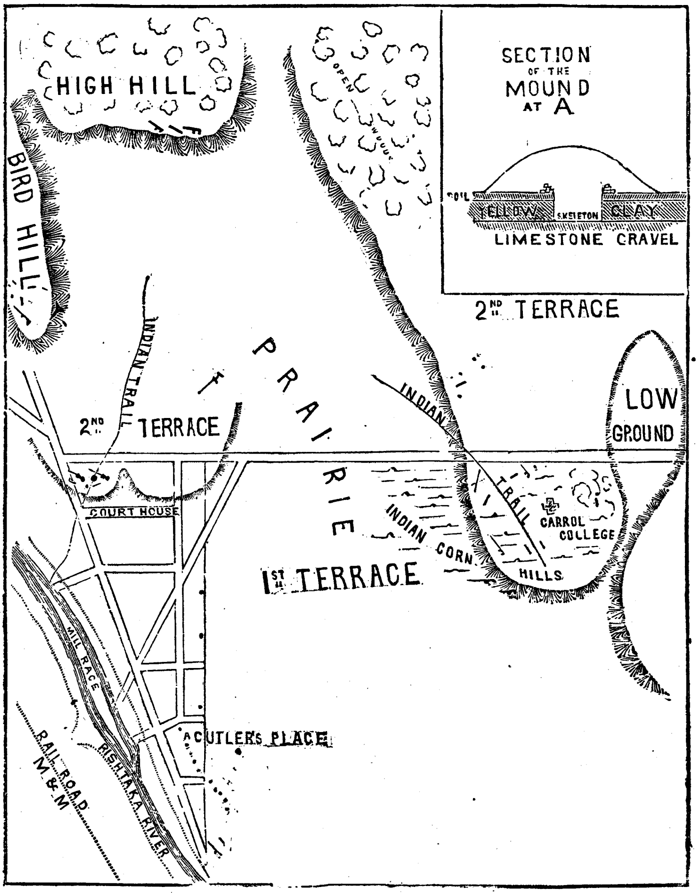

Fig. 6.—Map of Works at Waukesha.

ture of the works that here had been a center of native population. See map, Fig. 5.

The Fox river, also here furnishes a similar expanse of marsh filled with wild oats. The advantages for gaining a subsistence from the forests, and the stream and the open prairie are similar to these found in the previous locality. There are signs here of cultivation of the soil. (See Fig. 6.) We quote from Dr. Lapham: "Much of the ground about Waukesha was, in 1836, covered with Indian corn hills or remains of the recent culture of maize. In this locality as in numerous others, the mounds occupy the highest ground and the points of hills and other places whence the most extensive view, both above and below can be obtained. The town of Waukesha stands on a slightly undulating plain surrounded by hills, forming a fine amphitheatre, which in ancient times was doubtless crowded, as it is now, with numerous population. One fact is important in this connection —the mound builders occupied the same localities that are now the favorite resort of the present Indians, who still often make use of the mounds for the burial of their dead. They have a kind of veneration for them which may be the result of a lingering tradition. We need not look to Mexico nor any other country for the descendants of the mound builders. We probably see them in the present red race in the adjacent regions. Different tribes have different habits, and a stronger one may have overrun and swallowed up a weaker and then changed its customs and destroyed its institutions.

The corn hills found in this vicinity if they do not prove that the mound builders were agriculturists, or that here was an ancient village of the mound builders, at least they show the advantages of the locality. There are caches near Waukesha. A gentleman, long resident of the country, who owns a farm one mile east of the city, has pointed out a number of these caches on his land. They are like those at Great Bend, situated on the edge of a marsh and hidden away among deep forests. There are no effigies guarding these caches, and so we cannot ascribe them to the people who built the emblematic mounds. The coincidence, however, is worthy of thought for caches and corn fields indicate village residence.

2nd. The situation of the village with relation to lookouts and means of defense is worthy of notice. The reader will examine the map and compare it with the map at Great Bend and notice the occupied points in both. There are near the village high bluffs as at Great Bend. On these bluffs there are also emblematic mounds, which possibly were used as lookouts. Two of these groups overlook the village site; one which is not seen on the map is situated 1½ miles north of Waukesha. Dr. Lapham has described this group and a diagram is taken from his work. He says: "On a high and very commanding position" are three round mounds in front of four "lizard mounds." They are at the crossing of the old Madison road in the southwest quarter of Sec. 26 A. A sentinel stationed on them could give warning to the inhabitants on the approach of any hostile force long before they could reach the village. The lizards as in most other cases have their heads toward the south. "The general situation, distribution of the mounds as well as the topographical features of the country will be represented in the map." It will be noticed that they occupy three levels, those in the lower part mostly conical (probably Indian burial places those on the upper are on what may be called the second bank, others are on the high land east and south of the village.

We have referred to the turtle mound as forming a lookout. One of the most remarkable specimens of the turtle was found by Dr. Lapham at this place. The location of this would indicate that it was designed as a lookout to protect the village from approach by way of the river. The high bluff, called bird hill, is situated about one mile east of this. A description of this bird hill and its effigies has been given and does not need to be repeated. The village site was upon the grounds of Carroll College.

3rd. The form of the enclosure and the character of the ground are very similar to those found at Great Bend. Dr. Lapham says, the mounds form a quasi enclosure, and hence like many other groups of works, has been, by casual ob-

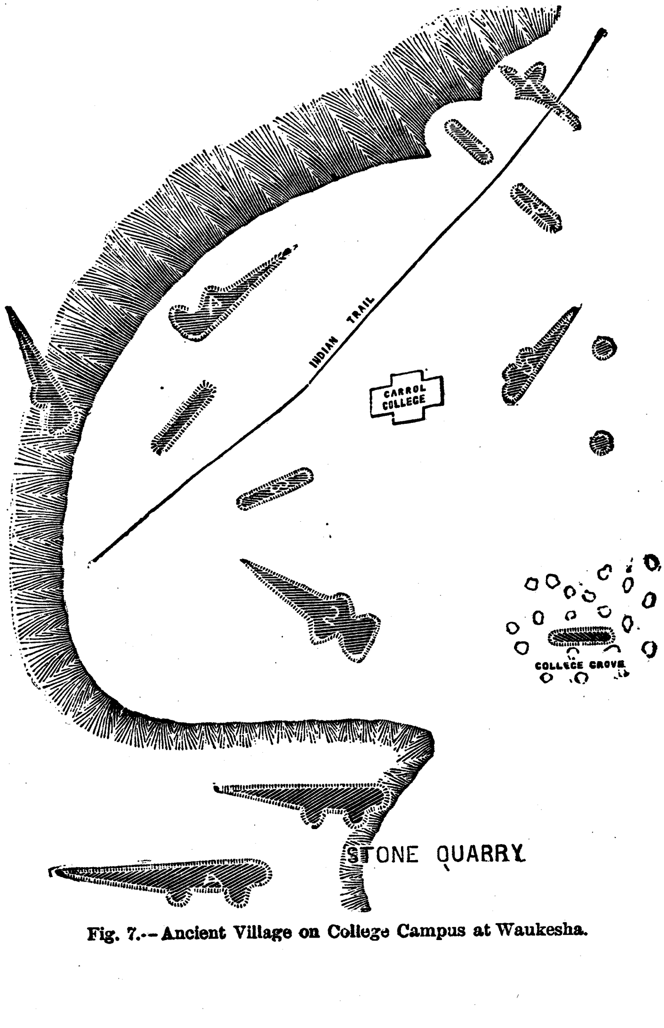

Fig. 7.—Ancient Village on College Campus at Waukesha.

servers, called a fort. If we were not well acquainted with the works in Ohio and elsewhere, which show that the mound builders were considerably advanced in military arts, we might suppose that this was intended for a rude fortification, but we can only regard it as an accidental arrangement, and not designed for any such purpose. Dr. Lapham's first impression of this locality was, however, a correct one. The mound builders' works were not all alike, and the system of defense which existed in Ohio would not be very likely to have appeared in Wisconsin. The emblematic mound builders defended their villages in a way peculiar to themselves. These fragmentary walls surrounding an enclosure were the means of defense by which the people guarded their villages. The ground on which the village is located is surrounded by low land, the same as that at Great Bend. The oblong mounds are erected near the edge of the rise of ground, and form a broken wall around the whole, making four sides of an enclosure, instead of three, as was the case in the former village. (See Fig. 7.)

4th. The effigies are quite similar. There are panther and wolf effigies both on the summit of the hill and upon its side. The effigies form a guard or defense to the enclosure and fill in the spaces between the oblong mounds. There is also a similar arrangement of parallel mounds which may be considered as forming the village, resembling that at Great Bend, but farther removed from the circumvallation and not so distinctly marked as a covered way. Still the analogy is worthy of notice.

5th. The covered way is another indication of a village site. There are or may be vilage sites which do not have this, but the parallel walls which lead to an enclosure may be generally regarded as an evidence that a village site has been reached. This is true, both among the emblematic mounds of Wisconsin and the earth-works of Ohio. Whether any such covered way can be found in other localities, it is true that in these two states it is peculiar to village sites. Marietta and Newark, Great Bend and Waukesha, may be compared, as the same feature is common to all.

6th. The outworks are similar to those a Great Bend. The hunting grounds which belong to this village are not found nearer than Pewaukee, which is about six miles away. There are works, there, however, which have been described by Dr. Lapham, and which have considerable resemblance to the works at Crawfordsville.

Another game drive has been discovered by the author on the very edge of Pewaukee lake. Here the mounds, which are all oblong mounds, are arranged in a peculiar position, making angles and open places along the brow of a bluff, as if the purpose was to make screens for hunters and traps for game. Whether these two series of works can be connected with the village site at Waukesha is a question, but we refer to them as among the items which make up the comparison between the villages.

V. Another locality where a village has been presumably identified is at Muscoda. The peculiarity here is that the enclosure was hidden away from observation by surrounding hill-tops, and was so remote from the river as to be entirely out of sight of any one who might be passing along the river. The enclosure is in a valley or swale, and has a number of effigies surrounding it. The effigies are all of them eagles. This village site has a number of game drives in proximity to it; two of them are situated on the same stream, only a mile or two away. The position of the enclosure is peculiar. The effigies and the fragmentary walls surround a swale, the land enclosed being much lower than that on which the effigies are placed. There are lookouts on a hill top three miles away, and there are nine wards or walls of defense in two separate lines between this place and the river. The spot is drained by waters of two small streams which make their head near this enclosure, Indian creek and Mill creek. The region is a favorable one for a village site. There are several particulars in which this enclosure resembles a village site.

MIGRATION AND DISTRIBUTION OF NORTH AMERICAN BIRDS IN BROWN AND OUTAGAMIE COUNTIES.

By S. W. WILLARD, West De Pere, Wis. (1883.)

This paper was prepared from recorded observations. It gives a systematic series of facts from which the generalizations of Messrs. Baird and Allen may be again applied.*

Brown County is well adapted for such a system of observation. The warm, short summers succeeded by the long cold winters mark distinctly each movement. The vernal and autumnal movements through these counties are large, thousands of migrants of species that are to some extent summer residents, pass us on their way to less crowded areas. These with the other migrants swell the throng to numbers almost incalculable.

To facilitate this study I have arranged the species in divisions based upon their migratory habits while in these counties.

CLASS I. Birds that are represented in this section throughout the year, but whose numbers vary in the different seasons. Members of this class may properly be called "residents."

†1. Parus atricapillus, L.
Black capped chickadee.

2. Sitta carolinensis, Gm.
White bellied nuthatch.

3. Cyanocitta cristata, (L.) Strickl.
Blue jay.

4. Picus villosus, L.
Hairy woodpecker.

5. Picus pubescens, L.
Downy woodpecker.

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*Amer. Journal Sci. 1866, pp. 78, 184, 227 (Baird.) Scribner's Monthly 1881, pp. 932 (Allen.)

†Nomenclature from Coues' "Check list of N. A. Birds."

6. Bubo virginianus, (Gm.) Bp.
   Horned owl.
7. Scops asio, (L.) Bp.
   Screech owl.
8. Strix nebulosa, Forst.
   Barred owl.
9. Cupidonia cupido, (L.) Bd.
   Prairie hen.
10. Bonasa umbella, (L) Steph.
    Ruffled grouse.
11. Passer domesticus, (L.) Koch.
    English sparrow.

    (Although not a native of America, yet its increasing numbers and familiar habits bring it so prominently into view that to omit it would be unfair.)

CLASS II. Includes the true migrants or those birds in which the migratory instinct is so strong as to urge onward their movements regardless of weather or the food supply.

1. Turdus migratorius, L.
   Robin. (Breeds.)
2. Turdus fuscescens, Steph.
   Wilson's thrush.
3. Turdus unalascæ nanus, (Aud.) Coues.
   Hermit thrush.
4. Turdus ustulatus aliciæ, (Bd.) Coues.
   Alice's thrush.
5. Turdus ustulatus swainsoni, (Cab.) Coues.
   Olive backed thrush.
6. Mimus carolinensis, (L.) Gr.
   Cat bird. (Breeds.)
7. Harporhynchus rufus, (L.) Cab.
   Brown thrush. (Breeds.)
8. Sialia sialis, (L.) Hald.
   Blue bird. (Breeds.)
9. Regulus calendula, (L.) Licht.
   Ruby crowned kinglet.
10. Regulus satrapa, Licht.
    Golden crowned kinglet.

11. Troglodytes domesticus, (Bartr.) Coues.
House wren. (Breeds.)

12. Telmatodytes palustris, (Bartr.) Cab.
Long billed marsh wren. (Breeds.)

13. Cistothorus stellaris, (Licht.) Cab.
Short billed marsh wren. (Breeds in Outagamie Co.)

14. Anthus ludovicianus, (Gm.) Licht.
Titlark.

15. Mniotilta varia, (L.) V.
Black and white creeper. (Breeds.)

16. Parula americana, (L.) Bp.
Blue yellow-backed warbler. (Breeds.)

17. Helminthophaga chrysoptera, (L.) Bd.
Blue golden winged warbler. (Breeds.)

18. Helminthophaga ruficapilla, (Wils.) Bd.
Nashville warbler.

19. Helminthophaga celata, (Say) Bd.
Orange crowned warbler.

20. Helminthophaga peregrina, (Wils.) Cab.
Tennessee warbler.

21. Dendrœca aestiva, (Gm.) Bd.
Summer warbler. (Breeds.)

22. Dendrœca virens, (Gm.) Bd.
Black throated green warbler.

23. Dendrœca cærulescens, (L.) Bd.
Black throated blue warbler.

24. Dendrœca coronata, (L.) Gr.
Yellow rumped warbler.

25. Dendrœca blackburniæ, (Gm.) Bd.
Blackburn's warbler.

26. Dendrœca striata, (Forst.) Bd.
Black poll warbler.

27. Dendrœca castanea, (Wils.) Bd.
Autumnal warbler.

28. Dendrœca pennsylvanica, (L.) Bd.
Chestnut sided warbler. (Breeds.)

29. Dendrœca maculosa, (Gm.) Bd.
Black and yellow warbler.

30. Dendrœca tigrina, (Gm.) Bd.
Cape May warbler.

31. Dendrœca palmarum, (Gm.) Bd.
Yellow red poll warbler.

32. Dendrœca pinus, (Bartr.) Bd.
Pine creeping warbler.

33. Siurus auricapillus, (L.) Sw.
Golden crowned thrush. (Breeds.)

34. Siurus nævius, (Bodd.) Coues.
Water thrush. (Breeds.)

35. Geothlypis trichas, (L.) Cab.
Maryland yellow throat. (Breeds.)

36. Myiodioctes pusillus, (Wils.) Bp.
Green black capped warbler.

37. Myiodioctes canadensis, (L.) Aud.
Canadian fly catching warbler.

38. Setophaga ruticilla, (L.) Sw.
American redstart. (Breeds.)

39. Pyranga rubra, (L.) V.
Scarlet tanager. (Breeds.)

40. Hirundo erythrogastra horreorum, (Bartr.) Coues.
Barn swallow. (Breeds.)

41. Iridoprocne bicolor, (V.) Coues.
White bellied swallow. (Breeds.)

42. Petrochelidon lunifrons, (Say) Cab.
Eave swallow. (Breeds.)

43. Cotile riparia, (L.) Boie.
Bank swallow. (Breeds.)

44. Stelgidopteryx serripennis, (Aud) Bd.
Rough winged swallow. (Breeds Outagamie Co.)

45. Progne subis, (L.) Bd.
Purple marten. (Breeds.)

46. Ampelis cedrorum, (V.) Bd.
Cedar bird. (Breeds.)

47. Vireo olivaceus, (L.) V.
Red eyed greenlet. (Breeds.)

48. Viveo philadelphicus, Cass.
Brotherly love vireo.

49. Vireo gilvus, (V.) Bp.
Warbling vireo. (Breeds.)

50. Vireo flavifrons, V.
Yellow throated vireo. (Breeds Outagamie Co.)

51. **Vireo solitarius, V.**
Blue headed vireo.

52. **Lanius ludovicianus excubitorides, (Sw.) Coues.**
White rumped shrike. (Breeds.)

53. **Passerculus sandvicensis savanna, (Wils.) Ridg.**
Savanna sparrow. (Breeds.)

54. **Poœcetes gramineus, (Gm.) Bd.**
Grass finch. (Breeds.)

55. **Melospiza lincolni, (Aud.) Bd.**
Lincoln's song sparrow.

56. **Melospiza palustris (Bartr.) Bd.**
Swamp song sparrow. (Breeds).

57. **Melospiza fasciata, (Gm.) Scott.**
Song sparrow. (Breeds.)

58. Spizella domestica, (Bartr.) Coues.
Chipping sparrow. (Breeds.)

59. Zonotrichia albicollis, (Gm.) Bp.
White-throated sparrow. (Breeds Outagamie Co.)

60. Zonotrichia leucophrys, (Forst.) Sw.
White-browed sparrow.

61. Chondestes grammicus, (Say) Bp.
Lark finch. (Breeds.)

62. Passerella iliaca, (Merr.) Sw.
Fox colored sparrow.

63. Zamelodia ludoviciana, (L.) Coues.
Rose breasted grosbeak. (Breeds.)

64. Passerina cyanea, (L.) Gray.
Indigo bird. (Breeds.)

65. Pipilo erythrophthalmus, (L.) V.
Chewink. (Breeds.)

66. Dolichonyx oryzivorus, (L.) Sw.
Bobolink. (Breeds.)

67. Molothrus ater, (Bodd.) Gray.
Cow bird. (Breeds.)

68. Xanthocephalus icterocephalus, (Bp.) Bd.
Yellow headed blackbird.

69. Sturnella magna, (L.) Sw.
Meadow lark. (Breeds.)

70. Icterus galbula, (L.) Coues.
Baltimore oriole. (Breeds.)

71. Quiscalus purpureus, (Bartr.) Licht.
Purple grackle. (Breeds.)

72. Tyrannus carolinensis, (L.) Bd.
King bird. (Breeds.)

73. Myiarchus crinitus, (L.) Cab.
Great crested fly-catcher. (Breeds Outagamie Co.

74. Sayiornis fusca, (Gm.) Bd.
Phoebe. (Breeds.)

75. Contopus virens, (L.) Cab.
Wood pewee. (Breeds.)

76. Empidonax minimus, Bd.
Least fly-catcher. (Breeds.)

77. Empidonax flaviventris, Bd.
Yellow bellied fly-catcher.

78. Antrostomus vociferus, (Wils.) Bp.
Whip-poor-will. (Breeds.)

79. Chordediles popetue, (V.) Bd.
Night hawk. (Breeds.)

80. Chætura pelasgica, (L.) Steph.
Swift. (Breeds.)

81. Trochilus colubris, L.
Ruby throated hummer. (Breeds.)

82. Ceryle alcyon, (L.) Boie.
Kingfisher. (Breeds.)

83. Coccygus erythrophthalmus, (Wils.) Bd.
Black billed cuckoo. (Breeds.)

84. Coccygus americanus, (L.) Bp.
Yellow billed cuckoo. (Breeds.)

85. Sphyropicus varius, (L.) Bd.
Yellow bellied woodpecker. (Breeds.)

86. Melanerpes erythrocephalus, (L.) Sw.
Red headed woodpecker. (Breeds.)

87. Colaptes auratus, (L.) Sw.
Flicker. (Breeds.)

88. Asio wilsonianus, (Less.) Coues.
Long eared owl. (Breeds.)

89. Asio accipitrinus, (Pall.) Newt.
Short eared owl.

90. Circus cyaneus hudsonius, (L.) Coues.
Marsh hawk. (Breeds.)

91. Accipiter fuscus, (Gm.) Bp.
Pigeon hawk.

92. Accipiter cooperi, Bp.
Cooper's hawk. (Breeds.)

93. Falco columbarius, L.
Pigeon falcon.

94. Falco sparverius, L.
Sparrow hawk.

95. Buteo borealis, (Gm.) V.
Hen hawk.

96. Ectopistes migratorius, (L.) Sw.
Wild pigeon. (Breeds.)

97. Zenaidura carolinensis, (L.) Bp.
Carolina dove. (Breeds.)

98. Squatarola helvetica, (L.) Cuv.
Black bellied plover.

99. Charadrius dominicus, Müll.
Golden plover.

100. Ægialites vociferus, (L.) Cass.
Kildeer plover. (Breeds.)

101. Ægialites semipalmatus, (Bp) Cab.
Ring neck plover.

102. Lobipes hyperboreus, (L.) Cuv.
Northern phalarope.

103. Philohela minor, (Gm) Gr.
Woodcock. (Breeds.)

104. Gallinago wilsoni, (Temm.) Bp.
Wilson's snipe. (Breeds.)

105. Ereunetes pusillus, (L.) Cass.
Semipalmated sandpiper.

106. Actodromas minutilla, (V.) Coues.
Least sandpiper.

107. Actodromas bairdi, Coues.
Baird's sandpiper.

108. Actodromas maculata, (V.) Coues.
Jack snipe.

109. Pelidna alpina americana, (Cass.) Allen.
Dunlin.

110. Symphemia semipalmata, (Gm.) Hartl.
Willet.

111. Totanus melanoleucus, (Gm.) V.
Greater tattler.

112. Totanus flavipes, (Gm.) V.
Lesser tattler.

113. Rhyacophilus solitarius, (Wils.) Bp.
Solitary tattler. (Breeds Outagamie Co.)

114. Tringoides macularius. (L.) Gr.
Spotted sandpiper. (Breeds.)

115. Tryngites rufescens, (V.) Cab.
Buff breasted sandpiper.

116. Ardea herodias, L.
Great blue heron. (Breeds.)

117. Botaurus mugitans. (Bartr.) Coues.
Bittern. (Breeds.)

118. Rallus virginianus, L.
Virginia rail. (Breeds Outagamie Co.)

119. Porzana carolina, (L.) V.
Common rail. (Breeds.)

120. Anas boscas, L.
Mallard. (Breeds.)

121. Anas obscura, Gm.
Black mallard.

122. Dafila acuta, (L.) Jen.
Pintail. (Breeds Outagamie Co.)

123. Chaulelasmus streperus, (L.) Gr.
Gadwall.

124. Mareca americana, (Gm.) Steph.
Widgeon.

125. Querquedula carolinensis, (Gm.) Steph.
Green winged teal.

126. Querquedula discors, (L.) Steph.
Blue winged teal. (Breeds.)

127. Spatula clypeata, (L.) Boie.
Shoveler.

128. Aix sponsa. (L.) Boie.
Wood duck. (Breeds.)

129. Mergus merganser, L.
Merganser or fish duck.

130. Mergus serrator, L.
Red breasted merganser.

131. **Mergus cucullatus, L.**
Hooded merganser. (Breeds.)

132. **Sterna hirundo, L.**
Common tern.

133. **Hydrochelidon lariformis, (L.) Coues.**
Black tern.

134. **Podicipes cornutus, (Gm.) Lath.**
Horned grebe.

135. **Podilymbus podiceps, (L.) Lawr.**
Hell diver.

CLASS III. Birds that are migratory but whose movements through these counties seem greatly influenced by changes of temperature. A moderate variation in our winter would undoubtedly cause many individuals of these species to become "winter residents" in this locality.

1. **Certhia** familiaris, L.
Brown creeper. (Breeds.)

2. **Sitta** canadensis, L.
Red bellied nuthatch.

3. **Eremophila** alpestris, (L.) Boie. (var. praticola, Henshaw, 1884)
Horned lark. (Breeds.)

4. **Lanius borealis, V.**
Butcher bird.

5. **Carpodacus** purpureus, (Gm.) Gr.
Purple finch. (Breeds.)

6. **Astragalinus** tristis, (L.) Cab.
Yellow bird. (Breeds.)

7. **Junco hiemalis, (L.) Scl.**
Snow bird.

8. **Spizella** monticola, (Gm.) Bd.
Tree sparrow.

9. **Agelæus** phœniceus, (L.) V.
Red winged blackbird. (Breeds.)

10. **Scolecophagus** ferrugineus, (Gm.) Sw.
Rusty grackle.

11. **Corvus frugivorus,** Bartr.
Crow. (Breeds)

12. Astur atricapillus, (Wils.) Bp.
    Goshawk.

13. Archibuteo lagopus sancti-johannis, (Gm.) Ridg.
    Rough-legged buzzard.

CLASS IV. Birds that are migratory, but whose movements, with those of Class III., are influenced to a great extent by immediate changes of temperature. In this class the southward movement is deterred until the freezing of our bays and rivers. Pot hunters for many seasons past have taken most of the following species, up to the very day of freezing up:

1. Fulica americana, Gm.
   Coot

2. Chen hyperboreus, (Pall.) Boie.
   Snow goose.

3. Bernicla canadensis, (L.) Boie.
   Canada goose.

4. Haliaetus leucocephalus, (L.) Savig.
   Bald eagle. (Breeds).

5. Bernicla canadensis hutchinsi, (Rich.) Coues.
   Hutchin's goose.

6. Fuligula marila, (L.) Steph.
   Greater black head.

7. Fuligula affinis, Eyt.
   Lesser black head.

8. Fuligula collaris, (Donov.) Bp.
   Ring neck duck. (Breeds Outagamie Co.)

9. Fuligula ferina americana, (Eyt.) Coues.
   Red head.

10. Fuligula vallisneria, (Wils.) Steph.
    Canvas back.

11. Clangula glaucium, (L.) Brehm.
    Golden eye. (Breeds Outagamie Co.)

12. Clangula albeola, (L.) Steph.
    Buffle head.

13. Harelda glacialis, (L.) Leach.
    Long tailed duck.

14. Œdemia americana, Sw.
    Black scoter.

15. Œdemia fusca, (L.) Flem.
    Velvet scoter.

16. Erismatura rubida, (Wils.) Bp.
    Ruddy duck.

17. Larus argentatus, Brünn.
    Herring gull.

18. Larus delawarensis, Ord.
    Ring billed gull.

19. Chroicocephalus philadelphia, (Ord.) Lawr.
    Bonaparte's gull.

20. Colymbus torquatus. Brünn.
    Loon.

CLASS V.—Birds from northern sections that visit us each fall. Some of the species remaining throughout the winter, others appearing irregularly during the colder months.

1. Anorthura troglodytes hiemalis, (Wils.). Coues.
   Winter wren. (A few breed in Outagamie Co.)

2. Ampelis garrulus, L.
   Bohemian waxwing.

3. Pinicola enucleator, (L.) V.
   Pine grosbeak.

4. Loxia leucoptera, Gm.
   White winged crossbill.

5. Loxia curvirostra americana (Wils.) Coues.
   Common crossbill,

6. Ægiothus linaria, (L.) Cab.
   Red-poll linnet.

7. Chrysomitris pinus, (Bartr.) Bp.
   Pine linnet.

8. Plectrophanes nivalis, (L.) Meyer.
   Snow bunting.

9. Centrophanes lapponicus, (L.) Kaup.
   Lapland longspur.

10. Perisoreus canadensis, (L.) Bp.
    Canada jay.

11. Picoides arcticus, (Sm.) Gray.
    Black backed three-toed woodpecker.

12. Nyctea scandiaca, (L.) Newt.
    Snowy owl.

13. Nyctala acadica, (Gm.) Bp.
    Saw whet owl. (Breeds.)

CLASS VI. Birds whose visitations are so rare as to compel me to place them in my list either as a stray from other sections, or as one whose regular occurrences have escaped my notice.

1. Turdus mustelinus, Gm.
   Wood thrush.
   I have found but one pair of these birds in Brown county, and they were nesting; the nest contained three eggs.

2. Protonotaria citrea, (Gm.) Bd.
   Prothonotary warbler.
   A single specimen was taken May 4, 1883, by Mr. F. L. Grundtvig, at Shiocton.

3. Spizella agrestis, (Bartr.) Coues.
   Field sparrow.
   A southerly bird, taken in Brown Co. only a few times in 1882.

4. Junco hiemalis oregonus, (Towns.) Coues.
   Oregon snow bird.
   A specimen of Junco was taken in W. De Pere October 6th, 1883, the markings (identified by Coues) inclined strongly towards oregonus

5. Icterus spurius, (L.) Bp.
   Orchard oriole.
   Noticed but twice in Brown Co.

6. Hylotomus pileatus, (L.) Bd.
   Pileated woodpecker.
   Heavier timber seems to be all that is necessary to make this species a resident in Brown Co.

7. Pandion haliaetus, (L.) Sav.
   Fish hawk.
   Only occasionally seen in Brown Co.

8. Corvus corax, L.
   Raven.
   I have taken but one specimen in Brown Co.

9. Centurus carolinus, (L.) Bp.
Red bellied woodpecker.
A rare spring visitor.

10. Cathartes aura, (L.) Ill.
Turkey buzzard.
None seen in Brown Co., a few were noticed by Mr. F. L. Grundtvig in Outagamie Co.

11. Ortyx virginiana, (L.) Bp.
Quail.
I have not met this species in Brown Co., although Louis Sheller, Green Bay, has a mounted specimen which he claims to have taken here.

12. Strepsilas interpres, (L.) Ill.
Turnstone.
June 2, '82, a flock of 5 of these birds were seen near West De Pere, 3 were taken.

13. Limosa fœda, (L.) Ord.
Marbled godwit.
Louis Scheller reports having taken this species near Green Bay I have not found it.

14. Bartramia longicauda, (Bechst.) Coues.
Field plover.
May 1st '82, a single specimen was taken by Harry Hammond in West De Pere.

15. Butorides virescens, (L.) Cab.
Green heron.
Mr. F. L. Grundtvig saw a single specimen near Shiocton, Outagamie Co.

16. Ardetta exilis, (Gm.) Gr.
Least bittern.
May 20th '83, a male of this species was taken near West De Pere.

17. Gallinula galeata, (Licht.) Bp.
Florida gallinule.
Subsequent observation (1884) warrants the insertion of this species in Class II.

18. Chen hyperboreus albatus, (Cass.) Ridg.
Lesser snow goose.
April 22d '81, a single specimen was taken on the shore of Fox River near De Pere.

Summing up the above six classes, I find the avian fauna of Brown and Outagamie counties, to consist of two-hundred and ten species. Eleven are residents throughout the year. Eighteen are strays or very rare visitors. Eighty-seven are summer residents, and ninety-four are through migrants. Of the above residents and migrants, one-hundred species have been known to breed in either Brown or Outagamie counties.

In the following table, I have attempted to compare the arrival of our migratory birds, for the years 1882 and 1883; giving as data, the results of Mr. F. L. Grundtvigs's observations at Shiocton, and mine at West De Pere.

Great value should especially be placed upon the observations of Mr. F. L. Grundtvig, while at Shiocton, for during these observations, his whole time was constantly devoted to the work. The collecting trips, usually made twice each day, took him through varied places, on both land and water.

Each arrival was recorded after personal observation and careful study. Few species escaped his notice, and no arrival to my knowledge, was omitted from his daily record.

Care should be exercised in using my notes with his. Although I have been very careful to record each arrival, and note every fact of interst respecting our birds, yet, owing to the many hurried trips that I was obliged to take, arrivals of the more shy and retiring species unquestionably escaped my notice, until increasing numbers made them more conspicuous. At times, a day or so would pass without the customary tramp; but afterwards, I was slow to record any species, whose abundance indicated that they had arrived during my absence. This partly explains a number of the instances where "A" in the following table has been placed among the Brown County arrivals.

ARRIVAL OF MIGRANTS IN BROWN AND OUTAGAMIE COUNTIES CONSECUTIVELY COMPARED FOR THE YEARS 1882 AND 1883.

	First Arrivals, Outagamie Co., 1882.	First Arrivals, Brown Co., 1882.	First Arrivals, Outagamie Co., 1883.	First Arrivals, Brown Co., 1883.
Turdus migratorius	Feb. 26	Mar. 10	Mar. 22	Mar. 26
Turdus fuscescens	May 10	May 8	May 22	A.*
Turdus unalascæ nanus	April 10	April 22	April 22	April 5
Turdus ustulatus swainsoni	May 10	B†	B.	B.
Mimus carolinensis	May 9	May 14	May 8	May 14
Harporhynchus rufus	May 7	May 18	B.	April 11
Sialia sialis	Mar. 3	Mar. 14	Mar. 29	Mar. 29
Regulus calendula	April 10	April 14	April 11	April 10
Regulus satrapa	April 9	April 3	April 9	April 5
Certhia familiaris	Mar. 28	April 6	Mar. 20	April 9
Troglodytes domesticus	May 5	May 13	May 7	May 12
Telmatodytes palustris	May 30	A.	A.	B.
Cistothorus stellaris	May 18	B.	A.	B.
Anthus ludovicianus	May 20	B.	B.	B.
Mniotilta varia	May 1	May 10	May 6	May 14
Parula americana	May 3	A.	May 7	May 23
Helminthophaga chrysoptera	May 15	May 10	May 19	May 15
Helminthophaga ruficapilla	May 4	May 8	May 7	B.
Helminthophaga celata	April 30	B.	May 1	B.
Helminthophaga peregrina	May 19	A.	May 22	May 21
Dendroeca aestiva	May 3	May 10	May 7	A.
Dendrœca virens	May 4	May 10	May 7	A.
Dendrœca caerulescens	May 8	B.	May 12	May 15
Dendrœca coronata	April 5	April 6	April 12	April 9
Dendrœca blackburniae	May 3	May 10	May 7	May 15
Dendrœca striata	May 10	A.	May 18	May 19
Dendrœca castanea	May 18	May 8	May 20	A.
Dendrœca pennsylvanica	May 3	May 10	May 8	A.
Dendrœca maculosa	May 3	A.	May 14	A.
Dendrœca tigrina	May 8	May 9	May 7	May 15
Dendrœca palmarum	May 1	A.	May 7	B.
Dendrœca pinus	May 3	April 21	April 24	May 15
Siurus auricapillus	May 9	May 8	May 9	May 15
Siurus naevius	April 26	A.	April 30	A.
Geothlypis trichas	May 10	May 31	May 10	A.
Myiodioctes pusillus	May 12	May 18	May 18	May 31
Myiodioctes canadensis	May 10	A.	May 18	B.
Setophaga ruticilla	May 3	May 10	May 7	May 15
Pyranga rubra	May 10	May 18	May 22	May 20
Hirundo erythrogastra horreorum	April 29	May 15	May 7	May 10
Iridoprocne bicolor	Mar. 29	April 1	April 7	May 7

* "A." Through neglect or omission the dates of the first arrivals were not recorded.
† "B." This species not noticed in the spring of that year.

ARRIVAL OF MIGRANTS IN BROWN AND OUTAGAMIE COUNTIES, ETC.— Continued.

	First arrivals, Outagamie Co., 1882.	First arrivals, Brown Co., 1882.	First arrivals, Outagamie Co., 1883.	First arrivals, Brown Co., 1883.
Petrochelidon lunifrons	April 25	April 21	April 29	May 10
Cotile riparia	May 12	B.	B.	B.
Stelgidopteryx serripennis	April 24	May 14	A.	May 21
Progne subis	April 10	April 16	A.	A.
Ampelis cedrorum	May 19	June 5	A.	A.
Vireo olivaceus	May 11	May 22	May 18	May 26
Vireo philadelphicus	May 23	May 31	B.	B.
Vireo gilvus	May 9	A.	May 8	A.
Vireo flavifrons	May 8	May 26	May 5	May 14
Vireo solitarius	B.	May 18	May 7	B.
Lanius ludovicianus excubitorides	A.	A.	A.	April 8
Carpodacus purpureus	Mar. 5	April 14	April 9	Mar. 14
Passerculus sandvicensis savana	A.	A.	April 26	April 28
Poœcetes gramineus	April 14	April 14	April 9	April 9
Melospiza lincolni	May 20	B.	B.	B.
Melospiza palustris	....	....	....	....
Melospiza fasciata	Mar. 29	Mar. 28	April 6	April 6
Spizella domestica	April 20	April 19	April 12	April 18
Zonotrichia albicollis	April 25	May 8	April 22	A.
Zonotricha leucophrys	May 13	A.	May 12	May 14
Chondestes grammicus	B.	May 3	B.	May 5
Passerella iliaca	April 13	April 21	April 9	April 11
Zamelodia ludoviciana	May 9	A.	May 16	May 23
Passerina cyanea	May 18	May 17	May 22	May 25
Pipilo erythrophthalmus	April 26	April 21	April 26	April 11
Dolichonyx oryzivorus	May 17	A.	May 15	May 15
Molothrus ater	April 17	April 14	May 3	April 11
Xanthocephalus icterocephalus	May 30	B.	B.	B.
Sturnella magna	Mar. 28	Mar. 28	April 2	April 6
Icterus galbula	May 4	May 5	May 7	May 13
Quiscalus purpureus	Mar. 29	April 3	April 6	April 8
Tyrannus carolinensis	May 8	April 12	May 7	May 14
Myiarchus crinitus	May 14	B.	May 7	B.
Sayiornis fusca	April 2	Mar. 29	April 6	April 8
Contopus virens	May 20	A.	May 26	A.
Empidonax minimus	May 5	A.	May 7	May 10
Empidonax flaviventris	May 18	A.	May 22	B.
Antrostomus vociferus	April 28	A.	April 26	A.
Chordediles popetue	May 19	A.	May 1	A.
Chætura pelasgica	May 9	April 1	May 7	May 10
Trochilus colubris	May 9	May 20	May 17	A.
Ceryle alcyon	April 1	April 9	April 9	April 11
Coccygus erythrophthalmus	May 18	May 20	May 25	B.
Sphyropicus varius	Mar. 27	April 7	April 9	April 7
Melanerpes erythrocephalus	May 12	April 3	May 8	May 15
Colaptes auratus	April 1	April 3	April 9	April 12

Believing that there exists certain relations between the dietetic habits of our true migrants and their order of arrival, I have prepared the following annotated list. I have chosen the order in which they arrived in the spring of 1882, as my observations then were more thorough than in 1883:

Turdus migratorius. (Robin.) Mch. 10.
Its principal food consists of worms, caterpillars and berries.*

Sialia sialis. (Blue bird.) Mch. 14.
Food — Larvæ and insects.

Sturnella magna. (Meadow lark.) Mch. 28.
Food — Larvæ and insects.

Melospiza fasciata. (Song sparrow.) Mch. 28.
Food — Seeds and insects.

Sayiornis fusca. (Phœbe.) Mch. 29.
A purely insectivorous bird.

Iridoprocure bicolor. (White bellied swallow.) Apr. 1.
Also an insectivorous bird.

Quiscalus purpureus. (Purple grackle.) Apr. 3.
In the spring its food is mostly worms, grubs and caterpillars.

Regulus satrapa. (Golden crowned kinglet.) Apr. 3.
Food — Small insects and larvæ.

Colaptes auratus. (Flicker.) Apr. 3.
Food — Ants, beetles and caterpillars.

Certhia familiaris. (Brown creeper.) Apr. 6.
Food — Small beetles and insects.

Dendrœca coronata. (Yellow rump warbler.) Apr. 6.
Food — Caterpillars, small flies and beetles.

Sphyropicus varius. (Yellow bellied wood-pecker.) Apr. 7.
Food — Ants, beetles and small insects.

Tyrannus carolinensis. (King bird.) Apr. 12.
Food is wholly insectivorous.

Regulus calendula. (Ruby crowned kinglet.) Apr. 14.
Food — Larvæ and small insects.

Carpodacus purpureus. (Purple finch.) Apr. 14.
Food — Seeds, buds, plant-lice and caterpillars.

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* The notes respecting the food were mostly taken from Prof. F. H. King's work, entitled "The Economic Relations of Wisconsin Birds," published in "Geology of Wisconsin," Vol. I.

Poœcetes gramineus. (Grass finch.) Apr. 14.
Food — Seeds and insects.

Molothrus ater. (Cow bird.) Apr. 14.
Food is chiefly insects.

Progne subis. (Purple marten.) Apr. 16.
Food wholly insectivorous.

Spizella domestica. (Chipping sparrow.) Apr. 19.
Food — Seeds, worms and insects.

Petrochelidon lunifrons. (Eave swallow.) Apr. 21.
Food wholly insectivorous.

Passerella iliaca. (Fox sparrow.) Apr. 21.
Food — Seeds, bugs and insects.

Pipilo erythrophthalmus. (Chewink.) Apr. 21,
Food — Seeds, insects and worms,

Turdus unalascæ nanus. (Hermit thrush.) Apr. 22.
Food — Ants, beetles and caterpillars.

The seed eaters as will be seen by this list, do not appear to arrive in force, until some time after the insect eaters have made their appearance. This is quite contrary to some existing ideas now held by some naturalists respecting these movements. But why these birds are not among the very first, appears to me a singular anomaly. In their case, the temperature must be an important agent in influencing their movements, for their food, the seeds, are as easily obtained in the earlier months, as in May or June, no new plants having had time to flower before their arrival.

While the food of a few of the earlier migrants consists chiefly of winged insects, yet the majority of the first comers subsist upon grubs, caterpillars and worms, that are largely found in crevices in the bark of trees, under fallen limbs, on old rails, and in many other similar places. Unless these birds are gifted with the art of discovering larvæ and insects while in their winter quarters, the awakening of articulate life must be an important factor in affecting these migrations.

Mr. F. L. Grundtvig when pursuing his close observations discovered that the yellow rumps (Dendrœca coronata) when they first arrived, associated more or less with the woodpeckers, and like them were successful in obtaining concealed larvæ and small insects from under the edges of the shaggy bark. They were seen to frequent the terminal branches, and seek their food amidst the starting foliage, after the only throng of their brother warblers began to arrive and winge insects were becoming numerous.

This matter of being able to obtain sufficient insect food in various ways, must give this warbler an advantage over its allies, which I think may possibly account for its immense numbers as compared with some of the other species.

Does not this rule apply to other birds as well, and in part explain the reason why our earlier species are among our *most abundant* birds?

Birds in districts of homogeneous characters are restricted to certain areas by isotherms, but in country not entirely suitable for certain representative species, would not the isotherm be only a minor consideration as affecting their distribution ?

Can we properly judge of the extent of the faunal areas in any specified section, until the whole section is practically inhabitable for them during the warmer months ? In other words, as civilization progresses and timbered districts and swampy tracts become converted into meadows and farming lands, may not the avian fauna of an adjoining southern district extend northward until checked by the isotherm that constitutes the actual boundary of these divisions ? Brown County at the lower terminus of the Fox River Valley is the last of a series of counties connecting with the warmer sections of sonthern Wisconsin and northern Illinois, that are throughout habitable for such birds as prefer meadows and cultivated fields.

As single field sparrows, orchard orioles, and wood thrushes are found here only at irregular intervals, must we not feel confident of the close proximity of the northern limit of the Alleghanian fauna, of which they are representative members ?

Shiocton, Outagamie Co., the place of Mr. F. L. Grundtvig's diligent and thorough observations is almost directly west from us at De Pere, yet notwithstanding this, he has never on any of his varied excursions found the lark finch, field sparrow or orchard oriole. Around Shiocton there are farms and some meadow lands but they are isolated. For miles on either side extends a tract of worthless land, once a forest, but now transformed by destructive fires into an impenetrable non-productive area. The banks of the Wolf River are at present wholly covered with green timber which is well adapted for arboreous species, but not for those referred to above. With these considerations in mind I believe that the northern limit of the Alleghanian fauna in eastern Wisconsin is not far from the southern boundary of Marinette County or where it meets the waters on the western shore of Green Bay.

THE VARIATION IN ATTRACTION DUE TO THE FIGURE OF THE ATTRACTING BODIES.

By D. P. Blackstone, A. M., C. E., Berlin, Wis.

INTRODUCTION.

1. This paper is a part of the investigations that I have nearly completed on the subject, *The Variation in Figure and in Attraction of a once Fluid Body, due to Rotation, Law of Density, and Contraction.* The portion of the investigations on that subject pertaining to attraction, herein given, is abbreviated by the omission of some of the mathematical demonstrations, and some evident deductions. The results attained by my method give numerical exactness to any power of the eccentricity of the ellipsoid.

This paper develops by geometrical methods the law of attraction for spheres, each of homogeneous mass, or each or either composed of fluid masses of heterogeneous densities. It also develops by the same methods the variation in attraction due to ellipsoidal figure, where one of the attracting bodies is an ellipsoid of homogeneous mass, the standard for measuring the variation being the attraction of the mass of the ellipsoid condensed at its own center.

A part of my investigation on attraction, not herein given, develops the variation in attraction due to ellipsoidal figure where the ellipsoid is composed of fluid masses of heterogeneous densities. In this paper I take it as granted that a fluid mass under the law of the mutual attraction of its own component particles, takes on the form of an oblate ellipsoid. In my investigation pertaining to fluid equilibrium I demonstrate under what conditions of rotation the fluid mass assumes the form of an oblate ellipsoid, and also under what conditions of rotation the fluid mass has not defined mathematical figure, but would go back if expanded by heat, to nebula, "without form and void."

In finding the attraction of an ellipsoid on any outside particle or body I avoid the use of the expedient of confocal ellipsoids. In case, however, the outside particle is in the plane of the equator or line of the poles, it is an evident inference from my investigation that two confocal ellipsoids having their foci at the same points, attract the same particle outside of both, as their masses. In case the outside particle is otherwise located, I have a short and simple demonstration which, if put in at the end of Art. 18 of this paper, would prove that confocal ellipsoids attract any outside particle, as their masses. Todhunter in the second volume of his *History of the Theories of Attraction and the Figure of the Earth,* says, referring to the expedient of confocal ellipsoids: "Legendre we see arrived at his theorem incidentally as he was developing a new demonstration of Laplace's theorem; and the improvement subsequently effected by Ivory in the treatment of Laplace's theorem has probably much diminished the interest which would otherwise have continued to belong to Legendre's. Nevertheless it is to be wished that a simple investigation could be supplied of the remarkable result; and perhaps this may be attained in consequence of thus drawing attention to it."

It is true that the final results of the investigation of this paper reduce to the same as those well known by mathematicians. It is also doubtless true that the modern method of the Calculus is the best for obtaining a specific conclusion. But it seems to me that a new and true geometrical investigation on an intricate subject like this, must furnish another lamp by which can be seen new deductive truths. However this may be, I feel well compensated for the brain force expended in the general mental culture received, and especially in a sharpened ability to detect the fallacious logic in my own scientific and philosophic thought.

2. Two particles at a sensible distance apart attract each other with a force directly proportional to the product of their masses and inversely proportional to the square of their distance. This law is accepted because it is the only law of attraction that accords with physical phenomena.

INVESTIGATION.

I.

SPHERICAL ATTRACTION.

It is proved under Heading I. by demonstration and deduction:

First.— That two homogeneous spheres, or two spheres, each made up in laminæ varying in densities from lamina to lamina, attract each other directly as product of masses, and inversely as square of distance from center to center.

Second.— That a mass composed of fluids under the law of the mutual attraction of component particles, arranges itself, in order of the densities of the fluids, in a sphere made up in laminæ with the most dense at the center.

3. To find the resultant attraction of an assemblage of particles constituting a homogenous sphere on an outside particle.

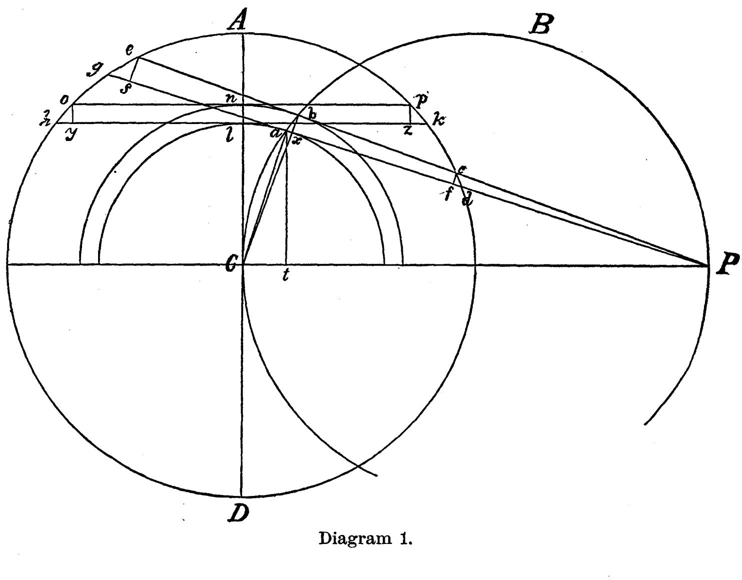

Diagram 1.

In Diagram 1 let C be the center of the sphere, having radius C A, and P the attracted particle. Also let C B P be a circle described on C P as diameter, From P draw any two lines, P g and P e cutting the sphere; also cutting the circumference C B P in points a and b, making the angle g P e infinitesimal. On the radius C A perpendicular to P C, take C l equal to chord C a, and C n equal to C b. Through l and n draw chords h k and o p, parallel to C P. Then chord h k equals chord g d, and o p equals e c. Per law of ultimate ratio when the angle e P g becomes infinitesimal, the point x of intersection of chord g d with C b coincides with point a, and a b equals l n.

Draw t a perpendicular to P C. Then angle C P a equals t a C. Let this angle be represented by ϑ. Then is circumference or length of arc generated by point l rotated on axis P C for one rotation or an infinitesimal part of a rotation to circumference or length of arc generated by point a so rotated, as unity to cosine ϑ.

Divide the equal chords g d and h k each into the same number of equal and infinitesimal parts, and from the points of division draw lines as s e, f c, etc., parallel to C a, and y o, z p, etc., parallel to C A. Then for one or an infinitesimal part of a rotation, the volumes generated by surfaces having dimensions a b, s e, f c, etc., each into an equal and infinitesimal division of length along g d, are directly proportional to squares of distances P a, P s, P f, etc. In case then of a sphere of homogeneous density each division along chord g d has a mass directly proportional to the square of its distance from P. Therefore per law of attraction for particles *directly as mass and inversely as square of distance*, the attraction of the mass at any division along chord g d, on particle P is the same as that at division a. The attraction then, in direction P a of whole mass between chords e c and g d, is equal to that of mass at division a into the number of divisions of chord g d into inverse square of distance P a.

Let mass of sphere between chords op and h k rotated be represented by m. Then because h k equals g d, and l n equals a b, and because circumference of point l to circumference of point a rotated is as unity to cosine ϑ, mass of division a into chord g d equals *m cos* ϑ. In right angled triangle Pa C let hypotheneus P C be represented by D. Then side Pa equals *D cos.* ϑ.

$$\text{Attraction of mass } (m \cos \vartheta) \text{ on P in direction Pa} = \frac{m \cos \vartheta}{D^2 \cos^2 \vartheta}$$

$$\text{Attraction of mass } (m \cos \vartheta) \text{ on P in direction P C} = \frac{m \cos^2 \vartheta}{D^2 \cos^2 \vartheta} = \frac{m}{D^2}$$

But $\frac{m}{D^2}$ equals the attraction of a mass (m) condensed to the size of a particle at the center of the sphere on particle P.

Because P C is the axis of rotation of chords e c and g d, particle P must be attracted in direction P C, and with a force equal to the attraction of the mass cut from the sphere by one rotation of the chords o p and h k, condensed at the center of the sphere.

As n l is any part of the radius A C the whole of a homogeneous sphere attracts an outside particle the same as the mass of the sphere condensed to its center.

4. A spherical shell is a sphere less a sphere of smaller radius. In accordance then, with investigation of Art. 3, a spherical shell attracts an outside particle the same as the mass of the shell condensed at its center.

5. A sphere made up of laminae varying in density from lamina to lamina is the same as a sphere composed of shells having densities corresponding to the laminae. The sphere, then, made up of laminae attracts an outside particle in conformity with the law for spherical shells or a homogeneous sphere.

6. When attracting sphere is condensed to a particle, the investigation of Art. 3 applies to the case where attracted particle P becomes a sphere. Two spheres, therefore, attract each other with a force directly as product of masses and inversely as square of distance from center to center.

7. To find the attraction of a sphere on a particle placed within it.

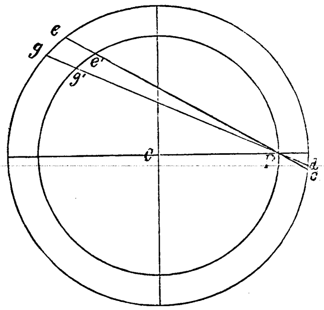

Diagram 2.

Diagram 2 shows particle P within the sphere. It is evident from investigation of Art. 3 that that portion of the sphere outside of the radius distance C P attracts particle P equally in opposite directions. The only uncounterbalanced attraction, then, on particle P is the attraction of that portion of the sphere inside of radius distance C P. Homogeneous spheres of same density vary in masses as cubes of radii. The attraction on particles inside of a homogeneous sphere vary, then, as their distances from the center of the sphere.

8. When the sphere is fluid and particle P becomes a small solid of less density than the sphere, then body P placed at the surface of the sphere floats, and when body P is more dense than the sphere at the surface it sinks. Its place of equilibrium is at the center of the sphere, in case all the laminae of the sphere are less dense than the body P, otherwise in a lamina having the same density as body P.

It is evident that the law of equilibrium requires a fluid mass acted on only by the force of the mutual attraction of component particles to assume a spherical figure, and in case the mass is composed of fluids of varying densities the fluids must take positions in spherical laminae in order of densities, with the most dense at the center.

II.

Preliminary Demonstrations Developing required New Expressions Pertaining to the Ellipse.

First: $A_{,} = B\sqrt{1+E_{,}^{2}\cos^{2}\vartheta} = A\sqrt{1-E^{2}\sin^{2}\vartheta}$

$B_{,} = B\sqrt{1+{}_{,}E_{,}^{2}\sin^{2}\vartheta} = A\sqrt{1-E^{2}\cos^{2}\vartheta}.$

Second: $\sin^{2}\alpha = \dfrac{E^{4}\sin^{2}\vartheta\cos^{2}\vartheta}{1-E^{2}+E^{4}\sin^{2}\vartheta\cos^{2}\vartheta}$

In the above expressions A and B represent the semi-major and semi-minor axes of the ellipse, $A_{,}$ any semi-diameter and $B_{,}$ its semi-conjuegate. E^2 equals $\frac{A^2-B^2}{A^2}$ and $E_{,}^2$ equals $\frac{A^2-B^2}{B^2}$. Angle α is the difference between the angle made by any diameter with its conjugate and a right angle. ϑ is further on defined.

9. *To find any diameter and its conjugate, the major and minor axes of the ellipse being given.*

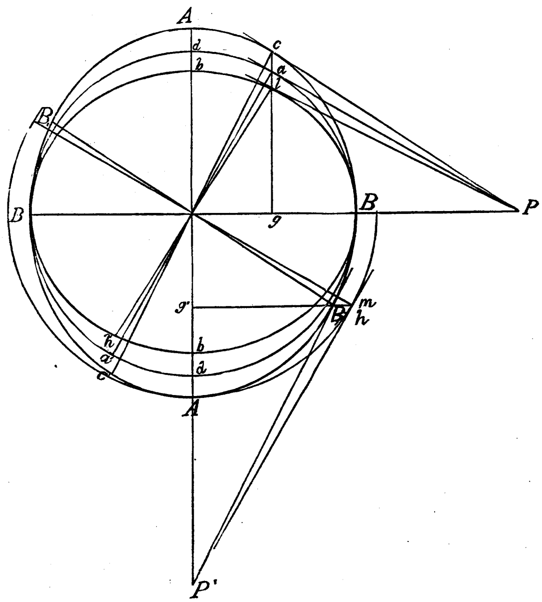

Diagram 3.

In Diagram 3* let A B A B be an ellipse having major axis A A and minor axis B B, and let B b B b be a second ellipse having B B major axis and similar in construction to first ellipse; also let B dB d be a circle with radius B C.

* In center of Diagram 3 C is left out.

Draw the tangent lines P c, P a and P l. Through the points of tangency c, a, l draw line c g so that the part l g is perpendicular to P C. Then by known demonstration of *conic sections* the line c g is straight, and g a is to g c as B to A, also g a is to g l as A to B. Since triangles l P g, a P g, and c P g have each a right angle at g and same base P g, the tangents of the angles l P g, a P g, and c P g are directly as g l, g a, and g c. Since the right angled triangles C l g, C a g, and C c g have the same perpendicular C g, the tangents of the angles C l g, C a g, and C c g are inversely as g l, g a, and g c. But angle a P g equals C a g. therefore angle l P g equals C c g, and angle c P g equals C l g. Also angle c P a equals a C l, and angle a P l equals c C a, and line C l produced is perpendicular to tangent line P c.

Produce major axis A A to P′, making distance C P′ to C P as A to B. Draw P′m tangent to circle having radius Cm equal to C A, and draw P′ $B_{,}$ tangent to ellipse having axes A A and B B. Through points of tangency m and $B_{,}$ draw m g′. m g′ is perpendicular to P′ C and parallel to P C. By constructions angle m P′ C equals a P C or C a g. Because then m g′ is to $B_{,}$ g′ inversely as A to B, angle C $B_{,}$ g′ equals c P g. Therefore $B_{,}$ C or $B_{,}$ $B_{,}$ is parallel to tangent line P c, and $B_{,}$ $B_{,}$ is a conjugate diameter to C $C_{,}$. The angle c C $B_{,}$ is greater or less than a right angle by the angle c C l or α.

Let angle C a g be represented by ϑ, C c g by $\vartheta - z$, and C l g by $\vartheta + y$. Hereafter in this investigation ϑ, or the angle in any ellipse in the situation of ϑ, is called the Elliptic Angle, $(\vartheta - z)$ is called the Alpha Elliptic, and $(\vartheta + y)$, the Beta Elliptic Angle.

It is now evident that:

$$Cg = B \sin \vartheta.$$

$$Cg' = A \sin \vartheta.$$

$$ag = B \cos \vartheta.$$

$$cg = \frac{A}{B} B \cos \vartheta = A \cos \vartheta.$$

$$mg' = A \cos \vartheta.$$

$$B_{,} g' = \frac{B}{A} A \cos \vartheta = B \cos \vartheta.$$

In right angled triangle C c g;

$$C c = A_{,} = \sqrt{A^2 \cos^2 \vartheta + B^2 \sin^2 \vartheta} = \sqrt{B^2 + (A^2 - B^2) \cos^2 \vartheta} =$$

$$\sqrt{A^2 - (A^2 - B^2) \sin^2 \vartheta}.$$

$$A_{,} = B \sqrt{1 + E_{,} \cos^2 \vartheta} = A \sqrt{1 - E^2 \sin^2 \vartheta}.$$

Likewise from right angled triangle C $B_{,}$ g′,

$$B_{,} = B \sqrt{1 + E_{,}^2 \sin^2 \vartheta} = A \sqrt{1 - E^2 \cos^2 \vartheta}.$$

10. *To find an expression for sine square of angle α.*

In triangle c C l,

$$\sin\alpha = \frac{\sin(\vartheta + y)\,\overline{cl}}{A_{,}}$$

$$cl = A\cos\vartheta - \frac{B^2\cos\vartheta}{A} = A\,E^2\cos\vartheta.$$

$$\sin(\vartheta + y) = \frac{A\sin\vartheta}{B_{,}}$$

$$\sin^2\alpha = \frac{A^4\,E^4\sin^2\vartheta\cos^2\vartheta}{A_{,}^2\,B_{,}^2} = \frac{E^4\sin^2\vartheta\cos^2\vartheta}{(1-E^2\sin^2\vartheta)(1-E^2\cos^2\vartheta)}$$

$$\sin^2\alpha = \frac{E^4\sin^2\vartheta\cos^2\vartheta}{1 - E^2 + E^4\sin^2\vartheta\cos^2\vartheta}$$

III.

OUTSIDE ELLIPSOIDAL ATTRACTION IN LINE OF POLES.

First.—An oblate Ellipsoid and an outside particle in line of the poles attract each other directly as product of mass of particle into mass of Ellipsoid multiplied by $(1-\frac{3}{5}n^2E_{,}^2+\frac{3}{7}n^4E_{,}^4-\frac{3}{9}n^6E_{,}^6+\text{etc.})$ *and inversely as square of distance from center of ellipsoid to particle.**

Second.—A prolate ellipsoid and an outside particle in line of the poles attract each other directly as product of mass of particle into mass of ellipsoid multiplied by $(1+\frac{3}{5}n^2E^2+\frac{3}{7}n^4E^4+\frac{3}{9}n^6E^6+\text{etc.})$ *and inversely as square of distance.*

In the first case n equals the minor axis of the ellipsoid divided by the distance and in the second, the major axis divided by distance, $E_{,}^2$ equals E^2 divided by $(1-E^2)$.

11. To find the attraction of an ellipsoid of rotation on an outside particle in line of axis of rotation.

In Diagram 4 let C be the center of the ellipsoid having major axis A A and minor axis B B, and let P be the attracted particle.

On P C as minor axis described a semi ellipse, similar to the one having C for its center. Also with C as the center and n C and l C as semi major axes describe two semi ellipses similar to ones already de-

*When not otherwise mentioned the ellipsoid is homogeneous. The word particle here used represents finite mass condensed to the dimensions of a particle.

scribed. The construction of the remaining portions of the diagram where not evident is explained.

Draw $B_{,}$ $B_{,}$ parallel to P a, and draw $A_{,}$ $A_{,}$ through point of tangency a and center C. $A_{,}$ $A_{,}$ and $B_{,}$ $B_{,}$ are, then, conjugate diameters.

Ordinate a d equals ordinate a g, l k equals l h. Per known demonstration of *Conic Sections;*

(*a*) g d : h k :: $B_{,}$: B.

When the angle e P g becomes infinitesimal, $A_{,}$ $A_{,}$ passes through the points of tangency a and b. From the similarity of the ellipses having C l, C n, and C A for semi major axes; b a : n l :: $A_{,}$: A. Draw s x through point a, and perpendicular to P a. Then s a $=$ b a cos α

(*b*) s a : n l :: $A_{,}$ cos. α : A.

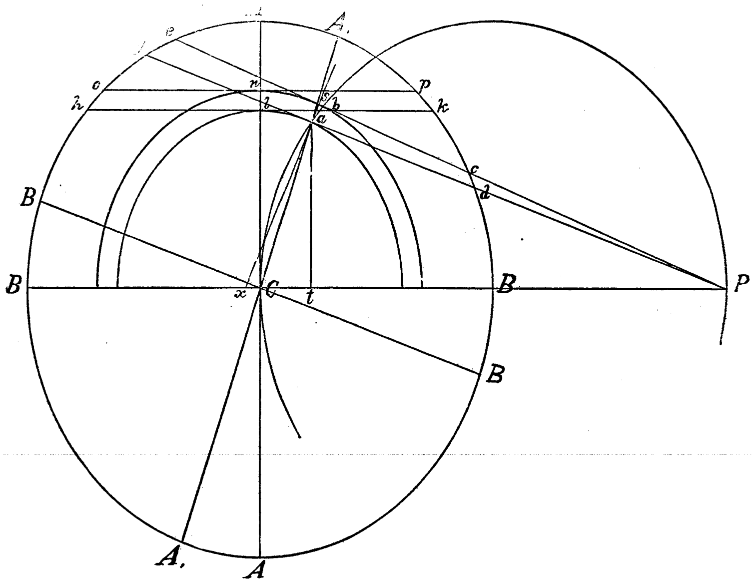

Diagram 4.

Draw t a perpendicular to P C. Per Art. 9, t a $=$ C l cos. ϑ. Then from the similarity of the ellipses;

(*c*) t a : C l :: A cos. ϑ : A.

The product of the proportions (a) (b) (c) gives;

g d $\times$ s a $\times$ t a: h k $\times$ n l $\times$ C l :: A $A_{,}$ $B_{,}$ cos ϑ cos α: A^2 B :: cos ϑ: 1.

The last ratio is true because $A_{,}$ $B_{,}$ cos α $=$ A B.

In accordance with a demonstration in Art. 3, g d $\times$ s a $\times$ t a represents a mass at point a, that attracts particle P in direction P a the same as the mass cut from the ellipsoid by rotating chords e c and g d on axis P C; and h k $\times$ n l $\times$ C l represents a mass (m) from likewise rotating chords o p and h k.

Angle C a P equals $(90°-\alpha)$, and angle a C P equals $90°-(\vartheta-z)$. Let C P equal D. Then in triangle C a P, $Pa = D\frac{\cos(\vartheta-z).}{\cos\alpha}$

Attraction of mass $(m \cos\vartheta)$ in direction Pa on $P = \frac{m \cos\vartheta \cos^2\alpha}{D^2 \cos^2(\vartheta-z)}$

Attraction of mass in direction $P\,C = \frac{m \cos\vartheta \cos(\vartheta+y) \cos^2\alpha}{D^2 \cos^2(\vartheta-z)}$

In triangle C c g, Diagram 3.

$$\cos(\vartheta-z) = \frac{A \cos\vartheta}{A_{,}}$$

In triangle C $B_{,}$ g, Diagram 3.

$$\cos(\vartheta+y) = \frac{B \cos\vartheta}{B_{,}}.$$

$$\text{Attraction, etc.,} = \frac{M}{D^2} \times \frac{A_{,}^2 B \cos^2\alpha}{A^2 B_{,}}$$

$$A_{,}^2 B_{,}^2 \cos^2\alpha = A^2 B^2, \text{ or } \frac{A_{,}^2}{A^2} = \frac{B^2}{B_{,}^2 \cos^2\alpha}$$

In case then of an oblate ellipsoid,

Attraction of mass $(m \cos\vartheta)$ in direction P C on $P = \frac{m}{D^2} \times \frac{B^3}{B_{,}^3}$

Likewise for a prolate ellipsoid,

Attraction of mass $(m' \cos\vartheta)$ etc., $= \frac{m'}{D_{,}^2} \times \frac{A^3}{A_{,}^3}$

$$\frac{B^3}{B_{,}^3} = \frac{B^3}{B^3(1+E_{,}^2\sin^2\vartheta)^{\frac{3}{2}}} = (1+E_{,}^2\sin^2\vartheta)^{-\frac{3}{2}}$$

$$(1+E_{,}^2\sin^2\vartheta)^{-\frac{3}{2}} = 1 - \frac{3}{2}E_{,}^2\sin^2\vartheta + \frac{3.5}{2.4}E_{,}^4\sin^4 - \frac{3.5.7}{2.4.6}E_{,}^6\sin^6\vartheta + \text{etc.}$$

$$\frac{A^3}{A_{,}^3} = (1-E^2\sin^2\vartheta)^{-\frac{3}{2}} = 1 + \frac{3}{2}E^2\sin^2\vartheta + \frac{3.5}{2.4}E^4\sin^4\vartheta + \frac{3.5.7}{2.4.6}E^6\sin^6\vartheta + \text{etc.}$$

For oblate spheroid,

$$\text{Attraction of mass } (m \cos\vartheta)\&c = \frac{M}{D^2}(1 - \frac{3}{2}E_{,}^2\sin^2\vartheta + \frac{3.5}{2.4}E_{,}^4\sin^4\vartheta - \text{etc.}$$

For prolate ellipsoid,

$$\text{Attraction of mass } (m' \cos\vartheta)\&c. = \frac{M'}{D_{,}^2}(1 + \frac{3}{2}E^2\sin^2\vartheta + \frac{3.5}{2.4}E^4\sin^4\vartheta + \text{etc.}$$

12. In the above expressions for attraction any power of E or $E_{,}$ is a constant for any part or the whole of the same ellipsoid, while any power of $\sin\vartheta$ varies from 0 to 1. In case of the oblate ellipsoid having a constant semi minor axis (B) mass (m) varies as A^2, or as the mass of the whole ellipsoid till the ellipsoid becomes a sphere. The same relation is true of the

prolate spheroid. The coefficients, then, for eccentricity square, fourth power, etc., for the ellipsoid can be correctly computed from a sphere.

If we should represent the mass of the sphere by unity, and compute the fractional masses cut from the sphere by rotating a system of chords comprising an infinite number, extending from A to C and perpendicular to radius A C, and multiply each of the fractions by its requisite $\sin^2\vartheta$, the sum of the products would be the value for $\sin^2\vartheta$ for the whole of an ellipsoid. The same method is likewise true for computing the average value for any power of $\sin\vartheta$. Let $\sin^2\psi_2$, $\sin^4\psi_4$, $\sin^6\psi_6$, etc., be the average values for $\sin^2\vartheta$, $\sin^4\vartheta$, $\sin^6\vartheta$, etc., for the whole of a homegeneous ellipsoid with the attracted particle at the surface.

By using certain expedients wonderfully abbreviating the just described system of computation, I get the exact numerical values for $\sin^2\psi_2$, $\sin^4\psi_4$, $\sin^6\psi_6$, &c., and also for $\cos\psi_1$, $\cos^2\psi_2$, $\cos^3\psi_3$, &c. Which are:

$$^*\text{Sin}^2\psi_2 = \frac{2}{5}.$$

$$\text{Sin}^4\psi_4 = \frac{2.\ 4}{5.\ 7}.$$

$$\text{Sin}^6\psi_6 = \frac{2.\ 4.\ 6}{5.\ 7.\ 9}.$$

$$\text{Sin}^8\psi_8 = \frac{2.\ 4.\ 6.\ 8}{5.\ 7.\ 9.\ 11},\ \text{\&c. for higher powers.}$$

$$\text{Cos}\,\psi_1 = \frac{3}{4}.$$

$$\text{Cos}^2\psi_2 = \frac{3}{5}.$$

$$\text{Cos}^3\psi_3 = \frac{3}{6}.$$

$$\text{Cos}^4\psi_4 = \frac{3}{7}\ \text{\&c. for higher powers.}$$

The expression for the attraction of the whole mass (M) of an oblate ellipsoid on a particle at the pole reduces to:

$$\frac{M}{B^2}\left(1 - \frac{3}{5}E_{\prime}^{2} + \frac{3}{7}E_{\prime}^{4} - \frac{3}{9}E_{\prime}^{6} + \text{etc}\right).$$

The expression, &c., for the prolate ellipsoid becomes:

$$\frac{M'}{A^2}\left(1 + \frac{3}{5}{}^2E + \frac{3}{7}E^4 + \frac{3}{9}E^6 + \text{etc}\right).$$

13. Let $\frac{B}{D}$ or $\frac{A}{D}$ be represented by n. Since in a right angled triangle having a constant perpendicular while its hypothneuse and base increase in length, the sine of the angle at the base diminishes as the hypothenuse increases, and as each and all the angles ϑ that make up the angle ψ_2 are

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*How these results are obtained is fully explained in the investigations on the subject referred to at the beginning of this paper.

from right angled triangles that have a common hypothenuse and each continues to have the same length of perpendicular as hypothenuse increases, therefore $\sin^2 \psi_2$ representing the average of all the $\sin^2 \vartheta$ varies as n^2. It can be shown likewise for $\sin^4 \psi_4$, etc., which represent the averages of all $\sin^4 \vartheta$, etc., that they vary as n^4, n^6, etc.

The expression, then, for the attraction of an oblate ellipsoid on a particle outside the pole is:

$$\frac{M}{D^2}\left(1-\frac{3}{5}n^2\ E_{,}^2+\frac{3}{7}\ n^4\ E_{,}^4-\frac{3}{9}\ n^6\ E_{,}^6+\text{etc.}\right)$$

The expression, etc., for prolate ellipsoid is:

$$\frac{M}{D_{,}^2}\left(1+\frac{3}{5}n^2E^2+\frac{3}{7}n^4E^4+\frac{3}{9}n^6\ E^6+\text{etc.}\right)$$

IV.

OUTSIDE ELLIPSOIDAL ATTRACTION IN PLANE OF THE EQUATOR.

First.—An oblate ellipsoid and an outside particle in plane of the equator attract each other directly as product of mass of particle into mass of ellipsoid multiplied by $(1+\frac{1}{2}\times\frac{3}{5}\ n^2 E^2+\frac{3}{2.4}\times\frac{3}{7}\ n^4\ E^4+\frac{3.5}{2.4.6}\times\frac{3}{9}\ n^6\ E^6+\text{etc.})$ *and inversely as square of distance from center of ellipsoid to particle.*

Second.—A prolate ellipsoid and an outside particle in the plane of the equator attract each other directly as product of mass of particle into mass of ellipsoid multiplied by $(1-\frac{1}{2}\times\frac{3}{5}\ n^2\ E_{,}^2+\frac{3}{2.4}\times\frac{3}{7}n^4\ E_{,}^4-\frac{3.5}{2.4.6}\times\frac{3}{9}\ n^6\ E_{,}^6+\text{etc.})$, *and inversely as square of distance.*

14. This article finds a method of dividing an ellipsoid into an infinite number of wedges equal each to each, where the edges of the wedges are in an equatorial diameter.

In Diagram 5 let AB AB be a section of ellipsoid passing through the center of the ellipsoid and at rightangles to an equatorial diameter. Draw lines C a, C a^1, C a^2, etc., so that angles A C a, A C a^1, A C a^2, etc., can be represented by the alpha elliptic angles $\vartheta-z$, ϑ_1-z_1, ϑ_2-z_2, etc.; also draw lines C b, C b_1, C b_2, etc., so that angles B C b, B C b_1, B C b_2, etc., can be represented by the beta elliptic angles $\vartheta+y$, ϑ_1+y_1, ϑ_2+y_2, etc. When the elliptic angle becomes 45° then the z angle equals the y angle.

In Diagram 3 angle A C c or C c g corresponds to angle A C a of Dia. 5, and angle A C l or C l g of Dia. 3, to angle B C b of Dia. 5. In triangles C c g and C l g (Dia. 3), $c\,g = A \cos \vartheta$, and $l\,g = \frac{B^2}{A} \cos \vartheta$.

$\tan C\,c\,g : \tan C\,l\,g :: \frac{B^2}{A} \cos \vartheta : A \cos \vartheta :: B^2 : A^2$, or $\tan A\,C\,a : \tan B\,C\,b$ $:: B^2 : A^2$.

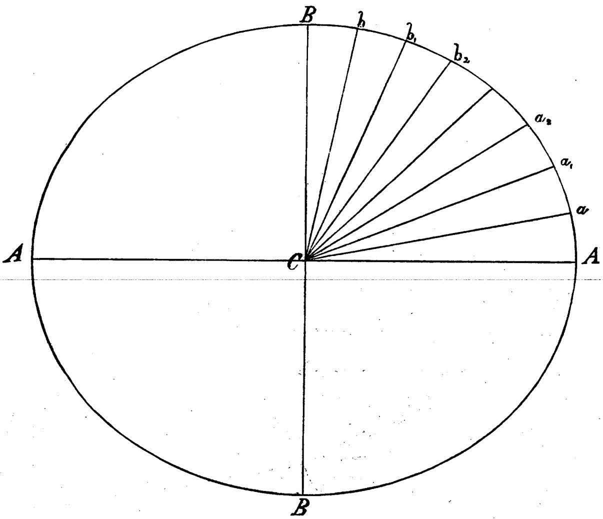

Diagram 5.

When the angles A C a and B C b become infinitesimal they are to each other as their tangents. Therefore infinitesimal angle A C a : angle B C b :: $B^2 : A^2$

The volume, then, of the wedge of the elipsoid measured by $A \times A^2 \times \frac{\text{ang. A Ca}}{360°}$ equals that measured by $A \times B^2 \times \frac{\text{ang. B Cb}}{360°}$ in case of the oblate ellipsoid. Likewise obtained, in the case of the prolate ellipsoid: $B \times A^2 \times \frac{\text{ang. A Ca}}{360°} = B \times B^2 \times \frac{\text{ang. B Cb}}{360°}$.

In Diagram 6 let A B A B be an ellipse having semi diameter C $B_{,}$ equal to $(B_{,})$, and $B_{,}$ $b_{,}$ $B_{,}$ $b_{,}$ a similar ellipse having C $B_{,}$ equal to $(a_{,})$, also let $B_{,}$ a $B_{,}$ be a circle with radius C $B_{,}$. From any point P in line C $B_{,}$ produced, draw tangent lines P $A_{,,}$, Pa, $Pb_{,,}$, and from points of tangency $A_{,,}$, a, and $b_{,,}$, draw $CA_{,,}$ Ca, and $Cb_{,,}$ Draw C $B_{,,}$ parallel to $A_{,,}$ P, and $Ca_{,,}$ parallel to $b_{,,}$ P. Then C $A_{,,}$ $(A_{,,})$ and C $B_{,,}$ $(B_{,,})$ are semi conjugate diameters in the one ellipse, and C $b_{,,}$ $(b_{,,})$ and $Ca_{,,}$ $(a_{,,})$ are corresponding semi conjugate diameters in the other.

Form points $A_{,,}$, a, and $b_{,,}$, draw ordinates to diameter $B_{,}$ $B_{,}$. These ordinates intersect diameter $B_{,}$ $B_{,}$ in a common point g, and C a g is an elliptic angle. a $g = B_{,} \cos \vartheta$, $A_{,,}$ $g = A_{,} \cos \vartheta$, and $b_{,,}$ $g = \frac{B_{,}^2}{A_{,}} \cos \vartheta$.

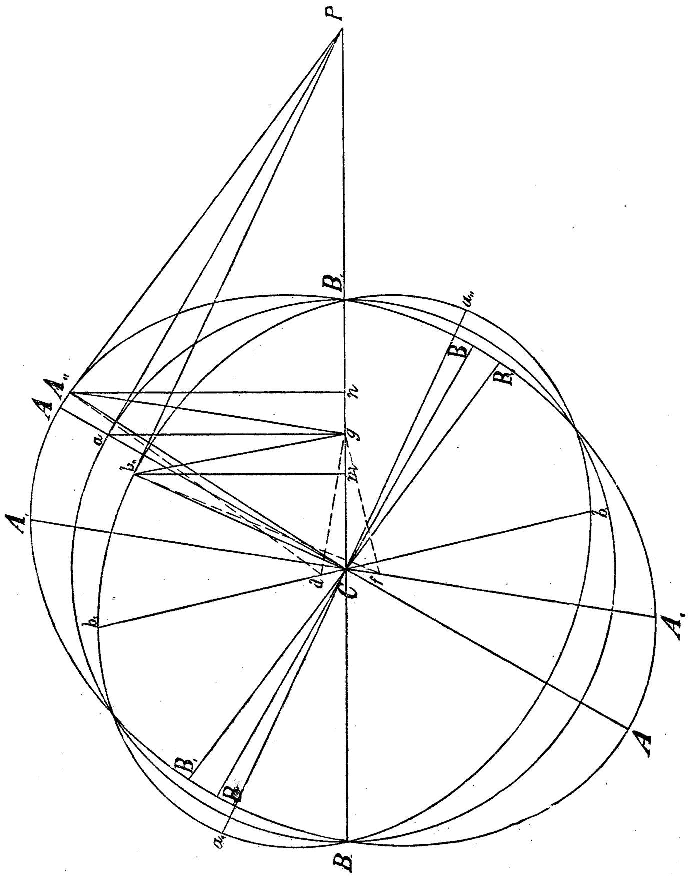

Diagram 6.

The ordinate $A_{,,}$ g being parallel to to $A_{,}$ C ($A_{,}$), the angle C $A_{,,}$ g is equal to the angle $A_{,}$ C $A_{,,}$ or the angle that $A_{,}$ makes with $A_{,,}$. Also $b_{,,}$ g being parallel to $b_{,}$ $C_{,}$ the angle C $b_{,,}$ g is equal to the angle that $b_{,}$ makes with $b_{,,}$.

Draw $A_{,,}$ n and $b_{,,}$ m perpendicular to diameter $B_{,}$ $B_{,}$. Then 90° plus or minus the angle g $b_{,,}$ m or g $A_{,,}$ n (α) equals the angle that $A_{,}$ makes with $B_{,}$. Draw g d and g f each equal in length to g C, having angles d g C and f g C each equal to angle α. Then from the right angled triangles d $A_{,,}$ g and f $b_{,,}$ g having perpendicular d g equal to f $g_{,}$:

$$\tan d A_{,,} g : \tan f b_{,,} g : : \frac{B_{,}^2}{A_{,}} \cos \vartheta : A_{,} \cos \vartheta : : B_{,}^2 : A_{,}^2.$$

When angle ϑ becomes infinitesimal points d and f coincide with point C, and angle d $A_{\prime\prime}$g equals C $A_{\prime\prime}$g, and f $b_{\prime\prime}$g equals C $b_{\prime\prime}$g. Therefore infinitesimal angles C $A_{\prime\prime}$g: C $b_{\prime\prime}$g :: $B_{\prime}^2$: $A_{\prime}^2$

Form Art. 10,

$A_{\prime}^2 = A^2 - (A^2 - B^2) \sin^2 \vartheta.$

$B_{\prime}^2 = B^2 + (A^2 - B^2) \sin^2 \vartheta.$

Then $A_{\prime}^2 + B_{\prime}^2 = A^2 + B^2.$

Angle C $A_{\prime\prime}$g represents any of the angles a C $a_{\prime}$, $a_{\prime}$ C a_2 etc., and C $b_{\prime\prime}$g, any of the corresponding angles b C $b_{\prime}$, $b_{\prime}$ C b_2, etc., of Dia. 5. The volume of infinitesimal wedge then from an oblate ellipsoid measured by $A \times A_{\prime}^2 \times \frac{\text{Ang. a C a}_{\prime}}{360^\circ}$ equals that measured by $A \times B_{\prime}^2 \times$ Ang. $\frac{\text{b C b}_{\prime}}{360^\circ}$

As $A_{\prime}^2 + B_{\prime}^2 = A^2 + B^2$, the iufinitesimal wedges of prolate ellipsoids, the sums of which make up the oblate ellipsoid are equal, each to each, in volume. The same can likewise be proved of wedges of a prolate ellipsoid.

15. To find, for any even power, an expression for the average of the eccentricities of all the infinitesimal wedges composing an ellipsoid, with edges in an equatorial diameter.

The edges of the elliptic wedges have a common semi-axis A and the other semi-axis varies from A to B as $A_{\prime}$ or $B_{\prime}$ vary from A to B.

$B_{\prime}$ for angle ϑ equals $A_{\prime}$ for angle $(90^\circ - \vartheta)$.

Eccentricity $\frac{A^2 - A_{\prime}^2}{A^2} = \frac{A^2 - B^2}{A^2} \sin^2\vartheta = E^2 \sin^2\vartheta = E^2 \cos^2(90^\circ - \vartheta).$

Eccentricity $\frac{A^2 - B_{\prime}^2}{A^2} = \frac{A^2 - B^2}{A^2} \cos^2\vartheta = E^2 \cos^2\vartheta = E^2 \sin^2(90^\circ - \vartheta).$

$$\frac{A^2 - A_{\prime}^2}{A^2} + \frac{A^2 - B_{\prime}^2}{A^2} + \frac{A^2 - A_2^2}{A^2} + \frac{A^2 - B_2^2}{A^2} + \frac{A^2 - A_3^2}{A^2} + \frac{A^2 - B_3^2}{A^2} + \&\text{c. to } 45^\circ,$$

Divided by the number of wedges equals,

$E^2(\sin^2\vartheta + \cos^2\vartheta + \sin^2\vartheta_{\prime} + \cos^2\vartheta_{\prime} + \sin^2\vartheta_2 + \cos^2\vartheta_2 + \&\text{c to } 45^\circ)$,

divided by the number of wedges.

Trigonometry gives:

$\sin^2 \vartheta = \frac{1}{2} - \frac{1}{2} \cos 2 \vartheta.$

$\cos^2 \vartheta = \frac{1}{2} + \frac{1}{2} \cos 2 \vartheta.$

$$\frac{\sin^2 \vartheta + \cos^2 \vartheta}{2} = \frac{1}{2} = \sin^2 45^\circ = \cos^2 45.^\circ$$

The value $\frac{1}{2}$ is true for any pair of wedges. It is therefore the true value for the coefficient of E^2 in the expression $E^2 \sin^2 \vartheta$ which gives $\frac{1}{2} E^2$ for the average eccentricity squared of all wedges.

$\frac{(A^2 - A_{\prime}^2)^2}{A^4} + \frac{(A^2 - B_{\prime}^2)^2}{A^4}$ + etc., to ϑ for $45_{\prime}^\circ$ divided by number of wedges, equals $E^4 (\sin^4 \vartheta + \cos^4 \vartheta)$ + etc., to ϑ for $45_{\prime}^\circ$ divided by number of wedges.

$$\sin^4 \vartheta = \frac{1}{2^2} - \frac{1}{2} \cos 2\vartheta + \frac{1}{2^2} \cos^2 2\vartheta.$$

$$\cos^4 \vartheta = \frac{1}{2^2} + \frac{1}{2} \cos 2\vartheta + \frac{1}{2^2} \cos^2 2\vartheta.$$

$$\frac{\sin^4 \vartheta + \cos^4 \vartheta}{2} = \frac{1}{2^2} + \frac{1}{2^2} \cos^2 2\vartheta.$$

The first term $\left(\frac{1}{2^2}\right)$ of the above result is true for any value given to ϑ from 0° to 45°; therefore $\frac{1}{2^2}$ is the average for that term. It is now required to find the average of the succession of terms, $\frac{1}{2^2} \cos^2 2\vartheta + \frac{1}{2^2} \cos^2 2\vartheta_{,} + \frac{1}{2^2} \cos 2\vartheta_{,,}$ + etc., to ϑ for 45°. When ϑ becomes 45°, 2ϑ becomes 90°; therefore these terms can be put in shape as follows: $\frac{1}{2^2}[\cos^2 2\vartheta + \cos^2 (90° - 2\vartheta) + \cos^2 2\vartheta_{,} + \cos^2 (90° - 2\vartheta_1) + \cos^2 2\vartheta_2 + \cos^2 (90° - 2\vartheta_2) +$ etc., to 2ϑ equal 45°], divided by the number of terms. The average value, then, for $\cos^2 2\vartheta$ is $\frac{1}{2}$. The average value of

$$\frac{1}{2^2} + \frac{1}{2^2} \cos^2 2\vartheta = \tfrac{1}{4} + \tfrac{1}{4} \times \tfrac{1}{2} = \tfrac{3}{8} = \frac{3}{2.4}$$

By like computation the average value of

$$\frac{\text{Sin}^6 \vartheta + \cos^6 \vartheta}{2} = \frac{1}{2^3} + \frac{3}{2^3} \cos^2 2\vartheta = \frac{15}{48} = \frac{3.5}{2.4.6}.$$

$$\frac{\text{Sin}^8 \vartheta + \cos^8 \vartheta}{2} = \frac{3.5.7}{2.4.6.8}.$$

$$\frac{\text{Sin}^{10} \vartheta + \cos^{10} \vartheta}{2} = \frac{3.5.7.9}{2,4.6.8.10},\ \text{etc., for higher powers.}$$

For each of the infinitisimal wedges of an oblate ellipsoid, mass and distance squared are constant factors. The expression then for the attraction of an oblate ellipsoid on a particle outside in the plane of the equator is:

$$\frac{M}{D^2}\left(1 + \frac{1}{2} \times \frac{3}{5} n^2 E^2 + \frac{3}{2.4} \times \frac{3}{7} n^4 E^4 + \text{etc.}\right).$$

For a prolate ellipsoid, etc.:

$$\frac{M'}{D_{,}^2}\left(1 - \frac{1}{2} \times \frac{3}{5} n^2 E_{,}^2 + \frac{3}{2.4} \times \frac{3}{7} n^2 E_{,}^2 - \text{etc.}\right).$$

V.

COMPARISON OF ATTRACTION AT POLE AND EQUATOR, AND ATTRACTION OF CONFOCAL ELLIPSOIDS.

First. *On an oblate ellipsoid the attraction at the pole exceeds that at the equator by* $\frac{M}{A^2}\left(\frac{1}{10}E^2 + \frac{19}{280}E^4 + \frac{27}{560}E^6 + \frac{163}{4480}E^8 + {}_{\prime\prime}\right)$ or by $\frac{M}{A^2}\left(\frac{1}{5}h + \frac{6}{35}h^2 + \frac{4}{35}h^3 + \frac{1}{14}h^4 + {}_{\prime\prime}\right)$

Second. *On a prolate ellipsoid the attraction at the equator exceeds that at the pole by* $\frac{M}{A^2}\left(\frac{1}{10}E^2 + \frac{37}{280}E^4 + \frac{229}{1680}E^6 + {}_{\prime\prime}\right)$ or by $\frac{M}{A^3}\left(\frac{1}{5}h + \frac{3}{7}h^2 + {}_{\prime\prime}\right)$

Third. *Confocal ellipsoids having foci at same points attract an outside particle in line of poles or plane of the equators directly as their masses.*

In the above enunciations h equals $\frac{A-B}{A}$ or E^2 equals h (2—h).

16. The expression for the attraction at the pole of an oblate ellipsoid is

$$\frac{M}{B^2}\left(1 - \frac{3}{5}E_{,} + \frac{3}{7}E_{,}^{4} - \frac{3}{9}E_{,}^{6} + \text{etc.}\right)$$ By substituting.

$\frac{E^2}{1-E^2}$ for $E_{,}^{2}$ and $A^2(1-E^2)$ for B^2, the expression becomes,

$$\text{(a)}\quad \frac{M}{A^2}\left(1 + \frac{2}{5}E^2 + \frac{2.4}{5.7}E^4 + \frac{2.4.6}{5.7.9}E^6 + \text{etc.}\right)$$

The expression for the same oblate ellipsoid at the equator is:

$$\text{(b)}\quad \frac{M}{A^2}\left(1 + \frac{1}{2}\times\frac{3}{5}E^2 + \frac{3}{2.4}\times\frac{3}{7}E^4 + \frac{3.5}{2.4.6}\times\frac{3}{9}E^6 + \text{etc.}\right)$$

Subtract expression (b) from (a) and the difference is:

$$\frac{M}{A^2}\left(\frac{1}{10}E^2 + \frac{19}{280}E^4 + \frac{27}{560}E^6 + \frac{163}{4480}E^8 + {}_{\prime\prime}\right)$$

By substituting as above for $E^2_{,}$ and for B^2, the expression for the prolate ellipsoid at the equator becomes:

$$\text{(c)}\quad \frac{M}{A^2}\left(1 + \frac{7}{10}E^2 + \frac{157}{280}E^4 + \frac{263}{560}E^6 + {}''\right)$$

The expression for Pole is:

$$\text{(d)}\quad \frac{M}{A^2}\left(1 + \frac{3}{5}E^2 + \frac{3}{7}E^4 + \frac{3}{9}E^6 + \text{etc.}\right)$$

$$\frac{M}{A^2}\left(\frac{1}{10}E^2 + \frac{37}{280}E^4 + \frac{229}{1680}E^6 + {}''\right)$$

equals difference.

17. To find the relation in law of attraction existing between two confocal ellipsoids having the same foci on a particle outside of both and in line of poles or plane of equator.

Let the semi major and the semi minor axes in the one be represented by a and b, and in the other by A and B.

$$e_{,}^{2}=\frac{a^2-b^2}{b^2}$$

$$E_{,}^{2}=\frac{A^2-B^2}{B^2}$$

$$e_{,}^{2} : E_{,}^{2} :: \frac{a^2-b^2}{b^2} : \frac{A^2-B^2}{B^2}$$

Since the ellipsoids are confocal.

$$a^2-b^2=A^2-B^2.$$

(a) $e_{,}^{2} : E_{,}^{2} :: \frac{1}{b^2} : \frac{1}{B^2}.$

(b) $e_{,}^{4} : E_{,}^{4} :: \frac{1}{b^4} : \frac{1}{B^4}$, etc. for higher powers.

It is evident from construction of right angled triangle Pa C in Dia. 4 that any sin ϑ for ellipsoid having ecentricity $e_{,}^{2}$ is to corresponding sin ϑ for ellipsoid having eccentricity $E_{,}^{2}$ as b to B. therefore

(c) $\sin^2 \vartheta : \sin^2 \vartheta_{,} :: b^2 : B^2$

(d) $\sin^4 \vartheta :: \sin^4 \vartheta'_{,} : b^4 : B_{,}^{4}$ etc. for higher powers.

Product of (a) and (c) is,

$$e_{,}^{2} \sin^2 \vartheta : E_{,}^{2} \sin^2 \vartheta_{,} :: \frac{b^2}{b^2} : \frac{B^2}{B^2} :: 1 : 1.$$

Product of (b) and (d) is,

$$e_{,}^{4} \sin^4 \vartheta : E_{,}^{4} \sin^4 \vartheta_{,} :: \frac{b^4}{b^4} : \frac{B^4}{B^4} : 1 : 1.$$

etc. for higher powers.

$$e_{,}^{2} \sin^2 \vartheta + e_{,}^{4} \sin^4 \vartheta + \text{etc} : E_{,}^{2} \sin^2 \vartheta_{,} + E_{,}^{4} \sin^4 \vartheta'_{,} + \text{etc.} :: 1 : 1.$$

This proves that confocal oblate ellipsoids attract an outside particle in line of poles directly as their masses.

Likewise it can be proven that confocal prolate ellipsoids in line of axis of rotation attract in conformity with law of masses.

As an ellipsoid can be made up of infinitesimal ellipsoidal wedges with edges in an equatorial diameter, confocal ellipsoids attract an outside particle in plane of equators as their masses.

It is evident that this law holds true for confocal ellipsoids made up of laminae varying in density from lamina to lamina providing corresponding laminae of each ellipsoid are of same density.

VI.

OUTSIDE ELIPSOIDAL ATTRACTION IN ANY DIRECTION.

First. — An oblate ellipsoid and any outside partiele attract each other directly as product of mass of particle into mass of ellipsoid multiplied by $[1-\frac{3}{5}\,n^2\,E^2\,(1-\frac{3}{2}\sin^2 O)-\frac{3}{5}E^4\,(n^2-\frac{5}{7}\,n^4+\frac{3}{5}\sin^2 O-\frac{3}{5}\sin^4 O-4n^2\sin^2 O+3n^2\sin^4 O+\frac{187}{70}\,n^4\sin^2 O-\frac{89}{40}\,n^4\sin^4 O)+{}_{\shortparallel}]$ *and inversely as square of distance from center of ellipsoid.*

Second — The sine of the angle made by the direction of the resultant attraction, and the direction from the particle to the center of the ellipsoid equals $\frac{3}{5}\,n^2\,E^2\sin O\cos O\,[1+E^2\,(\frac{3}{2}-2\sin^2 O-\frac{4}{7}\,n^2+\frac{23}{20}\,n^2\sin^2 O)+{}_{\shortparallel}]$.

Third — The increase in attraction on an oblate ellipsoid from the equator to the poles true to the fourth power of eccentricilty varies as the square of the sine of the elliptic angle.

In the above enunciations, n equals $B_{,}$ divided by D (distance), and O represents the elliptic angle used to find $B_{,}$.

18. To find an expression for the attraction on any outside particle, of any two opposite infinitesimal wedges of an ellipsoid with the edges in the diameter extending in direction to the particle.

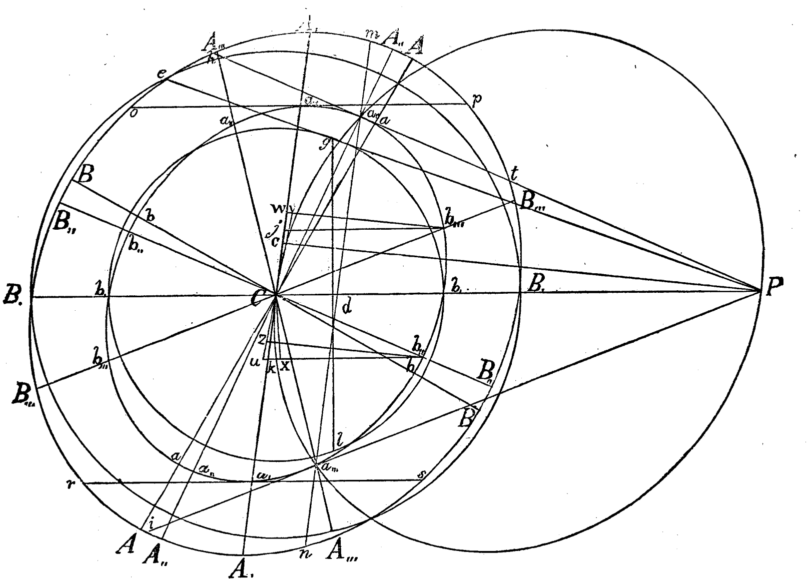

Diagram 7.

In diagram 7 let $B_{,}$ $B_{,}$ be the diameter of the ellipsoid extending in direction to the outside particle (P), A A and B B being the principal axes of the ellipsoid. This elliptic section rotated on axis $B_{,}$ $B_{,}$ through an infinitesimal angle represents the two opposite wedges in the plane of the principal axes. With C as a center and a a and b b as principal axes describe an ellipse similar to one having axes A A and B B, also describe circles with radii C $b_{,}$ and C $B_{,}$. On C P as a diameter corresponding to $B_{,}$ $B_{,}$ as a diameter describe another similar ellipse. From P draw Ph and Pi tangent lines to the ellipse having axes a a and b b. Draw diameter $B_{,,}$ $B_{,,}$ or $b_{,,}$ $b_{,,}$ parallel to tangent Ph, also diameter $B_{,,,}$ $B_{,,,}$ or $b_{,,,}$ $b_{,,,}$ parallel to tangent Pi. Through the points of tangency $a_{,,}$ and the center C draw the diameter $A_{,,}$ $A_{,,}$ or $a_{,,}$ $a_{,,}$, then $A_{,,}$ $A_{,,}$ and $B_{,,}$ $B_{,,}$ or $a_{,,}$ $a_{,,}$ and $b_{,,}$ $b_{,,}$ are conjugate diameters. $A_{,,,}$ $A_{,,,}$ and $B_{,,,}$ $B_{,,,}$ or $a_{,,,}$ $a_{,,,}$ and $b_{,,,}$ $b_{,,,}$ are likewise conjugate diameters. Through the points of tangency $a_{,,}$ and $a_{,,,}$ draw line m n, and diameter $A_{,}$ $A_{,}$ parallel to m n, then $A_{,}$ $A_{,}$ and $B_{,}$ $B_{,}$ or $a_{,}$ $a_{,}$ and $b_{,}$ $b_{,}$ are conjugate diameters, and $a_{,,}$ d and $a_{,,,}$ d are equal ordinates. From P draw line Pe tangent to the circle having radius C $b_{,}$, and from point of tangency g draw line g d l; then line g l is perpendicular to diameter $B_{,}$ $B_{,}$ and a double ordinate.*

From known demonstrations of *Conic Sections,*

$g\,d : a_{,,}d :: b_{,} : a_{,} :: B_{,} : A_{,}$.

Draw radius g C and let angle C g d or its equal g P C be represented by ϑ. Then because $g\,d = b_{,} \cos\vartheta$, and $a_{,,}d = a_{,} \cos\vartheta$,

Thickness of elliptic wedge at $a_{,}$ is to that at $a_{,,}$ as $a_{,} : a_{,} \cos\vartheta$ or $1 : \cos\vartheta$.

Likewise thickness of wedge at $a_{,}$ is to that at $a_{,,,}$ as $1 : \cos\vartheta$.

Through $a_{,}$ and $a_{,}$ draw double ordinates o p and r s. These double ordinate are equal because they are equally distant from center C.

Per *Conic Sections,*

Chord o p : chord h t :: $B_{,} : B_{,,}$.

Chord r s : chord i f :: $B_{,} : B_{,,,}$.

Let α be the difference between a right angle and the angle C $a_{,}$ p or C $a_{,}$ s, also let b be the difference between a right angle and the angle C $a_{,,}$ t and $b_{,}$ that of a right angle and angle C $a_{,,,}$ f.

The differential width at $a_{,}$ corresponding to n l in Dia. 4 is to differential width at $a_{,,}$ corresponding to s a Dia. 4 as $A_{,} \cos\alpha : A_{,,} \cos b$.

Also the differential width at $a_{,}$ is to that at $a_{,,,}$ as $A_{,} \cos\alpha : A_{,,,} \cos b_{,}$

The product then of thickness at $a_{,}$ into length op into width at $a_{,}$ is to that of thickness at $a_{,,}$ into length h t into width at $a_{,,}$

$$\text{As} \left\{ \begin{array}{ccc} 1 & : & \cos\vartheta \\ B_{,} & : & B_{,,} \\ A_{,}\cos\alpha & : & A_{,,}\cos b \end{array} \right\} :: A_{,}B_{,}\cos\alpha : A_{,,}B_{,,}\cos\vartheta\cos b :: 1 : \cos\vartheta.$$

Because $A_{,}B_{,} \cos a$ equals $A_{,,}B_{,,} \cos b$ the last ratio above is true.

*These double ordinates and line P C should intersect at d.

Likewise the product of the thickness at $a_{,}$ into length r s into width at $a_{,}$ is to that of the thickness at $a_{,,,}$ into length i f into width at $a_{,,,}$.

$$\text{As} \left\{ \begin{array}{ccc} B_{,} & : & B_{,,,} \\ 1 & : & \cos \vartheta \\ A_{,} \cos \alpha & : & A_{,,,} \cos b_{,} \end{array} \right\} :: A_{,}B_{,} \cos \alpha : A_{,,,}B_{,,,} \cos b_{,} \cos \vartheta :: 1 : \cos \vartheta.$$

Mass-factor then at $a_{,}$ is to mass-factor at $a_{,,}$ or $a_{,,,}$ as $1 : \cos \vartheta$.

If in Diagram 7 conjugate diameters $A_{,}$ $A_{,}$ and $B_{,}$ $B_{,}$ were at right angles the chord element of mass and the wedge mass would be $\cos^2 \alpha_{,}$ to unity greater. Regardless of the law of variations of the angle $\alpha_{,}$ from wedge to wedge if we assume a homogenous solid made up of elliptic wedges having a common edge length of $B_{,}$ $B_{,}$, and limited in width by an ellipse with principal semi-axis A and $A_{,}$ having its plane in center C and at right angles to diameter $B_{,}$ $B_{,}$, then we have a volume that can be divided into infinitesimal wedges of equal masses in accordance with Art. 14. If the ellipsoid be divided into wedges having the same angular thicknesses as those of the assumed solid, then the mass of any wedge of the ellipsoid is to the mass of the corresponding wedge of the assumed solid as the square of the cosine of the α angle ($\cos^2 \alpha_{,}$) to unity. In the assumed solid let m represent the mass of the chord element, m that of the wedge and M, the mass of the whole solid; then in the ellipsoid $m \cos^2 \alpha_{,}$ is the mass of the chord element, m $\cos^2 \alpha_{,}$ that of the wedge. Let M be the mass of the ellipsoid.

Draw k $b_{,,}$ and j$b_{,,,}$ parallel to diameter $B_{,}$ $B_{,}$. As it was proven that $a_{,,}$d equals $a_{,}$ $\cos \vartheta$ so, by similar construction of diagram with radius of circle $a_{,}$ C, with a point $P_{,}$ in extension of diameter $A_{,}$ A' and with points of tangency corresponding to $a_{,,}$ and $a_{,,,}$ at $b_{,,}$ and $b_{,,,}$, it can be proven that k $b_{,,}$ and j $b_{,,,}$ each equals $b_{,}$ $\cos \vartheta$.

By construction angle C$b_{,,}$ k equals angle $a_{,,}$ P C, and C$b_{,,,}$ j equals $a_{,,,}$ PC. Angle $b_{,,}$ k C and $b_{,,,}$ j C each varies from a right angle by the angle α. Let angle $a_{,,}$ P C be represented by $\vartheta + u$, and $a_{,,,}$P C by $\vartheta - v$,

$$a_{,,} P = \frac{D \sin a_{,,} C P.}{\cos b}$$

From $a_{,,}$ conceive a perpendicular drawn to diameter $B_{,}$ $B_{,}$. In construction then we have a right angled triangle with hypothenuse C$a_{,,}$ or $a_{,,}$ and with perpendicular equal to $a_{,}$ $\cos \vartheta \cos \alpha$, in which

$$\sin a_{,,} C P = \frac{a' \cos \vartheta \cos \alpha}{a_{,,}} = \frac{A_{,} \cos \vartheta \cos \alpha}{A_{,,}}$$

$$a_{,,} P = \frac{D A' \cos \vartheta \cos \alpha}{A_{,,} \cos b}.$$

Likewise,

$$A_{,,,} P = \frac{D A_{,} \cos \vartheta \cos \alpha}{A_{,,,} \cos b_{,}}$$

Draw line P c making an angle ($\alpha \pm z$) with P C, and let P c be the resultant direction of attraction for the two opposite chord elements. Draw line v C u making angle u C k or v C w equal to angle z; and draw lines

$b_{,,,}$ v and $b_{,,}$ z parallel to Pc. Then right angled triangle $b_{,,,}$ v C has angle C $b_{,,,}$ v equal to $\vartheta - v + (\alpha \pm z)$; and right angled triangle $b_{,,}$ z C has angle C $b_{,,}$ z equal to $\vartheta + u - (\alpha \pm z)$. Produce line $b_{,,}$ k to u, $b_{,,}$ z u is a right angled triangle. In triangle u C k angle C k u equals $90° + \alpha$, angle k C u equals z and C u k equals $90° - (\alpha \pm z)$.

$$\text{Side u k} = \frac{A_{,} \sin \vartheta \sin z}{\cos (\alpha \pm z)}$$

$$b_{,,}\, u = B_{,} \cos \vartheta + \frac{A_{,} \sin \vartheta \sin z}{\cos (\alpha \pm z)}$$

$$b_{,,}\, z = B_{,} \cos \vartheta \cos (\alpha \pm z) + A_{,} \sin \vartheta \sin z.$$

Likewise,

$$b_{,,,}\, v = B_{,} \cos \vartheta \cos (\alpha \pm z) - A_{,} \sin \vartheta \sin z.$$

In triangle $b_{,,}$ z C,

$$\cos\ [\vartheta + u - (\alpha \pm z)] = \frac{B_{,} \cos \vartheta \cos (\alpha \pm z) + A_{,} \sin \vartheta \sin z}{B_{,,}}$$

In triangle $b_{,,,}$ v C,

$$\cos\ [\vartheta - v + (\alpha \pm z)] = \frac{B_{,} \cos \vartheta \cos (\alpha \pm z) - A_{,} \sin \vartheta \sin z}{B_{,,,}}.$$

$$\text{Let } E^2 = \frac{A_{,}^2 - B_{,}^2}{B_{,}^2}$$

$$A_{,} = B_{,} \sqrt{1 + E^2}$$

$$\cos\ [\vartheta + u - (\alpha + z)] = \frac{B_{,} \cos \vartheta\ [\cos (\alpha \pm z) + \sqrt{1 + E^2} \tan \vartheta \sin z}{B_{,,}}$$

Let $l = \cos (\alpha \pm z)$, and $n = \sqrt{1 + E^2} \tan \vartheta \sin z$.

For mass ($m \cos \vartheta \cos^2 \alpha$) at $a_{,,}$ in direction Pc on particle P.

$$\text{Attraction} = \frac{m \cos^2 \alpha\, A^2_{,,}\, B_{,} \cos^2 b \cos^2 \vartheta\ (l + n)}{D^2\, A_{,}^2\, B_{,,} \cos^2 \vartheta \cos^2 \alpha} = \frac{m\, A_{,,}^2\, B_{,} \cos^2 b\, (l + n)}{D^2 A_{,}^2 B_{,,}}$$

$$A_{,,}^2 = \frac{A_{,}^2\, B_{,}^2 \cos^2 \alpha}{B_{,,}^2 \cos^2 b}.$$

$$\text{Att., etc., then} = \frac{m\, B_{,}^3\, (l + n) \cos^2 \alpha}{D^2\, B_{,,}^3}.$$

Likewise for mass ($m \cos \vartheta \cos^2 \alpha$) at $a_{,,,}$ in direction Pc on particle P

$$\text{Att.} = \frac{m\, B_{,}^3\, (l - n) \cos^2 \alpha}{D^2\, B^3_{,,,}}$$

Draw C X perpendicular to $b_{,,}$ u, and draw a line from C perpendicular to $b_{,,,}$ j produced. In right angled triangle $b_{,,}$ X C, or in a right angled triangle similar having hypotheuuse $B_{,,}$ C instead of $b_{,,}$ C,

Side for C X = $A_{,} \sin \vartheta \cos \alpha$.
Side for $b_{,,}$ X = $B_{,} \cos \vartheta - A_{,} \sin \vartheta \sin x$.

Hyp. $B_{,,}^2 = B_{,}^2 \cos^2 \vartheta + A_{,}^2 \sin^2 \vartheta \sin^2 \alpha + A_{,}^2 \sin^2 \vartheta \cos^2 \alpha - 2 A_{,} B_{,} \sin \vartheta \cos \vartheta \sin \alpha$.

$$= B_{,}^2 \left[1 + E^2 \sin^2 \vartheta - 2\sqrt{1+E^2} \sin \vartheta \cos \vartheta \sin \alpha\right]$$

Likewise,

$$B_{,,,}^2 = B_{,}^2 [1 + E_{,}^2 \sin^2 \vartheta + 2\sqrt{1+E^2} \sin \vartheta \cos \vartheta \sin \alpha].$$

Let $s = E^2 \sin^2 \vartheta$, and $t = 2\sqrt{1+E^2} \sin \vartheta \cos \vartheta \sin \alpha$. By substitution and reduction.

$$\text{Att. etc., at } a_{,,} = \frac{m\,(1+n) \cos^2 \alpha}{D^2 [1 + (s-t)]^{\frac{3}{2}}}$$

$$\text{Att. etc., at } a_{,,,} = \frac{m\,(1-n) \cos^2 \alpha}{D^2 [1 + (s+t)]^{\frac{3}{2}}}$$

$$\frac{1+n}{[1+(s-t)]^{\frac{3}{2}}} = (1+n)[1 - \tfrac{3}{2}\,(s-t) + \frac{3.5}{2.4}(s-t)^2 - \text{etc}].$$

$$= (1+n)\,(1 - \tfrac{3}{2}\,s + \tfrac{3}{2}t + ,,).$$

For mass at $a_{,,}$ in direction pc on p.

$$\text{Att.} = \frac{m\,(1+n) \cos^2 \alpha}{D^2}\,(1 - \tfrac{3}{2}\,s \pm \tfrac{3}{2}\,t + ,,).$$

For mass at $a_{,,,}$ etc.

$$\text{Att.} = \frac{m\,(1-n) \cos^2 \alpha}{D^2}\,(1 - \tfrac{3}{2}\,s - \tfrac{3}{2}\,t + ,,).$$

Multiply the first series by $(1+n)$ and the second by $(1-n)$ and divide the sum of the results by two and we get

$$\text{Average Att.} = \frac{m \cos^2 \alpha}{D^2}(1 - \frac{3}{2}\,ls + \frac{3}{2}nt + \frac{3.5}{2.4}\,ls^2 + \frac{3.5}{2.4}\,lt^2 - \frac{3.5}{4}\,nst - ,,).$$

$$l = \cos(\alpha \pm z) = 1 - \tfrac{1}{2}\sin^2(\alpha \pm z) - \frac{1}{2.4}\sin^4(\alpha \pm z) - \text{etc.}$$

Replacing the values of l, s, n and t,

$$(a.)\ \text{Att.} = \frac{m \cos^2 \alpha}{D^2}\Big[1 - \frac{3}{2}\,E^2 \sin^2 \vartheta + \frac{3.5}{2.4}E^4 \sin^4 \vartheta + \frac{3.5}{2}\sin^2 \vartheta \sin^2 \alpha - \frac{3.5}{2}\sin^4$$

$$\vartheta \sin^2 a \pm 3 \sin^2.$$

$$\vartheta \sin \alpha \sin z - \frac{1}{2}\sin^4(\alpha \pm z) - \frac{3.\ 4.\ 5.}{2.\ 5.\ 7.}E^6 \sin^6 \vartheta + ,, \Big].$$

Let $(a+y)$ be the angle that line PC makes with the resultant direction of attraction for the two opposite wedges, then any two corresponding opposite chord elements contribute in the attraction of the two opposite wedges.

$$(b.)\text{Att.} = \frac{m \cos^2 \alpha}{D^2}\Big[1 - \frac{3}{2}\,E^2 \sin^2 \vartheta + \frac{3.5}{2.4}\,E^4 \sin^4 \vartheta + \frac{3.5}{2}\sin^2 \vartheta \sin^2 \alpha -$$

$$\frac{3.5}{2}\sin^4 \vartheta \sin^2 \alpha \pm 3 \sin^2 \vartheta \sin\alpha \sin y - \frac{1}{2}\sin^2(a \pm y) - \frac{3.5.7}{2.4.6}\,E^6 \sin^6 \vartheta + ,, \Big]$$

In the above expression (b), for the two opposite wedges, angles α and $(\alpha \pm y)$ as well as eccentricity E are constant quantities. In accordance then with the expedient of Art. 12 for summation, an expression for the attraction of the two opposite infinitesimal wedges on particle P is found by putting

$$\text{Sin}^2 \vartheta = \frac{2}{5} n^2.$$

$$\text{Sin}^4 \vartheta = \frac{2.\ 4}{5.\ 7} n^4.$$

$$\text{Sin}^6 \vartheta = \frac{2.\ 4.\ 6}{5.\ 7.\ 9} n^6. \text{ Etc., for higher power .}$$

For the two opposite wedges in the plane of the principal axes of the ellipsoid on particle P,

$$\text{Att.} = \frac{m \cos^2 \alpha}{D^2} \left[1 - \frac{3}{5} n^2 E^2 + \frac{3}{7} n^4 E^4 + 3 n^2 \sin^2 \alpha - \frac{12}{7} n^4 \sin^2 \alpha \pm \frac{6}{5} n^2 \sin \alpha \sin y - \frac{1}{2} \sin^2 (\alpha \pm y) - \frac{3}{9} n^6 E^6 + {}_{''} \right]$$

In any two opposite wedges let $E_{,}$ represent the excentricity and angle $(\alpha_{,} + y_{,})$, the direction of the resultant, then for any two opposite wedges:

$$\text{Att} = \frac{m \cos^2 \alpha_{,}}{D^2} \left[1 - \frac{3}{5} n^2 E_{,} + {}'' \right]$$

$$\text{(c)} \quad \text{Att} = \frac{m}{D^2} \left[1 - \frac{3}{5} n^2 E_{,}^2 + \frac{3}{7} n^4 E_{,}^4 - \sin^2 \alpha_{,} + 3n^2 \sin^2 \alpha_{,} - \frac{12}{7} n^4 \sin^2 a_{,} \pm \frac{6}{5} n^2 \sin a_{,} \sin y_{,} - \frac{1}{2} \sin^2 (\alpha \pm y) - \frac{3}{9} n^6 E_{,}^6 + {}_{''} \right]$$

19. To find an expression for angle α, and for the eccentricity $E_{,}^2$ of any wedge.

Let O be the elliptic angle for the ellipse having A and B for semi major and semi minor axes, and let ξ be the elliptic angle for the ellipse having A and $A_{,}$ for semi major and semi minor axes; also let $a_{,}$ be any semi diameter of the ellipse having A and $A_{,}$ for semi major and semi minor axes, and let b be the semi minor axis of the ellipse having A for semi major axis and $a_{,}$ and $B_{,}$ for semi conjugate diameters.

For any infinitesimal wedge of the ellipsoid having its edge in diameter $B_{,} B_{,}$,

$$\text{Sin}^2 \alpha_{,} = \frac{a_{,}^2 B_{,}^2 - A^2 b^2}{a_{,}^2 B_{,}^2}$$

$$B_{,}^2 = B^2 + (A^2 - B^2) \sin^2 O.$$

$$a_{,}^2 = A^2 - (A^2 - B^2) \sin^2 O \sin^2 \xi.$$

$$a_{,}^2 + B_{,}^2 = A^2 + B^2 + (A^2 - B^2) \sin^2 O \cos^2 \xi.$$

Per *Conic Sections*,

$A^2 + b^2 = a_{,}^2 + B_{,}^2$.

Therefore $b^2 = B^2 + (A^2 - B^2) \sin^2 O \cos^2 \xi$.

$a_{,}^2 B_{,}^2 - A^2 b^2 = (A^2 - B^2)^2 \sin^2 O \cos^2 O \sin^2 \xi$.

$$\text{Sin}^2 \alpha_{,} = \frac{(A^2-B^2)^2 \sin^2 O \cos^2 O \sin^2 \xi}{a_{,}^2\ B_{,}^2} = \frac{E^4 \sin^2 O \cos^2 O \sin^2 \xi}{(1-E^2 \sin^2 O \sin^2 \xi)(1-E^2 \cos^2 O)}.$$

$\text{Sin}^2 \alpha_{,} = E^4 \sin^2 O \cos^2 O \sin^2 \xi + E^6 \sin^2 O \cos^4 O \sin^2 \xi +{}_{''}$

$\text{Sin}\ \alpha_{,} = E^2 \sin O \cos O \sin \xi + \frac{1}{2} E^4 \sin O \cos^3 O \sin \xi + \frac{1}{2} E^4 \sin^3 O \cos O$ $\sin^2 \xi + \frac{1}{4} E^6 \sin^3 O \cos^3 O \sin^3 \xi -{}_{''}$.

$E_{,}^2 = \frac{a_{,}^2 - B_{,}^2}{B_{,}^2} = E^2 \cos^2 O - E^2 \sin^2 O \sin^2 \xi + E^4 \cos^4 O - E^4 \sin^2 O \cos^2 O$ $\sin^2 \xi + E^6 \cos^6 O -{}_{''}$

$E_{,}^4 = E^4 \cos^4 O - 2 E^4 \sin^2 O \cos^2 O \sin^2 \xi + E^4 \sin^4 O \sin^4 \xi + 2 E^6 \cos^6$ $O -{}_{''}$.

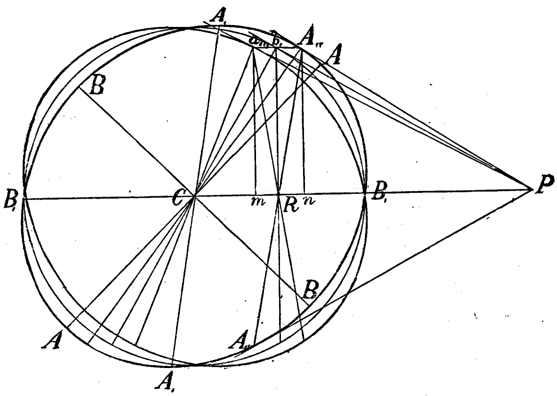

Diagram 8.

To find an expression for angle $(\alpha_{,} + y_{,})$ for any two opposite wedges.

Diagram 8 is constructed in accordance with diagram 7, having lower part laid over so that point $A_{,,,}$ becomes $a_{,,,}$. $A_{,,}$ n and $a_{,,,}$ m are drawn perpendicular to P C. Angle $a_{,,,}$ R $A_{,,}$ equals 2α, C $b_{,}$ R or $b_{,}$ P C equals ϑ, $A_{,,}$ P R equals $(\vartheta + \varkappa)$ and $a_{,,,}$ P R equals $(\vartheta - v)$.

In triangle $A_{,,}$ $Pa_{,,,}$,

(a). $\sin\ A_{,,}\ Pa_{,,,}$ or $\sin(\varkappa + v) = \frac{2 \sin \alpha}{\cos \alpha} \sin(\vartheta + \varkappa) \sin(\vartheta - v)$.

$Pb_{,} = D \cos \vartheta$; $PR = D \cos^2 \vartheta$; and $b_{,} R = D \sin \vartheta \cos \vartheta$.

$A_{,,} R = a_{,,,} R = \frac{A_{,}}{B_{,}} D \sin \vartheta \cos \vartheta = \sqrt{1+E^2}\ D \sin \vartheta \cos \vartheta$

$A_{,,}\ n = a_{,,,}\ m = \sqrt{1+E^2}\ D \sin \vartheta \cos \vartheta \cos \alpha$,

$$R\,n = R\,m = \sqrt{1+E^2}\,D \sin \vartheta \cos \vartheta \sin \alpha$$

$$P\,n = D \cos \vartheta \left(\cos \vartheta - \sqrt{1+E^2} \sin \vartheta \sin \alpha\right)$$

$$Pm = D \cos \vartheta \left(\cos \vartheta + \sqrt{1+E^2} \sin \vartheta \sin \alpha\right)$$

$$A_{\prime\prime}P = \sqrt{\overline{Pn}^2 + \overline{A_{\prime\prime}n}^2} = D \cos \vartheta \left[1 + E^2 \sin^2 \vartheta - 2\sqrt{1+E^2} \sin\vartheta\cos\vartheta\sin\alpha\right]^{\frac{1}{2}}$$

$$A_{\prime\prime\prime}P = \sqrt{\overline{Pm}^2 + \overline{a_{\prime\prime\prime}m}^2} = D \cos \vartheta \left[1 + E^2 \sin^2 \vartheta + 2\sqrt{1+E^2} \sin\vartheta\cos\vartheta\sin\alpha\right]^{\frac{1}{2}}$$

$$\operatorname{Sin}(\vartheta+u) = \frac{A_{\prime\prime}n}{A_{\prime\prime}P} = \frac{\sqrt{1+E^2} \sin\vartheta\cos\alpha}{\left[1+E^2 \sin^2\vartheta - 2\,(1+E^2)^{\frac{1}{2}} \sin\vartheta\cos\vartheta\sin\alpha\right]^{\frac{1}{2}}}$$

$$\operatorname{Sin}(\vartheta-v) = \frac{a_{\prime\prime\prime}m}{a_{\prime\prime\prime}P} = \frac{\sqrt{1+E^2} \sin\vartheta\cos}{\left[1+E^2 \sin^2\vartheta + 2\,(1+E^2)^{\frac{1}{2}} \sin\vartheta\cos\vartheta\sin\alpha\right]^{\frac{1}{2}}}$$

$$\operatorname{Sin}(\vartheta+u)\sin(\vartheta-v) = \frac{\left(1+E^2\right)\sin^2\vartheta\cos^2\alpha}{\left[(1+E^2 \sin^2\vartheta)^2 - 4\,(1+E^2)\sin^2\vartheta\cos^2\vartheta\sin^2\alpha\right]^{\frac{1}{2}}}$$

Expand and reduce this value for sin $(\vartheta+u)$ sin $(\vartheta-v)$, and substitute the result in expression (a) of this Art.,

$$\operatorname{Sin}(u+v) = 2 \sin\alpha \cos\alpha\,(\sin^2\vartheta + E^2 \sin^2\vartheta - E^2 \sin^4\vartheta - E^4 \sin^4\vartheta + E^4 \sin^6\vartheta$$
$$+ 2 \sin^4 \vartheta \sin^2 \alpha - 2 \sin^6 \vartheta \sin^2\alpha + E^6 \sin^6\vartheta - {}_{\prime\prime}).$$

$$\operatorname{Sin}(u+v) = 2 \sin\alpha\,(\sin^2\vartheta + E^2 \sin^2 \vartheta - E^2 \sin^4\vartheta - E^4 \sin^4\vartheta + E^4 \sin^6\vartheta - \tfrac{1}{2}$$
$$\sin^2\vartheta \sin^2\alpha + 2 \sin^4\vartheta \sin^2 \alpha - 2 \sin^6\vartheta \sin^2\alpha + E^6 \sin^6\vartheta - {}_{\prime\prime})$$

$\tan(u+v) = 2 \sin\alpha\,(\sin^2 \vartheta + E^2 \sin^2 \vartheta - E^2 \sin^4 \vartheta - E^4 \sin^4 \vartheta + E^4 \sin^6 \vartheta - \frac{1}{2} \sin^2 \vartheta \sin^2 \alpha + 2 \sin^4 \vartheta \sin^2 \alpha + E^6 \sin^6 \vartheta - '')$.

The difference ($4 \sin^6 \vartheta \sin^3 \alpha$) between tan u+v) and sin (u+v) is of the order of the sixth power of eccentricity, therefore to the sixth power of eccentricity, per this method of development, the sine, the arc and the tangent of the angle (u+v) are of the same length.

Diagram 9 is so constructed that triangles $A_{\prime\prime}$ P R and $A_{\prime\prime\prime}$ P R are equal to triangles like lettered in Dia. 8. In line P $A_{\prime\prime\prime}$, take P B equal to P $A_{\prime\prime}$, and let it be represented by unity. Produce P $A_{\prime\prime}$ to D, making P D equal to P $A_{\prime\prime\prime}$, and let it be represented by (1+a). Produce P D to F making P F equal to $(1+a)^2$. Complete parallograms P $A_{\prime\prime}$ C B, P D E B and P F G B, and draw diagonals P C, P E and P G.

By construction angles R P C and E P C are equal, and either of these angles is equal to half the difference of the angles P E D and E P D or E P B. Angle C P G is also half the difference of angles P G F and G P F or G P B. Diagonal P G is the direction of the resultant of the two forces represented by the lines 1 and $(1+a)^2$.

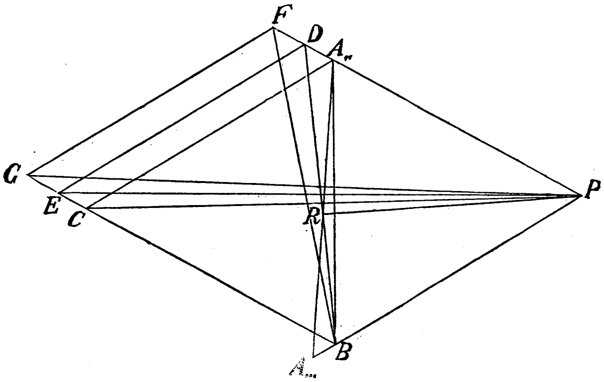

Diagram 9.

Angle R P E is equal to angle (u+v).

In triangle P E D,

$$\tan \frac{PED + EPD}{2} = \tan CPE \frac{2+a}{a}.$$

In triangle P G F,

$$\tan \frac{PGF + GPF}{2} = \tan CPG \frac{2+2a+a^2}{2a+a^2}$$

The half sum of angles PED and EPD is equal to the half sum of angles PGF and GPF, therefore

$$\tan CPE \frac{2+a}{a} = \tan CPG \frac{2+2a+a^2}{2a+a^2}$$

$$\frac{\tan CPG}{\tan CPE} = 2-\tfrac{1}{2} a^2+\tfrac{1}{2} a^3-\tfrac{1}{4} a^4+_{\prime\prime}$$

From values of $A_{\prime\prime}P$ and $a_{\prime\prime\prime}P$ already developed in this Art.,

$$a = 2\sqrt{1+E^2} \sin \vartheta \cos \vartheta \sin \alpha - 2E^2\sqrt{1+E^2} \sin^3 \vartheta \cos \vartheta \sin \alpha + (1+E^2)^{\frac{3}{2}} \sin^3 \vartheta \cos^3 \sin^3 \vartheta\, \alpha +_{\prime\prime}$$

$$a^2 = 4 \sin^2 \vartheta \cos^2 \vartheta \sin^2 \alpha +_{\prime\prime}$$

The angle CPE is one half of angle RPE or $\tfrac{1}{2}$ (u+v).

$$\tan \frac{u+v}{2} = \frac{1-\cos (u+v)}{\sin (u+v)} = \frac{1}{2} \sin (u+v) + \frac{1}{2.4} \sin^3 (u+v) + \text{etc.}$$

$$\tan CPG = 2(1-\sin^2 \vartheta \cos^2 \vartheta \sin^2 \alpha +_{\prime\prime}) \tan \frac{u+v}{2}$$

$$\tan(\alpha \pm z) = \tan\left(\mathrm{CPG} + \frac{u+v}{2}\right) = \frac{\tan \mathrm{CPG} + \tan \frac{u+v}{2}}{1 - \tan \mathrm{CPG} \tan \frac{u+v}{2}}$$

$$\sin(\alpha \pm z) = \frac{\tan(\alpha \pm z)}{\sqrt{1+\tan^2(\alpha \pm z)}}$$

As the chord elements of attraction from wedge to wedge vary in mass as $m \cos^2 \alpha$ the above expression for $\sin(\alpha \pm z)$ must be multiplied by $m \cos^2 \alpha$. Thus modified and expanded,

$$\sin(\alpha \pm z) = 3m \cos^2 \alpha \sin \alpha (\sin^2 \vartheta + E^2 \sin^2 \vartheta - {}_{\prime\prime}).$$

$$\sin(\alpha \pm z) = 3m \sin \alpha (\sin^2 \vartheta + E^2 \sin^2 \vartheta - E^2 \sin^4 \vartheta - E^4 \sin^4 \vartheta + E^4 \sin^6 \vartheta - \frac{3}{2} \sin^2 \vartheta \sin^2 \alpha + \frac{4}{3} \sin^4 \vartheta \sin^2 \alpha - \frac{23}{6} \sin^6 \vartheta \sin^2 \alpha + E^6 \sin^6 \vartheta - {}_{\prime\prime})$$

The letters in the above expression are for the plane of the principal axes. For any plane substitute $\alpha_{,}$, $E_{,}$, m, and $y_{,}$ for z. As $\alpha_{,}$ and $E_{,}$ are constant quantities for any two opposite wedges, summation of chord elements for opposite wedges can be made per expedient of Art. 12, by putting;

$$\sin^2 \vartheta = \frac{2}{5} n^2.$$

$$\sin^4 \vartheta = \frac{2.4}{5.7} n^4, \text{ etc., for higher powers.}$$

$$\sin(\alpha_{,} \pm y_{,}) = \frac{6}{5} m \sin \alpha_{,} n^2 \left(1 + E_{,}^2 - \frac{4}{7} E_{,}^2 n^2 - \frac{4}{7} E_{,}^4 n^2 + \frac{4.6}{7.9} E_{,}^4 n^4 - \frac{3}{2} \sin^2 \alpha_{,} + \frac{16}{21} n^2 \sin^2 \alpha_{,} - \frac{92}{63} n^4 \sin^2 \alpha_{,} + \frac{4.6}{7.9}, E_{,}^6 - {}_{\prime\prime}\right)$$

Substitute in the above expression the values given for $\sin \alpha_{,}$ and eccentricity ($E_{,,}$) in Art. 19.

$$\text{(b.)} \quad \sin(\alpha_{,} \pm y_{,}) = \frac{6}{5} \frac{m n^2 E^2 \sin O \cos O \sin \xi}{[(1 - E^2 \sin^2 O \sin^2 \xi)(1 - E^2 \cos^2 O)]^{\frac{1}{2}}}$$

$$[1 + E^2 \cos^2 O (1 - \tfrac{4}{7} n^2) - E^2 \sin^2 O \sin^2 \xi (1 - \tfrac{4}{7} n^2) + E^4 \cos^4 O (1 - \tfrac{8}{7} n^2 + \tfrac{8}{21} n^4) - E^4 \sin^2 O \cos^2 O \sin^2 \xi (\tfrac{5}{2} - \tfrac{52}{21} n^2 + \tfrac{20}{9} n^4) - \tfrac{4}{7} n^2 E^4 \sin^4 O \sin^4 \xi (1 - \tfrac{2}{3} n^2) + {}_{\prime\prime}].$$

21. To find the resultant direction of attraction for the whole Ellipsoid. For any two opposite wedges there are two corresponding opposite wedges in the adjacent quarters of the Ellipsoid. The resultant for these four wedges is found by multiplying the expression for the resultant of either of the two opposite wedges by the cosine of the angle [90° minus the alpha elliptic angle ($\xi - b$)], or the sine of the alpha elliptic angle ($\xi - b$). Let ($\alpha_{,} \pm y_{,,}$ be the angle for the resultant of the four wedges.

$$\sin(\xi - b) = \frac{A_{,} \sin \xi}{a_{,}} = \frac{\sin \xi (1 - E^2 \sin^2 O)^{\frac{1}{2}}}{(1 - E^2 \sin^2 O \sin^2 \xi)^{\frac{1}{2}}}.$$

Multiply this value for $\sin(\xi - b)$ by expression (b) Art. 20, then the expression for the resultant of the four wedges is,

$\sin(a_{,} \pm y_{,,}) = \frac{6}{5} m n^2 E^2 \sin O \cos O [(1 + \frac{3}{2} E^2 - 2 E^2 \sin^2 O - \frac{4}{7} n^2 E^2 + \frac{4}{7} n^2 E^2 \sin^2 O) \sin^2 \xi + \frac{4}{7} n^2 E^2 \sin^2 O \sin^4 \xi \pm_{,,}]$.

If the attraction of the pairs of wedges were equal, each to each, then per Art. 15, the resultant of attraction for the whole ellipsoid would be found by putting,

$$\sin^2 \xi = \frac{1}{2}$$

$$\sin^4 \xi = \frac{3}{2.4}, \text{ etc. for higher powers.}$$

Let $(\alpha \pm w')$ be the approximate angle for the resultant so found.

(a) $\sin(\alpha \pm w') = \frac{3}{5} Mn^2 E^2 \sin \theta \cos \theta [1 + E^2(\frac{3}{2} - 2 \sin^2 O - \frac{4}{7} n^2 + n^2 \sin^2 O) + E^4('') +_{,,}]$.

To correct this result let (s) be the angle that the resultant of any four wedges having the angle ξ greater than 45°, makes with the resultant of the four wedges so taken that the square of the sine of angle ξ in first plus the square of the sine of angle ξ in the second shall equal unity. The correction for any such group of eight wedges is the difference of a certain two angles the sum of which is a certain angle (s). Let p and r be these angles. Expressions for the sum and difference of the resultant attractions for the two four wedge groups are obtainable from expression (c) Art. 18. By a well known trigonometrical method the expression for the tangent of the half difference of the two angles p and r is:

$$\tan \frac{p - r}{2} = \frac{9}{50} MN^4 E^4 \sin^3 O \cos O [(1 + E^2(_{,,}) (2 \sin^2 \xi - 1)^2 \pm _{,,}].$$

$$(2 \sin^2 \xi - 1)^2 = 1 - 4 \sin^2 \xi \cos^2 \xi.$$

The expression $[\sin^2 a \cos^2 a + \sin^2 (45° - a) \cos^2 (45° - a] = \frac{1}{4}$, from well-known trigonometrical fromulæ, proves that the value of $\sin^2 \xi \cos^2 \xi$ for any and every group of eight wedges or for the average of all groups composing the ellepsoid is $\frac{1}{8}$, therefore, for the whole ellipsoid the correction becomes:

$$\tan \frac{p - r}{2} = \frac{9}{100} Mn^4 E^4 \sin^3 O \cos O [(1 + E^2(_{,,}) +_{,,}].$$

$$\sin \frac{p - r}{2} = \frac{9}{100} Mn^4 E^4 \sin^3 O \cos O [1 + E^2(_{,,}) + ''].$$

This correction united additionally, as the conditions require it, to expression (a) of this Art. gives:

$\sin(\alpha - w) = \frac{3}{5} Mn^2 E^2 \sin O \cos O [1 + E^2 (\frac{3}{2} - 2 \sin^2 O - \frac{4}{7} n^2 + \frac{23}{20} n^2 \sin^2 O) + E^4(_{,,}) +_{,,}]$.

This method of correction gives an expression exactly true to the eighth power of eccentricity. Another order of correction, similar to the one treated, commences with the eighth power of ecentricity, but its effect is small when eccentricity is large, owing to the fact that each group of eight wedges to be combined in the next order of resultants, is so composed of wedges from different parts of the ellipsoid, that the attractions of all groups of eight are very nearly equal each to each.

$$\mathit{M} = \frac{M^*}{1 - \sin^2 a_{,}} = \frac{M}{1 - \frac{1}{2} E^4 \sin^2 O \cos^2 O^2 + {}''}$$

Substitute this value for *M* in the above expression for sin $(\alpha - W)$ and we get for the whole ellipsoid the angle that the direction of attraction makes with the direction from the attracted particle to the center of the ellipsoid.

$$\text{(b)} \sin(\alpha - W) = \frac{3}{5} \mathit{M} n^2 E^2 \sin O \cos O \Big[1 + E^2 \big(\frac{3}{2} - 2 \sin^2 O - \frac{4}{7} n^2 + \frac{23}{20} n^2 \sin^2 O\big) + E^4 (_{,,}) + {}'' \Big]$$

When the attracted particle is at the surface of the ellipsoid n becomes uni y and the expression is:

$$\text{(c)} \sin(\alpha - W) = \frac{3}{5} \mathit{M} E^2 \sin O \cos O \Big[1 + E^2 \Big(\frac{13}{14} - \frac{17}{20} \sin^2 O\Big) + E^4 (_{,,}) + _{,,} \Big]$$

$$\sin(\alpha - W) = \frac{3}{5} \mathit{M} \sin O \cos O \Big[E^2 + E^4 \Big(\frac{13}{14} - \frac{17}{20} \sin^2 O\Big) + E^6 (_{,,}) + _{,,} \Big]$$

In the above, in order to get the term depending on E^4 exact. it is to be observed that *M* can be used for M, angle ξ, for $(\xi - b)$ and arc of angle α for sine or tangent, also so far as the expression is dependent on attraction (c) Art. 18 the terms E^4 and $\sin^2 \alpha$ are not involved.

22. To find the attraction of an oblate ellipsoid on any outside particle.

By requisite substitution, expression (c) Art. 18 for two opposite wedges becomes:

$$\text{(a)} \quad \text{Att.} = \frac{m}{D^2}\Big(1 - \frac{3}{5} n^2 E^2 \cos^2 O + \frac{3}{5} n^2 E^2 \sin^2 O \sin^2 \xi - \frac{3}{5} n^2 E^4 \cos^4 O + \frac{3}{7} n^4 E^4 \cos^4 O + \frac{3}{7} n^4 E^4 \sin^4 O \sin^4 \xi - \frac{43}{25} E^4 \sin^2 O \cos^2 O \sin^2 \xi + \frac{12}{5} n^2 E^4 \sin^2 O \cos^2 O \sin^2 \xi - \frac{198}{175} n^4 E^4 \sin^2 O \cos^2 O \sin^2 \xi + _{,,}\Big).$$

Expression (b) Art. 20 modified for tangent and reduced gives:

$$\tan(\alpha_{,} + y_{,}) = \frac{6}{5} n^2 E^2 \sin O \cos O \sin \xi \Big(1 + \frac{3}{2} E^2 \cos^2 O - \frac{4}{7} n^2 E^2 \cos^2 O - \frac{1}{2} E^2 \sin^2 O \sin^2 \xi + \frac{4}{7} n^2 E^2 \sin^2 O \sin^2 \xi + _{,,}\Big).$$

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* The Italic *M* represents greater mass than the Roman in this investigation.

Expression (b) Art. 21 gives:

$$\tan(\alpha - w) = \frac{3}{5} n^2E^2 \sin O \cos O \left(1 + \frac{3}{2} E^2 - 2E^2 \sin^2 O - \frac{4}{7} n^2 E^2 + \frac{23}{20} n^2 E^2 \sin^2 O + {}_{\prime\prime}\right).$$

$(\alpha_{\prime} \pm y_{\prime})$ is the angle that D* makes with the resultant of any two opposite wedges. and $(\nu - w)$ is the angle that D also makes with the resultant for the whole ellipsoid. The tangents of the angles having the same radius (D) are in the same plane perpendicular to D. To determine the distance of the resultant of any two opposite wedges from the resultant of the whole ellipsoid, these tangents may represent the adjacent side of a triangle having the included angle [90°—(ξ—b]. Let the tangent of angle $(\alpha_{\prime} \pm y_{\prime})$ be (b) and that of $(\alpha - w)$ be (a), then the third side (d) is the distance of the resultant, in tangent of angle. of any two opposite wedges from that of the whole ellipsoid.

Tugonometry gives:

$$d = \sqrt{a^2 - b^2 - 2ab \cos[90° - (\xi - b)]} = \sqrt{a^2 - b^2 - 2ab \sin(\xi - b)}.$$

$$d = \frac{3}{5} n^2E^2 \sin O \cos O \left(1 + \frac{3}{2} E^2 - 2E^2 \sin^2 O - \frac{4}{7} n^2 E^2 + \frac{23}{20} n^2E^2 \sin^2 O + 2E^2 \sin^2 O \sin^2 \xi - \frac{81}{70} n^2 E^2 \sin^2 O \sin^2 \xi - 2E^2 \sin^2 O \sin^4 \xi + \frac{8}{7} n^2E^2 \sin^2 O \sin^4 \xi + {}_{\prime\prime}\right).$$

Let $c^2 = 1 + \tan^2(\alpha - w)$.

$f = 1 + \tan^2(\alpha_{\prime} - y_{\prime})$.

Let r be the angle that the resultant of any two opposite wedges makes with the resultant of the whole ellipsoid.

Trigonometry gives:

$$\cos r = \frac{c^2 + f^2 - d^2}{2cf}$$

$$\cos r = 1 - \tfrac{9}{50} n^4 E^4 \sin^2 O \cos^2 O \left(1 + 3E^2 - 4E^2 \sin^2 O - \tfrac{8}{7} n^2 E^2 + \tfrac{23}{20} n^2 E^2 \sin^2 O + 12E^2 \sin^2 \xi + 4E^2 \sin^2 O \sin^2 \xi - \tfrac{81}{35} n^2 E^2 \sin^2 O \sin^2 \xi - 4E^2 \sin^2 O \sin^4 \xi + \tfrac{16}{7} n^2 E^2 \sin^2 O \sin^4 \xi + {}_{\prime\prime}\right).$$

Multiply expression (a) this Art. by the above value for cos r and the expression for the attraction of any two opposite wedges in the direction of the resultant for the whole ellipsoid becomes:

$$\text{Att.} = \frac{M}{D^2}\left(1 - \tfrac{3}{5} n^2 E^2 \cos^2 O + \tfrac{3}{5} n^2 E^2 \sin^2 O \sin^2 \xi - \tfrac{3}{5} n^2 E^4 \cos^4 O - \tfrac{9}{50} n^4 E^4 \sin^2 O \cos^2 O + \tfrac{3}{7} n^4 E^4 \cos^4 O + \tfrac{3}{7} n^4 E^4 \sin^4 O \sin^4 \xi - \tfrac{42}{25} E^4 \sin^2 O \cos^2 O \sin^2 \xi + \tfrac{12}{5} n^2 E^4 \sin^2 O \cos^2 O \sin^2 \xi - \tfrac{198}{175} n^4 E^4 \sin^2 O \cos^2 O \sin^2 \xi + {}_{\prime\prime}\right).$$

For the whole ellipsoid per Art. 15

$\sin^2 \xi = \frac{1}{2}$.

$\sin^4 \xi = \frac{3}{2.4.}$ Etc., for higher powers.

---

*Line D extends from attracted particle to center of ellipsoid.

The expression for the whole ellipsoid becomes:

$$\text{Att.} = \frac{\mathit{M}}{D^2}\left(1 - \tfrac{3}{5}\, n^2 E^2 \cos^2 O + \tfrac{3}{10}\, n^2 E^2 \sin^2 O -_{\prime\prime}\right).$$

$$\mathit{M} = \frac{\mathrm{M}}{\cos^2 \alpha_{\prime}} = \mathrm{M}\left(1 + \tfrac{1}{2} E^4 \sin^2 O \cos^2 O + \tfrac{1}{2} E^6 \sin^2 O \cos^4 O + \tfrac{3}{8} E^6 \sin^4 O \cos^2 O +_{\prime\prime}\right).$$

$$\text{b. Att.} = \frac{\mathrm{M}}{D^2}\left(1 - \tfrac{3}{5}\, n^2 E^2 \cos^2 O + \tfrac{3}{10}\, n^2 E^2 \sin^2 O - \tfrac{3}{5}\, n^2 E^4 \cos^4 O + \tfrac{3}{7}\, n^4 E^4 \cos^4 O - \tfrac{9}{25} E^4 \sin^2 O \cos^2 O + \tfrac{6}{5}\, n^2 E^4 \sin^2 O \cos^2 O + \tfrac{9}{56}\, n^4 E^4 \sin^4 O - \tfrac{261}{350}\, n^4 E^4 \sin^2 O \cos^2 O +_{\prime\prime}\right).$$

$$\text{Att.} = \frac{\mathit{M}}{D^2}\Big[1 - \tfrac{3}{5}\, n^2 E^2 \left(1 - \tfrac{3}{2} \sin^2 O\right) - \tfrac{3}{5} E^4 \big(n^2 - \tfrac{5}{7}\, n^4 + \tfrac{3}{5} \sin^2 O - \tfrac{3}{5} \sin^4 O - 4\, n^2 \sin^2 O + 3\, n^2 \sin^4 O + \tfrac{187}{70}\, n^4 \sin^2 O - \tfrac{89}{40}\, n^4 \sin^4 O\big) +_{\prime\prime}\Big]$$

23. To find the increase in attraction in passing on the surface of an oblate ellipsoid from the equator to the poles.

When the attracted particle is at the surface of the Ellipsoid n equals unity and D equals $B_{\prime}$, and expression (b) Art. 22 becomes

$$\text{Att} = \frac{\mathrm{M}}{B^2}\left(1 - \tfrac{3}{5} E^2 \cos^2 O + \tfrac{3}{10} E^2 \sin^2 O -_{\prime\prime}\right).$$

$$B_{\prime}^2 = A^2 \left(1 - E^2 \cos^2 O\right).$$

$$\text{Att} = \frac{\mathrm{M}}{A^2}\left(1 + \tfrac{2}{5} E^2 \cos^2 O + \tfrac{3}{10} E^2 \sin^2 O + \tfrac{8}{35} E^4 \cos^4 O + \tfrac{9}{56} E^4 \sin^4 O + \frac{69}{175} E^4 \sin^2 O \cos^2 O +_{\prime\prime}\right)$$

$$\text{(a)}\quad \text{Att} = \frac{\mathrm{M}}{A^2}\left(1 + \tfrac{2}{5} E^2 - \tfrac{1}{10} E^2 \sin^2 O + \tfrac{8}{35} E^4 - \tfrac{11}{175} E^4 \sin^2 O - \tfrac{1}{200} E^4 \sin^4 O +_{\prime\prime}\right)$$

At the poles angle O becomes zero, and

$$\text{(b)}\quad \text{Att} = \frac{\mathrm{M}}{A^2}\left(1 + \frac{2}{5} E^2 + \frac{2.4}{5.7} E^4 + \text{etc}\right)$$

At the equator angle O becomes ninety degrees, and

$$\text{(c)}\quad \text{Att} = \frac{\mathrm{M}}{A^2}\left(1 + \frac{3}{10} E^2 + \frac{3.3}{7.2.4} E^4 + \frac{3.3.5}{9.2.4.6} E^6 + \text{etc.}\right)$$

Subtract expression (a) from (b) and the difference is,

$$\frac{\mathrm{M}}{A^2}\left[\frac{1}{10} E^2 \sin^2 O + E^4 \sin^2 O \left(\frac{11}{175} + \frac{1}{200} \sin^2 O\right) +_{\prime\prime}\right].$$

$$= \frac{\mathrm{M}}{A^2}\left[\frac{1}{5} h \sin^2 O + h^2 \sin^2 O \left(\frac{53}{350} + \frac{1}{50} \sin^2 O\right) +_{\prime\prime}\right].$$

The increase in attraction then from the equator to the poles varies as the square of the sine of the elliptic angle, exact for the second power of excentricity or first power of ellipticity and very nearly true to the sixth power of eccentricity or the third power of ellipticity.

VII.

The gravity and the Figure of a body, due to its Rotation and the attraction of its Component Particles.

First.—The oblate ellipsoid is the figure of equilibrium due to the rotation and attraction of the component particles of a fluid body.

Second.—The increase in gravity from the equator to the poles varies as the square of the sine of the elliptic angle, or the angle with vertex at center of figure, and not as the square of the sine of latitude.

24. To find the combined effect of attraction and rotation on any particle in the plane of the equator of an oblate ellipsoid.

Case 1st. When the velocity of rotation is just sufficient to counterbalance the attraction of the ellipsoid on the particle.

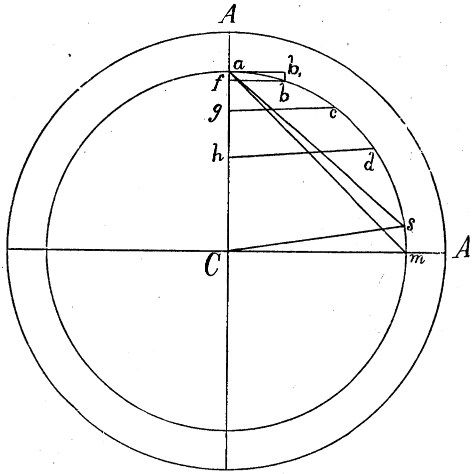

Diagram 10.

In Dia. 10 let a be the particle and let arc a b be the distance of rotation for an infinitesimal unite of time (t) or velocity of rotation. Let a f the versed sine of arc a b in direction A C represent the unite of attraction, also let f a in direction C A represent the repulsive effect of rotation. As attraction just counter-balances repulsion the particle must revolve in the circumference of a circle of radius a C. As attraction and repulsion act at a right angle to an infinitesemal portion of the circumference these forces can neither increase or diminish the velocity (v) of rotation.

Let a f, a g, a h, etc., to a C represent the attraction of the ellipsoid for one, two, three, etc., units of time acting on a particle with a constant force equal to the attraction of the ellipsoid at distance a C. On the circumference lay off aros a b, b c, c d, etc., to s, each equal to a b; and connect points f b, g c, h d, etc., to C s. By the law of the expedient of this demonstration the time required for particle a to revolve to s acted on by the combined forces is that required for a constant force equal to the attraction of the ellipsoid at distance a C, to move the particle over the distance a C. Let distance a C be represented by (a) and a f by (c). Per law of ultimate ratio tangent a $b_{,,}$, arc a b and chord a b are equal each to each.

$$\text{Chord } \overline{a\,b}^2 = v^2 = 2\,a \times c. \quad 2\,a = \frac{v^2}{c}$$

$$\text{Chord of a quadrant, } \overline{a\,m}^2 = 2\,a^2 = \frac{a\,v^2}{c}.$$

Per law of *falling bodies:*

$$a = t^2\,c. \quad t = \frac{\sqrt{a}}{\sqrt{c}}$$

$$\overline{a\,m}^2 = v^2\,t^2. \quad a\,m = v\,t.$$

v t is the length of the arc a s, and a m is the chord of a quadrant. The time required for the particle to revolve over the arc a s is $\frac{\sqrt{a}}{\sqrt{c}}$. $\sqrt{2}$ is the length of the chord a m, when $2\,\pi$ is the length of a circumference The time (T) required for a complete revolution of the particle or the rotation of the ellipse is:

$$T = \frac{\pi\,\sqrt{2\,a}}{\sqrt{c}}. \quad T^2 = \frac{2\,a\,\pi^2}{c}.$$

In case of a homogenious oblate ellipsoid, the mass inside of the layer having semi-major axis (a), varies as (a) cubed. The attraction, then, of the ellipsoid on particle (a) in the plane of the equator varies directly as distance (a). As the ellipsoid rotates as one mass the time of revolution of all component particles is the same, and all particles in the plane of the equator rotate without pressure.

Case 2d.—When the repulsion from rotation is not sufficient to counterbalance attraction.

It is evident from case 1st, without further investigation, that the loss of pressure for particle a varies inversely as the time squared of rotation of the ellipsoid to the time of rotation required squared for repulsion to counterbalance attraction.

Case 3d.—When the repulsion from rotation is greater than attraction.

In Dia. 11 let arc a $b_{,,}$ be the velocity of rotation for an infinitesimal unit of time. The initial impulse of rotation acting alone would throw particle (a) in direction of tangent to distance a $b_{,}$, equal to arc a $b_{,,}$. Let a f be the attraction for the first unit of time. Draw $b_{,,}$ f′ perpendicular to a C, then a f′ represents the force required acting in direction a C to make the particle revolve in a circle. The versed sine f′ a in direction C a is the repulsive effect from the rotation measured by the system of a circle. Draw f b perpendicular to a C, and from the initial point a, draw diagonals a b and a $b_{\prime\prime}$. Under the hypothesis that no component particle excep ing partic'e a, has freedom to change position in the ellipsoid, it is evident that this exceptional particle acted upon by the forces combined would be at the end of the first unit of time at b instead of at $b_{\prime\prime}$ as it was in Case 1st.

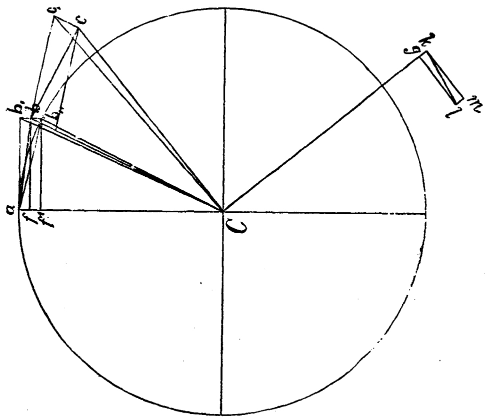

Diagram 11.

If during the second unit of time attraction did not act the particle would continue to move in direction a b to c′ making distance b c′ equal to a b. It is evident under the action of the forces combined at the end of the second unit of time, the particle would be found at some point c in in line c c′ drawn parallel to b C. The position of the particle for the third or any unit of time in due order can likewise be determined.

Triangles C b c and Cbc[1] are equal from having same base Cb and equal altitudes; triangles Cbc[1] and cab are equal from having equal bases bc[1] and ab and same altitude; triangle Cab and $Cab_{\prime\prime}$ are equal from having same base Ca and equal altitudes. It is now evident that the triangle evolved by the forces combined for any unity of time is equal not only to the one for the first unity of time but also to the one that would be evolved by the initial impulse of rotation combined with an attraction equal to the versid sine due to repulsion from rotation.

Measured, with reference to the arc $ab_{\prime\prime}$ of the circle attraction is to repulsion as af to f′a, but measured with reference to the arc ab in the path of the particle acted upon by the forces combined attraction and repulsion are equal and in equilibrium in the production of arc ab or any other ar c in the path of revolution of the particle.

The following is the enunciation of a proposition well known to be true from demonstration. "If a body describes an ellipse, being continually urged by a force directed towards the focus, that force must vary inversely as the square of the distance." In the case, then, under consideration if the attraction of the ellipsoid on the particle varied inversely as the square of the distance, the path of revolution would be an ellipse. In Dia. 11, let kl be any part of the elliptic path of revolution described in a unite of time. Take gk to fa inversely as $\overline{Ck}^2$ to $\overline{Ca}^2$, and draw gl and complte the parallelogram kglm. It is evident that the diagonal kl is the resultant effect of attraction kg being equal to the repulsion gk or lm. If the attraction then varied inversely as the cube or any other higher power of distance kg would be shorter than in the case just considered and the diagonal of equilibrium would be a line from k to some point between m and l. With a spherical central body, then, the path of revolution of the particle would be an ellipse, but with an ellipsoidal central body it is otherwise.

In the expression for the attraction of an oblate ellipsoid in the plane of the equator (Art. 22) subtitute (A) divided by (n) for (D) and the expression becomes:

$$\text{Att.} = \frac{M}{A^2}\left(n^2 + \tfrac{1}{2} \times \tfrac{3}{5}\, n^4 E^2 + \frac{3}{2.4} \times \tfrac{3}{7}\, n^6 E^4 + \text{etc.}\right)$$

The sum of the elements $\frac{Mn^2}{A^2}$, $\frac{3}{10}\frac{Mn^4E^2}{A^2}$, etc., make up the attraction of the ellipsoid. The first element acting alone would cause the particle to revolve in an ellipse; but the other elements acing conjointly would cause it to move in a path continuously increasing the distance from the center of the ellipsoid, or the path would be a spiral evolved by a radius vector increasing continuously in length and also decreasing in angular velocity so as to generate equal areas in equal time. All of these elements combined evolve a resultant path having a radius vector increasing and decreasing during a revolution as the radius vector of an ellipse would increase and decrease while additionally and contiauosly receiving increments of length. An appropriate appellation for the resultant path is elliptic spiral. The radius vector of an elliptic spiral generates equal areas in equal time. As far as observation has been able to determine each of the heavenly bodies rotates on an axis; it is, therefore, good common sense to conclude that every body in the heavens revolves in an elliptic spiral orbit continually with decreasing increments departing from its primary. When the particle is an interior one, then its repulsion or outward pressure depends upon the law of the interior attraction of the body.

25. It is evident without additional investigation that the repulsive effect from rotation parallel to the equator, decreases from equator to the poles as A cos O. Angle O is the elleptic angle measured from the plane of the equator.

26. To find the figure of a mass of homogeneous fluid due to rotation and mutual attraction of component particles, also to find the gravity at any point on the surface or within the rotating body.

From the nature of the case the two parts of the rotating fluid body as divided by the equatorial plane are similar and equal, and all sections parallel to that plane are circles. The body thus can be conceived, made up in an infinite number of laminæ or layers or shells so that the mass of the body within any layer may vary as the cube of the equatorial radius of the layer. The body can also be conceived, made up of an infinite number of eccentric cones or cones with eccentric bases, having their bases in the surface of the body and their vertices at the center of the equatorial section or center of body. These cones may be taken with such areas of base that their volumes shall vary as distance from base to center of body. In case the body in equilibrium is an ellipsoid, it can be conceived, made up of an infinite number of elliptic cones or cones with elliptic bases. If each elliptic cone has an elliptic base with one principal axis, of length due it per the system of dividing the ellipse extending from either pole of the ellipsoid to the equator per law of alpha or beta elliptic angles (see Art. 14 and Diagram 5), and the other principal axis of length due it from proportional distance from center of the ellipsoid, then the cones have equivolent bases and their volumes vary as distances from bases to center of body. Per the expedient of the layers and the cones, any layer by the cones is conceivably cut up into infinitesimal parts, so that each part has mass proportional to its distance from the center of the body.

Fluid equilibrium, or a state of rest for any and all of the component particles requires that the pressure from any infinitesimal part of a layer on the fluid interior shall just equal that of any other part of same layer having the same layer surface area.

Such ultimate parts of a layer may be called layer elements of mass. As all sections of the rotating fluid body, parallel to the plane of the equator must be circles, and as the equatorial plane must divide the body into two equal parts whatever the figure of a section in a plane of the axis of rotation, a line of layer elements of mass in either polar radius must balance a line of elements in an equatorial radius. It is safe then to take as granted that gravity at either pole to gravity at the equator is inversely as polar to equatorial radii. As the sphere is the figure of equilibrium for a fluid body not rotating, and as a sphere rotated on a center axis generates a centrefugal or repulsive force in lines of ordinates of axis, proportional to lengths of ordinates, and as the oblate ellipsoid is the only figure that has the required relations to the sphere to continue a fluid mass in equilibrium in passing from a state of rest to a condition of rotation, it is safe to take as granted that such is the figure of equilibrium for a rotating ing mass, providing it be demonstrated that every element of mass of a layer presses, each to each, equally on interior mass.

The general expression for attraction on a particle at the surface of an ellipsoid, is:

$$\text{Att.} = \frac{M}{A^2}\left[\ 1+\frac{4}{5}\,h-\frac{1}{5}\,h\sin^2 O+\frac{18}{35}h^2-\frac{53}{350}h^2\sin^2 O-\frac{1}{50}h^2\sin^4 O+h^3\,('')+''\right]$$

To satisfy the conditions the elliptic angle (O) in the above must be measured from the polar axis. The following is an equivolent expression with the elliptic angle (O) measured from an equatorial radius:

$$\text{Att.}=\frac{M}{A^2}\left[1+\frac{4}{5}h-\frac{1}{5}h\cos^2 O+\frac{18}{35}h^2-\frac{53}{350}h^2\cos^2 O-\frac{1}{50}h^2\cos^4 O+h^3\,('')+''\right]$$

Let a represent an equatorial radius varying from O to A, then for mass interior to any layer M varies as (a) cube, hence interior attraction varies as a. For interior attraction a can be substituted for M divided by A^2. h in the above expression for attraction equals A—B divided by A. To put the expression in shape so that h may represent unity divided by A, the constant terms $1+\frac{4}{5}h+\frac{18}{35}h+$etc., so far as used in the computation must be made unity. The same result is obtained by not making this change, providing due allowances are made for A—B not being equal to unity.

$$\text{Att}=a\left[1-\tfrac{1}{5}h\cos^2 O-\tfrac{53}{150}h^2\cos^2 O-\tfrac{1}{50}h^2\cos^4 O-h^3\,(,,)-\,,,\right].$$

The difference in attraction for any point on the polar radius and same layer point on the equatorial radius is:

$$\left(\frac{1}{5}h+\frac{6}{35}h^2+\frac{4}{35}h^2+\,,,\right)$$

When the rotating fluid body is in equilibrium the mass from a layer in any equatorial cone must just balance the mass from same layer in either of the polar cones. As these masses vary as their distances from the center of the body, gravity in the plane of the equator and in the polar axis must vary inversely as same distances, and the centrifugal force or repulsion from rotation in the plane of the equator must, in case of equilibrium, be expressed by,

$$a\,h-a\left(\frac{1}{5}h+\frac{6}{35}h^2+,,\right)=a\left(\frac{4}{}h-\frac{6}{35}h^2-\,,,\right)$$

The repulsion from rotation at any point in or on the rotating body in direction parallel to the equatorial plane is per demonstration (Art. 25),

$$\text{Rep.}=a\cos O\left(\frac{4}{5}h-\frac{6}{35}h^2-\frac{4}{35}h^3-\,,,\right)$$

Gravity is the third side of a triangle in which the two sides (attraction and repulsion of rotation) and the included angle $[(O-z)+(\alpha-w)]$ are given. The third side or

$$\text{Gravity}=\left\{\overline{\text{Att.}}^2+\overline{\text{Rep.}}^2-2\,\text{Att.}\times\text{Rep.}\times\text{Cos}\,[(O-z)+(\alpha-w)]\right\}^{\frac{1}{2}}$$

$$\text{Gravity}=a\left[1-h\cos^2 O+\tfrac{1}{2}h^2\cos^2 O-\tfrac{1}{2}h^2\cos^4 O+h^3(,,)-\,,,\right]$$

The expression for any radius of an oblate ellipsoid in terms of ellipticity and sine of elliptic angle (O) in which angle angle (O) is measured from an equatorial radius is:

$$A_{,} = A \left[1-h \sin^2 O + \tfrac{1}{2} h^2 \sin^2 O - \tfrac{1}{2} h^2 \sin^4 O \pm h^3 (\text{``}) \pm \text{``} \right]$$

For any point ($a_{,}$) on the surface or within the ellipsoid:

$$a_{,} = a \left[1-h \sin^2 O + \tfrac{1}{2} h^2 \sin^2 O - \tfrac{1}{2} h^2 \sin^4 O + h^3 (\text{``}) - \text{``} \right]$$

The above expressions for gravity and radial distance prove that gravity for all points in the same layer of the ellipsoid varies inversely as distance from point to center of body. To comprehend how this result satisfies the second test for equilibrium in full it must be understood in the expedient of the infinitesimal layers and cones, that the same system of cones is used only to divide up one or any one layer. The point now required to be proven is that when any cone is so moved that its axis is changed to the normal or direction of gravity, without changing the point of base on the layer, the cone cuts the same mass from the layer as when in first position. The expedient used to divide up the layer requires the ellipse to be described with a variable radius with the center fixed at the center of the ellipse. Per law of ultimate ratio the radius is constant in describing an infinitesimal arc. The same ellipse can be conceived described with the same variable radius, and with that radius kept on the normal or indirection of gravify, providing the center so vary in locations that the describing end of the radius be kept on the ellipse to be described. In this case the ellipse is known, because it is the one describ d by the first method. For any point of the curve, then, the center in the normal, or in direction of gravity is known. Per law of ultimate ratio by this method an infinitisimal arc of the ellipse is described with the same constant radius as in first instance, and with a fixed center. The same infinitesimal arc of the ellipse, then, is described by either expedient. Therefore the cone in either position cuts from the same layer the same volume or mass.

A fluid mass takes on a spherical figure from the mutual attraction of component particles. If such spherical body receives an initial impulse of rotation sufficient to cause one complete rotation during infinity of time, then the ultimate ratios initiated for change of figure are those, and those only, that are due to change from a sphere to an oblate ellipsoid. This should be taken as demonstration that the oblate ellipsoid is the figure of equilibrium and alone that figure, unless there is real ground for positive proof otherwise.

VIII.

The Figure of Equilibrium, the Density and Temperature of the Earth and Other Planets.

First.—The oblate Ellipsoid is the figure of equilibrium of a rotating fluid mass of heterogeneous density, and all solids manifest the fluid property in some degree under a reqnisite continued pressure.

Second.—The average density of the earth's crust in depth about 130 miles is 2.96 times water, and at the center about 3.05 times that of the crust, or 9 times water. At other points the density is given in table 4, this chapter.

Third.—The temperature of the earth from surface to center at first increases about 1° C. per 90 feet, but this rate of increase so diminishes that at the depth of 130 miles the temperature becomes about 3,600° C. Thence to the center the rate of increase is so small that the temperature continues nearly uniform.

Fourth.—The earth has yet to cotract, radially, about 150 miles to become throughout zero temperature. The interior flames will be, continually, fed by the fuel of pressure of outside load to a limit beyond which the earth's mass cannot compress. The present interior, at a few miles below the surface begins to get plastic, and from about 130 miles below the surface to the center it becomes so plastic that the temperature is kept nearly uniform by convection of heat.

NOTE.—The density of a fluid earth composed, throughout, proportionally of the same elements would increase from surface to center, not withstanding the commotion produced by the heat generated by pressure. In case of such an earth at 15° C., if there were no heat from pressure, and therefore a state of rest, its increase in density would be per law of compression. If heat sufficient to raise the temperature of the whole mass 50° C. were put into such earth so as to leave surface at 15° C., and have the increase in tempergture from surface to center per law of compression, then in case no heat escaped, per law of convection there would be no state of rest till the whole mass became of uniform temperature, 65° C. It is evident, then, that an earth having a crust with moulten interior would be at a state of rest proportionally to the thickness and non-conducting heat property of its crust. Not with-standing the moulton interior of the earth (if she has such) is now at temperature nearly uniform, yet I suppose before the crust solidified or become plastic that heat radiated into cold space so rapidly that in spite of the law of convection, the temperature at the center of the earth was thousands of degrees higher than at the surface. The heighth to which material is now being thrown from the sun, proves that the temperature at his center is higher beyond comprehension than at his surface. Let those believing solidification commenced at the center keep these facts in mind while reading this chapter.

27. To find the decrease in attraction on a rotating fluid oblate ellipsoid from the poles to the equator.

Conception 1st. Such an oblate Ellipsoid can be conceived made up of an infinite number of oblate Ellipsoids having a common center, and each component Ellipsoid of homogeneous density.

Conception 2d. The same oblate Ellipsoid can be conceived made up also in shells or layers with each shell or layer of homogeneous density. The surface of the layers in this case would be at the surface of the component Ellipsoids of conception first.

The attraction of each component ellipsoid can be computed by formulae already developed for homogeneous ellipsoids, and the attraction for the heterogeneous mass is equal to the sum of the attractions of the component parts.

The attraction of first or largest component ellipsoid at pole is:

$$\frac{m}{B^2}\left[1-\frac{3\,E^2}{5\,(1-E^2)}+_{\prime\prime}\right]=\frac{m}{A^2}(1+\tfrac{2}{5}\,E^2+_{\prime\prime})\cdot$$

The attraction at equator of same is:

$$\frac{m}{A^2}(1+\tfrac{3}{10}\,E^2+_{\prime\prime})$$

Decrease from pole to equator is:

$$\frac{m}{A^2}(\tfrac{1}{10}\,E^2+_{\prime\prime}=\frac{m}{A^2}(\tfrac{1}{5}\,H+_{\prime\prime})$$

The attraction at the pole of first ellipsoid for the second component ellipsoid is:

$$\frac{m_{\prime}}{B^2}\left[1-\frac{3b^2\,E^2}{5\,B^2\,(1-E^2)}+{}''\right]=\frac{m_{\prime}}{A^2}\left[\frac{1}{1-E^2}-\frac{3\,a^2\,E^2}{5\,A^2\,(1-E^2)^2}\right]=\frac{m_{\prime}}{A^2}$$

$$\left[1+E^2+_{\prime\prime}-\tfrac{3}{5}\,n^2\,E^2+_{\prime\prime}\right],\text{ in which } n^2=\frac{a}{A^2}.$$

The attraction at equator for same is:

$$\frac{m_{\prime}}{A^2}\left[1+\tfrac{3}{10}\,n^2\,E^2+_{\prime\prime}\right].$$

Decrease is:

$$\frac{m_{\prime}}{A^2}\left[2\,H-\tfrac{9}{5}\,h\,n^2\pm_{\prime\prime}\right].$$

Results are thus obtained for all the component ellipsoids.

The decrease in attraction from pole to equator of the heterogeneous oblate ellipsoid or sum of results for component ellipsoid is:

$$\frac{2\,H}{A^2}(m+m_{\prime}+m_2+m_3+\text{etc.})-\frac{9}{5\,A^2}(m\,H+m_{\prime}\,n^2\,h+m_2\,n_{\prime}^{\,2}\,h_{\prime}+m_3\,n_2^{\,2}\,h_2+\text{etc.}).$$

The general expression for the attraction of a homogenous oblate ellipsoid on any outside particle, when modified by the requisite substitutions. proves that the decrease in attraction from the equator to the pole of the heterogenous ellipsoid, caused by any of the interior component homogeneous ellipsoid, varies in accordance with the law for a homogeneous oblate ellipsoid, when the attracted particle is at any point on the surface. The decrease in attraction then, from the equator to the pole, true for the second power of eccentricity, varies as the square of the sine of the elliptic angle, or the angle of *geocentric latitude.*

28. To find the decrease in attraction of an oblate ellipsoid on a particle in the surface of any layer from the plane of the equator to a polar radius.

Under the conditions of this discussion, when a heterogeneous ellipsoid becomes homogeneous, then all the layers become similar and of equal ellipticity. The layers of the heterogeneous ellipsoid can be made similar by taking away certain crescent pieces. To determine the attraction on any particle in the surface of any interior layer, the attraction of certain outside crescent pieces and the interior mass need only be considered, as all the other exterior mass attracts the particle equally in opposite directions.

In the last article an expression is developed that can be used to determine the attraction of the interior mass. A method to find the attraction of the crescent pieces become manifest from diagram 4. The attraction on particle P of that portion of the ellipsoid cut out by rotation of the lines Pe and Pg depends upon the length of chord dg or ce, when angle g Pe is small or infinitesimal. The point of tangency a bisects chord d g. The length of chord d g varies as diameter $B_{,} B_{,}$. The diameter $B_{,} B_{,}$ becomes longer by increasing the ellipticity. When point P is moved to the interior of the ellipsoid, that portion of the chord d g, as shown in diagram 2, by Pd, is equal to $gg_{,}$, in case the ellipsoid is composed of similar layers, or is of homogeneous density. If the ellipsoid is composed of layers of decreasing ellipticities or with density increasing from surface to center, then Pd is less than $gg_{,}$. The angle P ax of diagram 4 is a right angle by construction, and PaC is less than a right angle. The angle Cax, or angle α, or the *angle of the vertical* bacomes nothing when the layer, of which a is the point of tangency becomes a circle. When the ellipticity of the ellipse having a in point of tangency is less than that of the ellipse BA BA, then the difference between $gg_{,}$ and Pd of diagram 2, or the attraction for the external crescent pieces is at ained from the expression already obtained for the sine of angle α or the angle of the vertical.

$$\sin \alpha = E^2 \sin \vartheta \cos \vartheta +_{''} = 2 \, h \sin \vartheta \cos \vartheta +_{''}.$$

When point of tangency a, of diagram 4, is in the surface of the layer, and point P is moved in semi axis BC, to the surface of the same layer, then the radius for the angle α for any direction of chord dg cutting the layer, varies in length from zero to semi axis b. The general expression for any of the radii is, b sin ϑ.

Let E be the eccentricity and H the ellipticity of the outside layer. The expression for the sine of the angle of the vertical for the ellipse having semi minor axis b and eccentricity E is, $\sin \alpha = b E^2 \sin^2 \vartheta \cos \vartheta$.

The expression for the sine of the corresponding *angle of the vertical* for a layer having semi minor axis b and eccentricity e is, $\sin \alpha_{,} = b e^2 \sin^2 \vartheta \cos \vartheta$.

$$gg_{,} - Pd = 2 \sin \alpha - 2 \sin \alpha_{,}.$$

The expression for any chord of a layer drawn from a pole of the layer is, $2 b \cos \vartheta$.

$$\frac{gg_{,} - Pd}{2 b \cos \vartheta} = (E^2 - e^2) \sin^2 \vartheta = 2 (H - h) \sin^2 \vartheta.$$

The attraction of the mass cut from a homogeneous oblate ellipsoid having semi minor axis b and eccentricity e, by any two chords drawn from a pole, the one chord making an infinitesinal angle with the other is:

$$\text{Att.} = \frac{m}{b^2} (1 - \tfrac{3}{2} e^2 \sin^2 \vartheta +_{,,}).$$

The attraction then of the mass cut from the whole ellipsoid having semi minor axis B and eccentricity E by the two chords extended, on a particle at the pole of the interior layer, having semi minor axis b and eccentricity e, providing the density of the whole mass is homogeneous, is

$$\text{Att.} = \frac{m}{b^2} (1 - \tfrac{5}{2} e^2 \sin^2 \vartheta + E^2 \sin^2 \vartheta +_{,,})$$

To make summation for whole ellipsoid we must put, as hertofore:

$$\sin^2 \vartheta = \tfrac{2}{5}.$$

$$\sin^4 \vartheta = \frac{2, 4}{5, 7}, \text{ etc., for higher powers.}$$

For whole ellipsoid as above described, then, on particle at pole of layer:

$$\text{Att.} = \frac{m}{b^2} (1 - e^2 + \tfrac{2}{5} E^2 +_{,,}) = \frac{m}{a^2} (1 - O + \tfrac{2}{5} E^2 +_{,,}).$$

Likewise obtained for particle in equator of same layer:

$$\text{Att.} = \frac{m}{a^2} (1 + \tfrac{1}{2} e^2 - \tfrac{1}{5} E^2 +_{,,}).$$

Attraction at pole, then, less that of the equator, is:

$$\text{Dif. of Att.} = \frac{m}{a^2} (\tfrac{3}{5} E^2 - \tfrac{1}{2} e^2 +_{,,}) = \frac{m}{a^2} \left[\tfrac{1}{5} h + \tfrac{6}{5} (H - h) +_{,,} \right].$$

An oblate ellipsoid having semi-minor axis B, and ellipticity H, and density increasing from surface to center can be made up of a homogeneous oblate ellipsoid, having semi minor axis b and ellipticity h, with density the same as layer having semi minor axis b and ellipticity h, and of other homogeneous oblate ellipsoids having semi minor axis less than b and ellipticities less than h, and also an outside part, composed of layers having semi minor axes varying from B to b, with ellipticities varying from H to h.

Let 1 be the density of the layer having semi minor axis b. For the outside crescent masses there can be substituted one crescent mass of the same volume as the sum of the crescent masses, with a density, so as to give an equivolent attractive effect. Let this density be c times the surface density of the heterogeneous ellipsoid. Let M be the mass of the whole heterogeneous ellipsoid, *M* the mass of the homogeneous ellipsoid, having density 1, and m, $m_,$, m_2. etc., the masses of the homogeneous ellipsoids having semi minor axis less than b.

It is now evident from investigations already made, that for the surface of any layer, the attraction at the pole of the layer, less that at the equator, can be expressed as follows:

$$\text{Diff. of Att.} = \frac{M}{M}\left[\tfrac{1}{5}h + \frac{6c}{51}(H - h)\right] + \frac{2h}{M}(m + m_, + m_2 + \text{etc.})$$

$$-\frac{9}{5M}(m\,h + m_,\,n^2\,h_, + m_2\,n_,^2\,h_2 + \text{etc.})$$

The result from the general expression for the attraction of a homogeneous oblate ellipsoid on any outside particle, when the requisite substitutions for the case under consideration are made, proves that the decrease in attraction on the surface of any layer from its pole to its equator varies in accordance with the law for the homogeneous oblate ellipsoid at its surface.

29. To find the figure of equilibrium of a fluid rotating mass, increasing in density from surface to center.

The attraction at the surface of any layer at its equator being less than at its poles, the thickness of any layer at its equator is greater than at its poles. As the decrease in attraction on the surface of any layer varies per law for the surface of a homogeneous oblate ellipsoid, the increase in the thickness of the layer as caused by attraction, must follow the law for the increase in the radii of an oblate ellipsoid. The effect of the centrifugal force to give its additional increase of ellipticity follows for the layer the law for the surface of the homogeneous ellipsoid. The combined effects, then, of attraction and centrifugal force, or gravity, cause each layer to be an oblate ellipsoidal layer, or the figure of equilibrium of all layers to be, also that of an oblate ellipsoid.

30. To find the density of the earth from surface to center, the mean density being $\frac{40}{21}$ times greater than that of a surface layer 127 miles deep.

The increase in the density of liquids caused by pressure, as shown by Oersted's apparatus and other experiments, varies as the pressure, measured under the condition of constant temperature. Gasses follow the same law. Deschanel says, "The true compressibility of water, according to recent experiments conducted under the direction of M. Jamin, by Messrs. Amaury and Descamps, is at the temperature of 15° Centigrade .0000427 per atmosphere." In these experiments the compressibility of glass was taken to be 0000029 per atmosphere. The fact that solids can be compressed shows that solids possess the fluid property essential to compressibility. The fact that rocks are found bent which once were straight, also that a pane of glass or a slab of marble can be bent by a certain continued pressure demonstrates that the particles of solids can move on each other. The movements of solid ice in glaciers is proof in the same direction. The effect of pressure above and below the columns left for supports in deep mines gives like testimony. The deep canyons of Colorado permit the water to cut so deep and no deeper, because below a certain depth the solid rock bottom like putty, rises from weights of high banks.

It is the theory of the geologist that the earth, below a thin solid crust, begins to become plastic, and at certain small depth becomes so plastic that the temperature thence to the center can only slightly increase, owing to the *law of convection of heat.* If the theory of the geologist be true, then the increase in the density of the interior of the earth caused by pressure varies as outside pressure. It is only in the case the theory is not true that we need trouble ourselves about the shadow of a doubt that remains in reference to the law of compressibility of fluids applying to solids.

If computations made by formulæ already developed, modified by the condition of the theory of the geologist, builds up the earth from center to surface in layers, giving the difference of gravity of corresponding layer points in polar and equatorial radius in harmony from center to surface and exactly meets the observed difference of gravity at the surface, likewise for ellipticity of layers so as to meet the observed ellipticity at surface, also giving a computed direction for gravity at the surface at any latitude exactly in agreement with the observed direction, then it seems to me it must be accepted that the theory of the geologist is truth, and that the theory of the astronomer, based on computations made from uncertain data is a fallacy.

TABLE I.

1.	2.	3.	4.	5.	6.	7.	8.
No. Layer.	Volume.	Incr. Dens.	Density.	Mass Layers	Mass H.—Ellipsoids.	Ellipticity.	$-\frac{9}{35}$ h n² m.
31	2791	....	1.0000	2791	29791	$\frac{1}{294}$	—0032142
30	5048	.12675	1.1267	5687	3421	$\frac{1}{298.2}$	3408
28	4376	.2623	1.3890	6078	5758	$\frac{1}{305.6}$	4875
26	3752	.2876	1.6766	6291	5058	$\frac{1}{312}$	3617
24	3176	.3020	1.9788	6284	4174	$\frac{1}{317.3}$	2501
22	2648	.3012	2.2800	6037	3207	$\frac{1}{321.6}$	1593
20	2168	.2841	2.5641	5559	2272	$\frac{1}{324.9}$	923
18	1736	.25[illegible]0	2.8161	4888	1469	$\frac{1}{327.5}$	480
16	1352	.2091	3.0252	4090	857	$\frac{1}{329.3}$	220
14	10[illegible]6	.1613	3.1865	3237	442	$\frac{2}{330.5}$	86
12	728	.1148	3.3013	2403	198	$\frac{1}{331.4}$	28
10	488	.0744	3.3757	1647	74	$\frac{1}{331.7}$	7
8	296	.0430	3.4187	1012	22	....	1
6	152	.0213	3.4400	523	4.6	....	....
4	56	.4083	3.4483	193	.53	....	....
2	8	.0020	3.4503	27	.014	....	....
....	29791	....	....	56747	56747	....	—.0049881

The numbers in column 1, table 1, represent the polar radii of similar elliptic layers or shells composing an oblate ellipsoid. The numbers in column 2 are the differences between the cubes of 31 and 30, 30 and 28, 28 and 26, etc. As the volumes of similar oblate ellipsoids vary as the cubes of their polar radii, the numbers in column 2 are proportional to the volumes of the component layers. The mean density of the earth as attained by experiments is, at least very nearly, $\frac{40}{21}$ times that at surface. The whole mass of the earth, then, may be represented by 31 cubed multiplied by $\frac{40}{21}$, or 56745, or by 56745 divided by 56745. The first number in column 3 is so assumed as to give the requisite mass in the earth under the law that the increase in compression or density varies as pressure. The other numbers in this column are computed and show the increments in density from layer to layer. The numbers in column 4 are the computed densities of the layers, and those in column 5 divided by 56745, the masses. The pressure of the outside layer compared with that of any other, varies as the attraction of the ellipsoid on the masses of these layers. The increment of density for the pressure of any interior layer is found by multiplying the assumed increment .12675 by the pressure of the interior layer divided by the pressure of the outside layer.

The numbers in column 6, divided by 56745 are the masses of the homogeneous ellipsoids, having radi, 31, 30, 28, etc., composing also the ellipsoid, and these numbers are found by multiplying the cubes of the numbers of column first by those of column third, excepting the first number, which is 31 cubed The numbers in column 7 are explained in connection with table 4.

The formulæ already developed for the attraction of a heterogeneous oblate ellipsoid at the pole less that at the equator, is:

$$\text{Diff. of Att.} = \frac{2H}{A^2}(m + m_, + m_2 + \text{etc}) - \frac{9}{2A^2}(m H + m_, n^2 h + n_2 n_,^2 h_, + \text{etc})$$

For the purpose of this computation A, and $m + m_, + m_2$ + etc., or M, can each be made unity, and the formulæ put in form as follows:

$$\text{Diff. Att,} = 2H - \tfrac{9}{5} m H - \tfrac{9}{5} m_, n^2 h - \tfrac{9}{5} m_2 n_,^2 h_, - \text{etc.}$$

The numbers in column 8 are the computed resu'ts of $-\frac{9}{5}$ m H, $-\frac{9}{5}$ $m_,$ n^2 h — etc

TABLE II.

1.	2.	3.	4.	5.	6.	7.	8.
No. Layer.	Volume.	Incr. Den.	Density.	Mass Layer.	Mass H.— Ellipsoid.	Ellipticity.	$-\frac{9}{5}$ h n^2 m.
31	2791	....	1.0000	2791	29791	$\frac{1}{294}$	—.0032142
30	2611	.11867	1.1187	2921	3202	$\frac{1}{298.2}$	3190
29	2437	.1261	1.2448	3033	3075	$\frac{1}{302}$	2827
28	2269	.1326	1.3774	3125	2910	$\frac{1}{305.6}$	2464
27	2107	.1378	1.5152	3192	2712	$\frac{1}{309}$	2112
26	1951	.1415	1.6567	3232	2487	$\frac{1}{312}$	1779
25	1801	.1435	1.8002	3242	2242	$\frac{1}{314.8}$	1469
24	1657	.1436	1.9438	3220	1985	$\frac{1}{317.3}$	1190
23	1519	.1418	2.0856	3168	1725	$\frac{1}{319.6}$	942
22	1387	.1379	2.2235	3084	1468	$\frac{1}{321.6}$	729
21	1261	.1322	2.3557	2970	1224	$\frac{1}{323.4}$	551
20	1141	.1248	2.4805	2830	998	$\frac{1}{324.9}$	406
19	1027	.1160	2.5965	2666	795	$\frac{1}{326.3}$	290
18	919	.1060	2.7025	2483	618	$\frac{1}{327.5}$	202
17	817	.0953	2.7978	2285	468	$\frac{1}{328.5}$	136
16	721	.0842	2.8820	2077	344	$\frac{1}{329.3}$	88
15	631	.0730	2.9550	1864	246	$\frac{1}{330}$	55
14	547	.0622	3.0172	1650	170	$\frac{1}{130.6}$	33
13	469	.0519	3.0691	1439	114	$\frac{1}{331.1}$	19
12	397	.0423	3.1114	1235	73	$\frac{1}{331.4}$	10
11	331	.0338	3.1452	1041	51	$\frac{1}{332}$	6
10	271	.0262	3.1714	859	26	$\frac{1}{332}$	3
9	217	.0197	3.1911	692	14	....	....

TABLE II — continued.

1.	2.	3.	4.	5.	6.	7.	8.
No. Layer.	Volume.	Incr. Den.	Density.	Mass Layer.	Mass H.— Ellipsoid.	Ellipticity.	$-\frac{9}{5}$ h n² m.
8	169	.0143	3.2054	541	7	....	....
7	127	.0100	3.2154	408	3.4	....	....
6	91	.0066	3.22 0	293	1.3	....	....
5	61	.0041	3.2261	196.8	.5	....	....
4	37	.0023	3.2284	119.4	.14	....	....
3	19	.0011	3.2295	61.4	.029	....	....
2	7	.0004	3.2299	22.7	.003	....	....
1	1	.0002	3.2301	3.23	.000	....	....
....	29791	....	....	56733.53	56750.372	....	—0050643

Tables 2 and 3 are made on plan of table 1.

2 H $= \frac{1}{147} =$ .0068027.

Table 1 gives: .0068027 — .0049881 = .0018146 for difference in attraction.

Table 2 gives: .0068027 — .0050643 = .0017384 for difference in attraction.

Table 3 gives: .0068027 — .0051030 = .0016997 for difference in attraction.

The difference between first result and second is .0000762, and that of second and third, 0000384. The first difference is about double that of the second. From these differences we can closely estimate what would be the result in case the outside layer be kept of thickness one thirty-first part of radius, and the other layers be reduced to infinitesimal thickness. The result in that case for attraction at pole less that at the equator would be about .001665, or $\frac{1}{600}$.

The observed gravity at the pole, less that at the equator, is $\frac{1}{195}$; and the centrifugal force at the equator is $\frac{1}{289}$, and nothing at the pole. The observed attraction at the pole, less that at the equator, is: $\frac{1}{195} - \frac{1}{289} = \frac{1}{600}$.

I find by computations that a true result for attraction cannot be attained in accordance with observed and known data, and divide the earth, from surface so center into layers infinitesimally thin. To meet that data an outside layer of about

TABLE III.

1.	2.	3.	4.	5.	6.	7.	8.
31	2791	....	1.0000	2791	29791	$\frac{1}{294}$	—0032142
30	$1327\frac{5}{8}$	.1151	1.1151	1480	3107	$\frac{1}{298.2}$	3095
$29\frac{1}{2}$	$1283\frac{3}{8}$	.0620	1.1771	1510	1519	$\frac{1}{300}$	1523
29	$1239\frac{7}{8}$	.0636	1.2407	1538	1551	$\frac{1}{302}$	1426
$28\frac{1}{2}$	$1197\frac{1}{8}$	.0651	1.2058	1563	1507	$\frac{1}{303.7}$	1330
28	$1155\frac{1}{8}$	.0664	1.3722	1585	1457	$\frac{1}{305.6}$	1234
$27\frac{1}{2}$	$1113\frac{7}{8}$	.0676	1.4389	1603	1406	$\frac{1}{307.2}$	1142
27	$1073\frac{3}{8}$	.0685	1.5083	1619	1348	$\frac{1}{309}$	1050
$26\frac{1}{2}$	$1033\frac{5}{8}$	.0693	1.5776	1630	1289	$\frac{1}{310.5}$	962
26	$994\frac{5}{8}$	.0698	1.6474	1638	1227	$\frac{1}{312}$	876
$25\frac{1}{2}$	$956\frac{3}{8}$	.0701	1.7175	1642	1162	$\frac{1}{313.3}$	796
25	$918\frac{7}{8}$	.0702	1.7877	1642	1097	$\frac{1}{314.8}$	719
$24\frac{1}{2}$	$882\frac{1}{8}$	.0700	1.8577	1638	1029	$\frac{1}{316}$	645
24	$846\frac{1}{8}$	.0696	1.9273	1630	962	$\frac{1}{317.3}$	576
$23\frac{1}{2}$	$810\frac{7}{8}$	.0689	1.9962	1618	894	$\frac{1}{318.4}$	512
23	$776\frac{3}{8}$	.0680	2.0642	1602	827	$\frac{1}{319.6}$	452
$22\frac{1}{2}$	$742\frac{5}{8}$	.0669	2.1311	1582	762	$\frac{1}{320.6}$	397
22	$709\frac{5}{8}$	.0655	2.1966	1558	697	$\frac{1}{321.6}$	346
$21\frac{1}{2}$	$677\frac{3}{8}$	.0639	2.2605	1530	635	$\frac{1}{322.6}$	300
21	$645\frac{7}{8}$	.0623	2.3228	1500	577	$\frac{1}{323.4}$	260
$20\frac{1}{2}$	$615\frac{1}{8}$	.0602	2.3830	1465	518	$\frac{1}{324.2}$	222
20	$585\frac{1}{8}$	.0581	2.4411	1428	465	$\frac{1}{324.9}$	189
$19\frac{1}{2}$	$555\frac{7}{8}$	.0558	2.4969	1388	413	$\frac{1}{325.6}$	159
19	$527\frac{3}{8}$	.0534	2.5503	1345	366	$\frac{1}{326.3}$	133
$18\frac{1}{2}$	$499\frac{5}{8}$	.0509	2.6012	1299	322	$\frac{1}{327}$	111
18	$472\frac{5}{8}$	.0483	2.6495	1252	281	$\frac{1}{327.5}$	92
$17\frac{1}{2}$	$446\frac{3}{8}$	.0450	2.6951	1203	244	$\frac{1}{328}$	75
17	$420\frac{7}{8}$	.0429	2.7380	1152	211	$\frac{1}{328.5}$	61
$16\frac{1}{2}$	3[illegible]6$\frac{1}{8}$	.0402	2.7782	1100	180	$\frac{1}{328.9}$	49
16	$372\frac{1}{8}$	.0375	2.8157	1048	153	$\frac{1}{329.3}$	39
$15\frac{1}{2}$	$348\frac{7}{8}$	.0348	2.8505	994	129	$\frac{1}{329.7}$	31
15	$326\frac{3}{8}$	.0322	2.8827	941	108	$\frac{1}{330}$	24
$14\frac{1}{2}$	$304\frac{5}{8}$	.0297	2.9124	887	90	$\frac{1}{330.3}$	19
14	$283\frac{5}{8}$	.0272	2.9396	834	74	$\frac{1}{330.6}$	14
$13\frac{1}{2}$	$262\frac{3}{8}$	.0248	2.9644	781	61	$\frac{1}{330.9}$	11
13	$243\frac{7}{8}$	.0224	2.9868	728	49	$\frac{1}{331.1}$	8
$12\frac{1}{2}$	$225\frac{1}{8}$	.0202	3.0070	677	39	$\frac{1}{331.3}$	6
12	$207\frac{1}{8}$	.0182	3.0252	627	31	$\frac{1}{331.4}$	4
$11\frac{1}{2}$	$189\frac{7}{8}$	.0161	3.0413	577	24	$\frac{1}{331.5}$	....
11	$173\frac{3}{8}$	.0143	3.0556	530	19	$\frac{1}{331.6}$	....
$10\frac{1}{2}$	$157\frac{5}{8}$	.0126	3.0682	484	15	$\frac{1}{331.7}$	....
10	$142\frac{5}{8}$	.0109	3.0791	439	11	....	....
$9\frac{1}{2}$	$128\frac{3}{8}$	.0095	3.0886	396	8	....	....
9	$114\frac{7}{8}$	.0081	3.0967	356	5.9	....	....
$8\frac{1}{2}$	$102\frac{1}{8}$	.0069	3.1036	317	4.2	....	....
8	$90\frac{1}{8}$	.0058	3.1094	281	3	....	....
$7\frac{1}{2}$	$78\frac{7}{8}$	.0048	3.1142	246	2	....	....
7	$68\frac{3}{8}$	.0040	3.1182	213	1.37	....	....
$6\frac{1}{2}$	$58\frac{5}{8}$	.0033	3.1215	183	.90	....	....
6	$49\frac{5}{8}$	.0026	3.1241	155	.56	....	....
$5\frac{1}{2}$	$41\frac{3}{8}$	.0020	3.1261	129	.33	....	....
5	$33\frac{7}{8}$	.0016	3.1277	106	.20	....	....
$4\frac{1}{2}$	$27\frac{1}{8}$	.0011	3.1288	84.9	.10	....	....
4	$21\frac{1}{8}$	.0008	3.1296	66.1	.05	....	....

TABLE III — continued.

1.	2.	3.	4.	5.	6.	7.	8.
$3\frac{1}{2}$	$15\frac{7}{8}$	.0006	3.1302	49.7	.03	....	....
3	$11\frac{3}{8}$	.0004	3.1306	35.6	.01	....	....
$2\frac{1}{2}$	$7\frac{5}{8}$	.0002	3.1308	23.8	....	....	....
2	$4\frac{5}{8}$	.0001	3.1309	14.5	....	....	....
$1\frac{1}{2}$	$2\frac{3}{8}$	....	3.1309	7.3	....	....	....
1	$\frac{7}{8}$	....	3.1309	2.7	....	....	....
$\frac{1}{2}$	$\frac{1}{8}$	....	3.1310	.4	....	....	....
......	29791	....	....	56745	....	....	—0051030

TABLE IV.

No. L.	Mass Layer.	Mass H. E.	Dens.	Cres. D.	Cen. Force	Att.	Gravity.	Polar Radii.	Equatorial Radii.	Ellipticity.
1	2	3	4	5	6	7	8	9	10	11
31	2791	29791	1.00	1.00	$\frac{1}{289}$	$\frac{1}{598}$	$\frac{1}{194.8}$	3950.0000	3963.5136	$\frac{1}{293.3}$
30	3058	6235	1.11	1.05	$\frac{1}{303.2}$	$\frac{1}{678}$	$\frac{1}{209.5}$	3822.5806	3835.4641	$\frac{1}{297.6}$
29	3168	3026	1.24	1.11	$\frac{1}{316.7}$	$\frac{1}{718}$	$\frac{1}{219.8}$	3695.1612	3707.4496	$\frac{1}{301.6}$
28	3250	2787	1.37	1.16	$\frac{1}{329.9}$	$\frac{1}{758}$	$\frac{1}{230}$	3567.7418	3579.4618	$\frac{1}{305.4}$
27	3303	2542	1.50	1.21	$\frac{1}{342.9}$	$\frac{1}{798}$	$\frac{1}{240}$	3440.3224	3451.4991	$\frac{1}{308.9}$
26	3326	2265	1.64	1.26	$\frac{1}{355.5}$	$\frac{1}{837}$	$\frac{1}{249.5}$	3312.9030	3323.5579	$\frac{1}{311.9}$
25	3316	1997	1.78	1.31	$\frac{1}{367.6}$	$\frac{1}{875}$	$\frac{1}{258.8}$	3185.4836	3195.6365	$\frac{1}{314.7}$
24	3274	1719	1.91	1.35	$\frac{1}{379}$	$\frac{1}{911}$	$\frac{1}{267.6}$	3058.0642	3067.7319	$\frac{1}{317.3}$
23	3198	1449	2.04	1.38	$\frac{1}{389.8}$	$\frac{1}{945}$	$\frac{1}{276}$	2930.6448	2939.8425	$\frac{1}{319.6}$
22	3091	1196	2.17	1.42	$\frac{1}{399.9}$	$\frac{1}{978}$	$\frac{1}{284}$	2803.2254	2811.9667	$\frac{1}{321.9}$
21	2960	968	2.29	1.45	$\frac{1}{409.1}$	$\frac{1}{1008}$	$\frac{1}{291}$	2675.8060	2684.1058	$\frac{1}{323.4}$
20	2802	768	2.40	1.48	$\frac{1}{417.5}$	$\frac{1}{1036}$	$\frac{1}{297.6}$	2548.3866	2556.2521	$\frac{1}{325}$
19	2622	591	2.51	1.50	$\frac{1}{424.9}$	$\frac{1}{1062}$	$\frac{1}{303.6}$	2420.9672	2428.4080	$\frac{1}{326.4}$
18	2427	446	2.60	1.52	$\frac{1}{431.5}$	$\frac{1}{1083}$	$\frac{1}{308.6}$	2293.5478	2300.5725	1/327.[illegible]
17	2220	323	2.87	1.43	$\frac{1}{437.3}$	$\frac{1}{1104}$	$\frac{1}{313.2}$	2166.1284	2172.7420	$\frac{1}{328.5}$
16	2006	226	2.76	1.54	$\frac{1}{442.3}$	$\frac{1}{1121}$	$\frac{1}{317.3}$	2038.7090	2044.9179	$\frac{1}{329.4}$
15	1791	157	2.82	1.55	$\frac{1}{446.6}$	$\frac{1}{1133}$	$\frac{1}{320.5}$	1911.2896	1917.0977	$\frac{1}{330.1}$
14	1589	103	2.87	1.56	$\frac{1}{450.2}$	$\frac{1}{1145}$	$\frac{1}{323}$	1783.8702	1789.2810	$\frac{1}{330.7}$
13	1374	71	2.9[illegible]	1.57	$\frac{1}{453.2}$	$\frac{1}{1156}$	$\frac{1}{325.7}$	1656.4508	1661.4675	$\frac{1}{331.2}$
12	1175	41	2.95	1.57	$\frac{1}{455.6}$	$\frac{1}{1162}$	$\frac{1}{327.4}$	1529.0314	1533.6557	$\frac{1}{331.8}$
11	989	22	2.98	1.57	$\frac{1}{457.5}$	$\frac{1}{1169}$	$\frac{1}{328.9}$	1401.612[illegible]	1405.8479	$\frac{1}{331.9}$
10	813	11	3.00	1.57	$\frac{1}{459}$	$\frac{1}{1174}$	$\frac{1}{330}$	1274.1926	1278.0406	$\frac{1}{332.1}$
9	656	6	3.02	1.57	$\frac{1}{460.2}$	$\frac{1}{1179}$	$\frac{1}{331}$	1146.7732	1150.2347	$\frac{1}{332.3}$
8	513	4	3.03	1.57	$\frac{1}{460.8}$	$\frac{1}{1182}$	$\frac{1}{331.5}$	1019.3538	1022.[illegible]294	$\frac{1}{332.4}$
7	385	1	3.04	1.57	$\frac{1}{461.3}$	$\frac{1}{1183}$	$\frac{1}{331.8}$	891.9344	894.6247	$\frac{1}{332.5}$
6	276	.....	3.04	....	$\frac{1}{461.9}$	$\frac{1}{1183}$	$\frac{1}{332.2}$	764.5150	766.8203	$\frac{1}{332.6}$
5	186	.....	3.05	....	$\frac{1}{462.8}$	$\frac{1}{1183}$	$\frac{1}{332.6}$	637.0956	639.0165	$\frac{1}{332.6}$
4	113	.....	3.05	....	$\frac{1}{462.8}$	......	......	....	....	.....
3	58	.....	3.05	....	$\frac{1}{462.8}$	......	......	....	....	.....
2	21	.....	3.05	....	$\frac{1}{462.8}$	......	......	....	....	.....
1	3	.....	3.05	....	$\frac{1}{462.8}$	......	......	....	....	.....
...	56745	56745	...	...	......	......	......	....	....	.....

130 miles thickness must be kept intact, while the interior layers are made infinite in number. This shows that the law of compressibility is inapplicable to the crust on account of increase in temperature, while it is applicable to the interior from uniformity of temperature.

The numbers in column 2, table 4, divided by 56745 are the proportional masses composing the earth taken in thirty-one layers, the outside layer having an assumed average density of unity, or 2.96 times that of water, the mean density of the earth being 5.65 times that also of water. The other layers have masses the same as if earth were taken in layers infinitesimally thin. The numbers in column 3, divided by 56745 are the proportional masses of thirty-one ellipsoids composing the earth under conditions explained for second column. The first number in column 4 is the average density of layer 31, and the other numbers of the column taken in order are the densities at division surfaces between the layers The fractions in column 6 represent the quotients of centrifugal force divided by attraction at the surface of each layer. These results are easily attained, the one at the surface of the earth and the masses of layers being known.

Column 9 gives the polar radii of the thirty-one layers, the polar radius of the earth being about 3,950 miles.

The formulæ already developed for the attraction at the pole of any layer less, that at the equator is:

$$\text{Dif. Att.} = \frac{\mathit{M}}{\text{M}}\left[\tfrac{1}{5}\text{h} + \frac{6\text{c}}{5\,\text{l}}(\text{H}-\text{h})\right] + \frac{2\text{h}}{\text{M}}(\text{m}+\text{m}_{,}+\text{etc.}) - \frac{9}{\text{M}}(\text{mh}+\text{m}_{,}\,\text{n}^2\text{h}_{,}+\text{etc.})$$

The values for c are given in column 5. These numbers are easily computed when the densities and the ellipticities of the layers are known. Before making Table 4, I had so unraveled its net-work by a system of assumptions and corrections that I knew to a close approximation each result. The values for l are given in column 4. M of the formulæ for the surface of any layer is found by adding numbers in column 2 from layer 1 to the layer required inclusive. *M* equals M less the sum of numbers in column 3 not inclusive of the required layer, m, $\text{m}_{,}$, m_2, etc., are given in column 3. For the surface of any layer H equals $\frac{1}{294}$, and for any layer from 1 to 5 *M* equals M, l equals 3.05; c, 1.57; and m, $\text{m}_{,}$, etc., are each zero. For the fifth layer the fraction for ellipticity equals that for gravity; and the fraction for gravity equals the sum for attraction and centrifugal force. For fifth layer, then,

$$\text{g} = \text{h} = \tfrac{1}{5}\text{h} + \frac{1.57 \times 6}{3.05 \times 5}\left(\tfrac{1}{294} - \text{h}\right) + \tfrac{1}{462.8} = \tfrac{1}{332.66}.$$

Equatorial radius $= 637.0956 \times \frac{332.6}{331.6} = 639.0165.$

For layer sixth:

$\text{h}_{,} = \frac{1}{332.66}$, c $= 1.57$, l $= 3.04$. Assume $\frac{1}{332.63}$ for h.

Computation now gives for attraction $\frac{1}{1182}$, $g = \frac{1}{1182} + \frac{1}{361.9} = \frac{1}{332.12}$. Average g for the layer equals a trifle less than $\frac{1}{2}(\frac{1}{332.66} + \frac{1}{332.12}$ or $\frac{1}{332.39}$. Equitorial radius of sixth layer less that of fifth equals $127\,4194 \times \frac{332.4}{331.4} = 127\,8038$, or equitorial radius of sixth layer is 766.8203 miles. The polar and equitorial radii now found for sixth layer tests the assumption for ellipticity. Thus the process is continued from layer to layer in order.

For the surface of the earth, Table 4 gives attraction $\frac{1}{598}$. gravity $\frac{1}{194.8}$, and ellipticity $\frac{1}{293.3}$. It is accepted that attraction is $\frac{1}{600}$, gravity $\frac{1}{195}$ and ellipticity $\frac{1}{294}$. It is accepted also that the mean density of the earth is 5.65 times that of water, and that the surface crust density is not far from one-half of the mean. Further, it is accrpted that a fluid of uniform temperature is compressed directly as applied pressure. Table 4 is made up in accordance with these known facts, making a due allowance for an increase in crust temperature. It seems reasonable, then, to accept the results of the *Tables*.

The expression already developed for the sine of the angle made by radial direction with the direction of attraction is, $\frac{6}{5}\, h\, n^2\, m \sin O \cos O$. Columns 8, of Tables 1, 2 and 3, gives the values for $\frac{9}{5}\, h\, n^2\, m$. From these results the direction of attraction at any point on the surface of the earth is, $005137 \times \frac{2}{3} \sin O \cos O$. When angle O becomes 45°,

$$.005137 \times \tfrac{2}{3} \sin O \cos O = .001712.$$

At 45° the centrifugal force changes the direction of attraction:

$$\tfrac{1}{2} \times \tfrac{1}{289} = \tfrac{1}{578} = .001730.$$

The direction of gravity or of normal thus computed is:

$$.001712 + .001730 = .003442.$$

The direction of the normal for 45° is:

$$\tfrac{1}{294} = .003401.$$

The error is $\frac{1}{86}$, while the limit of error in the results attained by experiments for the mean density of the earth, or the ratio of surface density to mean is a fraction greater than this. The tables can be adjusted to meet the discrepancy $\frac{1}{86}$, but it would add nothing to accuracy as long as the accepted results of observation are equally uncertain.

To one now doubting the theory of the geologist, I have to say in due time, I shall give him a result for the precession of the equinoxes, computed from the data of *Table* 4, agreeing with observation.

The one effect of the attraction of the sun and moon on the earth wholly liquid, is changeable figure; the other effect on the earth wholly solid, is precession of equinoxes. The effect of the attraction on the particles of a liquid or solid just filling the solid unyielding crust container is the same. To be otherwise the container must instantaneously yield to certain changes of figure due certain effects of the attraction on the particles of the enclosed liquid. In such event the container has the liquid property and from the logic of the astronomer there should be no precession.

The component of the moon's attraction that produces the ocean tides, is only a small fraction of the whole, and this component decreases to nothing at the center of the ear h. The slowness of the action of this component force and the cohesion of the particles of water are such that the tide at any meridan does not appear till two hours after the moon has passed that meridan. If the tidal work was done instantaneously the tide would appear directly under the moon. A less component of attraction and a greater cohesion of particles results in slower tidal work. Such a decrease in the component attractions and such an increase in the cohesion of the particles from the surface of the earth to its center can be conceived from which the tidal effects would be wholly neutralized. It is at least evident in case of days of one hour instead of twenty-four, supposing no change of figure from change of rotation, that the ocean tides would glide to the condition of no tides as effectually as a boy slides over a thin scale of ice. The astronomer seems to have forgotten that it takes time to break ice. What is true of a water ocean and days of one hour is true of a plastic ocean and days of twenty-four hours. A crust that would be perceptibly flexible if the day were a month, might be imperceptibly so for a day of twenty-four hours. In case then, of the one hundred and twenty seven miles of solid rock crust and the plastic moulten interior what more could be reasonably expected for tides on the continents than infinitesimal vibrations.

31. The density or specific gravity of the original crust of the earth at the temperature of 0 Centigrade.

The order of evolution is from a condition of homogeneity to that of heterogeneity. To meet the results of the requisite test observations and experiments, the computations of the last article require the plastic interior of the earth to be homogeneous excepting the effect from the variation of pressure. That portion of the primitive crust not yet disintegrated by the action of water or otherwise is likewise homogeneous, and the results of the best investigations point it out to be a neutral rock, largely basic, such a rock as would be formed from the disintegrated material, not including the elements gathered in from the pristine heterogeneous atmosphere. Lyell, in speaking of trappean or volcanic rocks, says: "Abich has, therefore, proposed that we weigh these rocks in order to appreciate their composition in cases where it is impossible to separate their component minerals. Thus basalt from Staffa, containing 47.80 per cent. of silica, has a specific gravity of 2.95; whereas trachyte, which has 66 per cent. of silica, has a sp. gr. of only 2.68; trachytic porphyry, containing 69 per cent. of silica, a sp. gr of only 2.58. If we take a rock of intermediate composition, such as that prevailing at the Peak of Teneriffe, which Abich calls Trachyte-dolerite, its proportion of silica being intermediate, or 58 per cent. it weighs 2.78." On this principal ã trappean rock thrown up from a depth of 38 per cent. of silica would have a specific gravity of 3.12.

For each degree Centigrade granite expands in volume .000026, marble

000030, and French glass .000026. In using either of these fractions for primitive crust rock the margin of error is doubtless not large.

Deschanell says the compression for glass per atmosphere is about .0000029. Using for apparatus the moon and Mars instead of Oersted's Piezometer in experiment on the moon's crust and the crust of Mars, instead of on a piece of glass, I find crust rock material is compressed .0000037 per atmosphere. To one understanding the conditions, the results disagree within the limits of a good corroboration of the reliability of the apparatus.

Using for expansion .00003, and for compression .0000037, the computed temperature at 127 miles below the surface of the earth is about 3600° C. Per observations near the surface the increase in temperature is about one degree Centigrade in 90 feet, or 58 degrees in a mile. The average temperature of the crust, then, can not be far from 2500° C. The crust, then, in cooling to zero would contract about seven and one half per cent. This would make the density or specific gravity of crust rock about 3.20.

Lyell's table for "Analysis of Minerals most abundant in Volcanic and Hypogene Rocks," gives the following specific gravities: Hornblende-Faymont, in diorite, 3.20; Hornblende-Etna, in volcanic, 3.01; Uralite-Ural, 3.14; Angite-Bohemia, 3.35; Angite-Vesuvius, in lava, 3.25; Diallage-Hartz, n Gabbro, 3.23; Hypersthene-Labrador, 3.39; Bronzite-Greenland, 3.20, Olivite Carlsbod, in basalt, 3.40; Olivite-Mt. Somma, 3.33. The metals are developments from the disintegrated portion of the primitive crust. Duly considered in all directions it seems not unreasonable that crust rocks have a specific gravity of 3.20 at zero Centigrade.

32. *The interior density and temperature of the moon.*

The moon is admitted to be the direct and the only satellite offspring of the earth, and under the accepted law of its evolution, positive evidence is required to prove its component materials in like proportions, to vary from those of the earth. The mean density of the moon is about three fifths that of the earth, or 3.38 times that of water. In accordance with the method used in computing the interior density of the earth, to keep up a suitable degree of consistency and harmony with known facts, a crust or outside layer density of 3.20 must be used. If the mean density, 3.38, be a trifle small, or the surface density, 3.20, a little large, the remedy is to increase the factor .0000037 for compression, or to freeze the moon to 100 or more degrees below zero. As the factor .0000037 satisfies the conditions of Mars, that factor should not be changed. The freezing out process, then, is the only antidote. Computation gives the center density of the moon 3.52. The compression for a twenty-seven miles crust, or for about, 2,320 atmospheres, is .0086, or .0000037 per atmosphere.

It may be that the water and the air of the moon, chemically, have not yet wholly found quiet resting places, and here and there in its interior chemical action is generating heat. Doubtless, however, the moon, to the center, is solid, practically dead and colder than ice.

33. *The interior density and temperature of Mars.*

Newcomb says the mean density of Mars is 4.17 times water. Using 3.20 for the crust, the center density figures out 5.10. The compression for a fifty-six miles crust, or about 11000 atmospheres is .041, or .0000037 per atmosphere. These results are claimed to be only rough approximations. From them, nevertheless, it is doubtless safe to conclude that Mars is a solid to the center, that his interior heat has nearly all escaped and that the water and the air has been considerably absorbed in the interior of the planet.

34. *The interior temperature of the earth.*

The variation in the density of the earth from surface to center is given in Table 4, which has already been described. The conditions of this table require that the temperature of the interior layers be the same, which would be practically so in case of a moulten or liquid interior per law of convection. The compression for the one hundred and twenty-seven miles crust, or about 60000 atmosphere on the interior at temperature zero, should be .0000037 multiplied by 60000, or .222. The compression for the same crust of the earth in its presents condition given in Table 4 is only .11, or computed to three decimal places is .114. The difference .108 is caused by internal heat. This difference, .108 divided by .00003 gives the interior temperature to be 3600° Centigrade.

34. Interior density and temperature of Venus.

Newcomb gives 4.81 for the mean density of Venus, and 7,660 miles for her mean diameter or 258 miles less than the mean diameter of the earth, On the hypothesis that Venus has a moulten interior and a crust about the thickness of that of the earth, by using 3 for the crust density we get the required mass into the planet with a center density of 7, and a crust compression factor of .0913. The compression for one hundred and twenty three miles crust or about 49, 000 atmospheres is at temperature zero .1813. The difference between .1813 and .0913 divided by .00003 gives for the interior temperature of Venus 3000° Centigrade. Per Newcomb the gravity on the surface of Venus is .82, Mars .39, Earth 1.

35. *The interior density and temperature of Mercury.*

Mercury has a mean density, per Newcomb, 6.85, and a diameter of about 3000 miles, and also a surface gravity .46. The Moon's diameter is 2160 miles, mean density 3.38, crust density 3.20 and center density 3.52. Mars diameter is 4211 miles, mean density 3.17, surface density 3.20, center density 5.10, and surface gravity .39.

Without computation judging by a glance from the figures from the Moon and Mars, the crust density of Mercury must be from 5 to 5.50. Proctor thinks that 6.85 is too great for the mean density, and that it should be about that of the earth, 5.65. Under this condition Mercury's crust density would be from 4 to 4.30. The smallness of the diameter of this planet indicates that its interior heat has all or nearly all escaped. In case its interior heat has not escaped the figures above given for crust density must be made larger.

36. The crust density of Jupiter's satellites.

The diameters of Jupiter's satellites in orders of Nos. per Loomis is in miles, 2436, 2187, 3576 and 3057. There is some uncertainty about these diameters, and Newcomb says they vary from 2200 to 3700 miles. The mean densities of these satellites in order, per diameters of Loomis is, 1.05, 1.90, 1.70 and 1.32. The averages of these mean densities is 1.49, or a little more than the mean density of Jupiter, which is 1.38. The surface gravity of these satellites is very small, hence the center density can not be very much greater han the crust density. The average crust density can not vary much from 1.30.

37. As already obtained, the near surface or crust density of Mercury is about 5, Venus at present average temperature, 3, or at zero 3.20, the Earth at present average temperature, 2.96, or at zero 3.20, the Moon at zero 3.20, Mars at zero 3.20, and the average of Jupiter's satellites 1.20. From these results I see away back in the past a large ring around the sun; this ring separated into three, like the rings now around Saturn; and from these three came the triplet planets, Mars, the Earth and Venus.*

CONCLUSION.

During the delay of two years in the publication of this Report of the Academy of Sciences, Arts and Letters, I have added three chapters to this paper. As it stands the title is inappropriate, and the introduction fails to give due credit to the paper as presented. *The Attraction and the Figure of Equilibrium of a Rotating Fluid Mass, and the Interior Density and Temperature of the Earth,* is a more appropriate title. Measured by my reading of what has been written on the subject, this investigation attains not only some new final results, but it opens, by its new methods, a new field for valuable deductions. The new way of finding any diameter of the ellipse is a change from the complex to the simple. The system using chord and wedge elements of attraction instead of shell elements is a grand step of advance in simplification. By the new system mathe-

* It is due the author to say that the chapters of this paper were written at periods separated by months. The last chapter was composed after the previous ones had passed from his hands, and he was forced to keep up the connection with the other chapters, partially from memory. His excuse for not unifying the paper under an appropriate title is want of time.

matical expressions are attainable, easy to integrate, while by the old method complex expression are unavoidable, requiring the ability of a Legendre, a Laplace, or an Ivory to integrate.

In Article 12 I have given the fractional numbers for integrating the chord elements of attraction for an ellipsoid. If every man and women, from Adam and Eve to the last born of their posterity, had been engaged in the work of making the computations for these fractional numbers by the method outlined in Article 12, the end in view would now be unattained. Such being the impossibility in the way of that method, I will now give my other method in brief. It is as follows:

In diagram 1, Art. 3, let particle P be at the surface of the sphere having center C, in line P C of the diagram, then secant line P d a g becomes chord P a g and equals to chord k l h or 2 r cos ϑ. Likewise chord p n o equals 2 r cos ϑ. Let radius A C perpendicular to the axis of rotation be divided into n parts by a system of chords drawn parallel to axis P C, and also let these chords vary in length from chord to chord by a common difference 2 r divided by n. Let lines p n o and k l h be any two adjoining chords of the system. The mass cut from the sphere by a rotation of these chords equals $\frac{4}{3}\ \pi\ r^3\ (\cos^3\vartheta - \cos^3\vartheta_{\prime})$. As the increments to the cosines used in this computation vary from cos. to cos. as 2 r divided by n, cos. ϑ may be represented by any simple variable quantity (y). When n becomes infinite or 2 r divided by n, infinitisimal, then the differential mass or,

$$dm = \tfrac{4}{3}\ \pi\ r^3\ 3\ y^2\ dy.$$

Multiply each chord element of mass making up the sphere by its requisite cos ϑ, $\cos^2\vartheta$, $\cos^3\vartheta$, and so on to cos. having an exponent infinite. It is now required to intigrate the expressions y d m, y^2 d m, y^3 d m, etc., between the limits zero and unity.

$$\int_0^1 y\ d\,m = \tfrac{4}{3}\ \pi\ r^3 \int_0^1 3\ y^3\ d\ y = \tfrac{4}{3}\ \pi\ r^3 \times \tfrac{3}{4}.$$

$$\int_0^1 y^2\ d\,m = \tfrac{4}{3}\ \pi\ r^3 \int_0^1 3\ y^4\ d\ y = \tfrac{4}{3}\ \pi\ r^3 \times \tfrac{3}{5}.$$

$$\int_0^1 y^3\ d\,m = \tfrac{4}{3}\ \pi\ r^3 \int_0^1 3\ y^5\ d\ y = \tfrac{4}{3}\ \pi\ r^3 \times \tfrac{3}{6}.$$

Etc., to exponent infinite.

$\frac{4}{3} \pi r^3$ represents the mass of the whole sphere. The values, then, for

$$\text{Cos. } \vartheta = \tfrac{3}{4}.$$
$$\text{Cos.}^2 \vartheta = \tfrac{3}{5}.$$
$$\text{Cos.}^3 \vartheta = \tfrac{3}{6} \text{ etc., to cos. with exponent infinite.}$$

$$\text{Sin}^2\vartheta = 1 - \cos^2\vartheta = \tfrac{2}{5}.$$
$$\text{Sin}^4\vartheta = (1 - \cos^2\vartheta)^2 = 1 - 2\cos^2\vartheta + \cos^4\vartheta = \tfrac{2 \cdot 4}{5 \cdot 7}.$$
$$\text{Sin}^6\vartheta = (1 - \cos^2\vartheta)^4 = 1 - 4\cos^2\vartheta + 6\cos^4\vartheta - 4\cos^6\vartheta + \cos^8\vartheta = \tfrac{2 \cdot 4 \cdot 6}{5 \cdot 7 \cdot 9},$$

Etc. for higher powers.

The truth contained in the celebrated proposition of the square of the hypothenuse was doubtless well known long before the time of Pythagoras. Pythagoras in joy from the simplicity and the exactness of his demonstration of the celebrated proposition gave exclamation to the Greek word, *Eureka*. The memoirs of Legendre, Laplace and Ivory on *attraction* do not contain *Eureka* demonstrations. It requires inventive genius as well as mathematical ability to make such demonstrations. For borrowed knowledge on the subject of my writing to Sir Isaac Newton, I am indebted more by far than to all the rest combined.

Genera of the Family Attidae:

WITH A PARTIAL SYNONYMY.

BY

GEORGE W. AND ELIZABETH G. PECKHAM.

INTRODUCTION.

In the following paper we have endeavored to bring together the definitions of those genera of the family Attidae which have been generally received, and also of those which are part of the synonymy of the received genera. Up to this time these definitions have been so widely scattered through different works and periodicals that it has been a matter of great practical inconvenience to study and to compare them. It is probably due, in a measure, to this fact that many species have been placed in genera from which a moderate regard for the generic definitions would have excluded them; although perhaps a further difficulty may have arisen from a confusion of the two modes of classification, the one based on a type, and the other based on a general definition. To make clear the distinction between these two modes, we quote from Whewell[1], "Natural groups given by type, not by definition . . . . . the class is steadily fixed, though not precisely limited; it is given, though not circumscribed; it is determined, not by a boundary line without, but by a central point within; not by what it strictly excludes, but by what it eminently includes; by an example, not by a precept; in short, instead of a definition we have a *type* for our director. A type is an example of any class, for instance, a species of a genus, which is considered as eminently possessing the character of the class. All the species which have a greater affinity with this type-species than with any other, form the genus and are ranged about it, deviating from it in various directions and different degrees." On the other side we have from Mill:[2] " . . . . . the next step is to ar-

[1] The Philosophy of the Inductive Sciences, Vol. 1, pp. 476, 477.

[2] A System of Logic, pp. 504, 505. Huxley, also says: "It is said, in short, that a natural history class is not capable of being defined — that the class Rosaceæ for instance, or the class Fishes, is not accurately and

range those *infimae species* into larger groups . . . . . and in doing this it is true that we are naturally and properly guided, in most cases at least, by resemblance to a type. . . . . . But though the groups are suggested by types, I cannot think that the group, when formed, is *determined* by the type; that in deciding whether a species belongs to the group, a reference is made to the type and not to the characters. . . . . . The truth is, on the contrary, that every genus or family is framed with distinct reference to certain characters, and is composed, first and primarily, of species which agree in possessing all those characters. To these are added, as a sort of appendix, such other species, generally in small number, as possess *nearly* all the properties selected; wanting some of them one property, some another, and which, while they agree with the rest *almost* as much as those agree with one another, do not resemble in an equal degree any other group. Our conception of the class continues to be grounded on the characters; and the class might be defined, those things which *either* possess that set of characters, *or* resemble the things that do so, more than they resemble anything else. And this resemblance itself is not, like resemblance between simple sensations, an ultimate fact unsusceptible of analysis. Even the inferior degree of resemblance is created by the possession of common characters. . . . . . *Nor can there be any real difficulty in representing, by an enumeration of characters,* the nature and degree of the resemblance which is strictly sufficient to include any object in the class. There

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absolutely definable, inasmuch as its members will present exceptions to every possible definition; and that the members of the class are united together only by the circumstance that they are all more like some imaginary average race or average fish, than they resemble anything else. But here, as before, I think the distinction has arisen entirely from confusing a transitory imperfection with an essential character. So long as our information concerning them is imperfect, we class all objects together according to resemblances we *feel*, but cannot *define*; we group them around *types*, in short. Thus, if you ask an ordinary person what kind of animals there are, he will probably say beasts, birds, reptiles, fishes, insects, etc. Ask him to define a beast from a reptile and he cannot do it; but he says, things like a cow or a horse are beasts, and things like a frog or a are always some properties common to all things which are included. Others there often are, to which some things, which are nevertheless included, are exceptions. But the objects which are exceptions to one character are not exceptions to another; the resemblance which fails in some particulars, must be made up for in others. The class, therefore, is constituted by the possession of *all the characters which are universal*, and *most* of those which admit of exceptions. If a plant had the ovules erect, the stigmata divided, possessed the albumen, and was without stipules, it possibly would not be classed among the Rosaceæ. But it may want any one, or more than one, of these characters, and not be excluded. The ends of a scientific classification are better answered by including it. Since it agrees so nearly, in its known properties, with the sum of the characters of the class, it is likely to resemble that class more than any other in those of its properties which are still undiscovered."

A further confusion has arisen from certain authors making their generic definitions descriptive rather than comparative. For example, the definition of the genus Maratus Karsch is doubtless a good description, so far as it goes, of the species for which the genus was formed, and yet is equally applicable to many other genera, and in no way assists in organizing knowledge, nor in facilitating identification, which should be the two-fold purpose of a classification.

The synonymy of the genera is only partial; and those who have had most experience in the difficulties of this

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lizard are reptiles. You see *he does* class by type, and not by definition. But how does this classification differ from that of the scientific zoologist? how does the meaning of the scientific class-name of "Mammalia" differ from the unscientific of "Beasts?" Why, exactly because the former depends on a definition, the latter on a type. The class Mammalia is scientifically defined as "all animals which have a vertebrated skeleton and suckle their young." Here is no reference to type, but a definition rigorous enough for a geometrician, and such is the character which every scientific naturalist recognizes as that to which his classes must aspire — knowing, as he does, that classification by type is simply an acknowledgment of ignorance and a temporary device." Educational Value of Natural History Sciences; Lay Sermons, Addresses and Reviews, pp. 82, 83.

class of work will be least harsh in their criticism of its defects.

The key is based almost entirely on the generic descriptions, and is designed not only to aid in the identification of genera, but also, in a general way, to group together those genera which have common characteristics, and thus to aid in a comparison of the different groups. Its usefulness must be lessened by the fact that the generic position of a species has been commonly determined merely by its possessing a greater number of the characteristics of one genus than of any other. For example: Cyrba Simon has legs 4, 1, 3, 2. The greater number of characteristics of C. bi-maculatu Keyserling carry that species to the genus Cyrba, although it has the leg-formula 4, 3, 1, 2. If in the key Cyrba has been distinguished from other genera by the fact that its leg-formula is 4, 1, 3, 2, bi-maculata must go elsewhere.

We have also, for the purpose of facilitating comparison, arranged the characteristics of the different genera in the form of a table.

We have been perplexed by a lack of precision in the stating of characteristics. We venture to suggest that it would be well to express the dimensions of parts in terms of other parts of the same species. For example, the clypeus should be described not as " very low," or "rather high," but as one fifth or one half as wide as the middle anterior eyes. We believe that Menge is the only author who states definitely the height of the cephalothorax. He does so by comparing the height with the width.

Not having the work in which it is described, we have omitted the genus Portia Karsch. In his Arachnol. Blätter V. Zur Attiden-Gattung Portia, Dr. Karsch says that this genus resembles Eris (C. Koch) Simon, but differs from it in that the first pair of legs is not much more robust than the others; metatarsus + tarsus of the fourth are longer than patella + tibia of fourth, not equal or shorter as in Eris); and the spines on the tibiae and metatarsi of the hind legs extend to the base. The quadrangle of the eyes, also, is not wider behind than in front.

As we have undertaken to prepare a monograph of this family, we shall be very glad to receive Attidae from any part of the world, and to send in return spiders of the United States.

We give below a brief account of the Attid genera.

Milwaukee, Wisconsin, March, 1884.

THE ATTID GENERA.

From Latreille to Walckener, inclusively, the whole family constitutes but one genus, Salticus Latr. or Attus Walck. In 1832 Hentz detached the genera Lyssomanes, Synemosyna, and Epiblemum; Lyssomanes having the eyes in four rows; Synemosyna corresponding in part to Salticus (Latr.) C. Koch, or Leptorchestes Thorell, 1870; and Epiblemum in part to Calliethera C. Koch, 1837. In 1833 Sundevall divided Attus Walck. into two genera, Salticus and Attus. Salticus having the cephalic abruptly higher than the thoracic part, and the quadrangle of the eyes nearly square. Between 1833 and 1850 twenty-four genera were formed by C. Koch, most of which were so poorly defined by their author that their identification has been difficult or impossible. These genera, however, have been used as a basis of work by later authors who have redefined and united them, so that eighteen out of Koch's twenty-four genera are still used, beside some of his sub-genera which have been raised to the rank of genera by Thorell. A short history of C. Koch's genera would run as follows: Heliophanus, 1833; Euophrys, 1834; Dendryphantes, 1837; Pyrophorus, 1837; (the name Pyrophorus had already been used, and the genus was identical with Salticus (Latr.) Sund., 1833); Toxeus, 1846; (probably also included in Salticus (Latr.) Sund.; Janus, 1846; (the name Janus was preoccupied; the genus is in part Synemosyna Hentz, 1832, and in part Janigena Karsch, 1880); Philia, 1846, (the name Philia was preoccupied, and for it Thorell substituted, Philæus in 1870); Hyllus, 1846; (identical with Dineresus White, formed in the same year); Thiania, 1846; Marpissa, 1846; (the name Marpissa was preoccupied;

Thorell substituted Marptusa in 1877); Cocalus, 1846; Plexippus, 1846; Phidippus, 1846; Amycus, 1846; Alcmena, 1846; Asaracus, 1846; (this genus, without any striking characteristic, and formed for one imperfect individual, has never been used); Phyale, 1846; Eris, 1846; Ciris, 1848; Mævia, 1848; Rhanis, 1848 (identical with Homalattus White, 1841); Psecas, 1850; (this vaguely characterized genus has not been adopted by later authors); Icelus, 1850; (the name Icelus being preoccupied Simon substituted Icius in 1873); Ballus, 1850; (this was a sub-genus of Attus, made a genus by Thorell in 1870); Dia and Parthenia, two sub-genera of the genus Euophrys, were combined and made a genus with the name Ælurops (both Dia and Parthenia being preoccupied) by Thorell also in 1870.

During this period only one author, beside Koch, made any genera in the family Attidae. This was A. White, who, in 1841, made Homalattus; and in 1846 Dineresus, of which Hyllus C. Koch, takes precedence; and after 1850 no new genera were formed for many years. Of Westring and Blackwall, both writing in 1861, the former followed Sundevall's division (1833), into Salticus and Attus, while the latter used only Salticus Latr. unmodified. In 1864, Simon combined the Attid genera to form five: Rhanis C. Koch, Attus Walck, Cyrtonota Sim., Heliophanus C. Koch, and Salticus (Latr.) This arrangement, which was not generally adopted, seems not to have satisfied its author, as in 1869, Simon made an entirely new classification of the Attidae, recombining them into ten genera of which two, Menemerus and Yllenus were new.

We now come to 1870, in which year Thorell published the first part of his work on the genera and species of European spiders, probably the most important contribution thus far offered to arachnological literature in the department of classification. In so far as the Attidae are concerned his most valuable work was the unravelling of C. Koch's European genera. He resolved the family into thirteen provisional genera, one of which, Leptorchestes, was new. He also formed the genus Diolenius for the species A. phrynoides Walck.; and he made the changes in the nomenclature of some of C. Koch's genera which have already been mentioned.

In 1871, the genus Hasarius was formed by Simon. In 1872, Taczanowski described a new genus, Jelskia, which he placed under the family Dinopidae, but which seems to us to belong to the Attidae, since although the eyes are in four rows, (as in Lyssomanes Hentz), the eyes of the third row, are small, not as in the Dinopidae, larger than the others. In 1873 Simon substituted the name Icius for Icelus C. Koch.

In 1876, Simon modified his classification of the Attid genera, and succeeded in making an arrangement so good that as Dr. L. Koch remarks, it will form the basis for all future work. The new genera which he formed in this year were Synagles, Neera, Neon, Hyctia, Thya, Saitis, Pellenes, Habrocestum, Cyrba and Phlegra.

In 1877, Thorell made the genera Agorius and Viciria, and substituted the name Marptusa for Marpissa C. Koch. In the same year Simon formed the genus Bavia, and Simon and Cambridge each described a genus having the eyes in four rows; these are Evenus Simon, and Athamas Cambridge. Also in 1877, the genera Oedipus and Scartes were formed by Menge.

In 1878, Thorell formed the genera Boethus and Sinis; Karsch, the genera Lycidas, Ligonipes, Ligurinus, Maratus, Ascyltus and Mopsus; and Taczanowski, the genus Chirothecia.

In 1879, L. Koch formed the genera Astia, Scirtetes, Rhombonotus, Scaea, and Lagnus, and in 1880, Opisthoncus. In 1880, also, we have the genus Janigena Karsch. In 1881, Keyserling formed Jotus, and Ergane, and Thorell, Simaetha, Discocnemius, Ephippus, Euryattus, Omoedus and Coccorchestes.

In 1882, Keyserling formed Thorellia (which afterwards proved to be identical with Saitis Simon), Eulabes, Tanypus, Acmaea (these three names being preoccupied they were afterward supplanted, Eulabes by Pirithous, Tanypus by Sinnamora, and Acmaea by Drepanephora); Morgaromma, Erasmia, Sobara, Selaophora, Prostheclina, Cytaea, Atrytone, Hadrosoma and Therosa; and Cambridge formed the genus Mago. This latter author, who has described a large number of species, has, with a few exceptions, included them all in the genus Salticus Latr.

In 1883, Keyserling formed the genera Lauharulla, Scythropa and Sandalodes, and substituted the names Pirithous, Sinnamora, and Drepanephora for Eulabes, Tanypus, and Acmaea.

In 1884 Simon formed the genera Mithion, Lystrocteisa and Chalcolecta.

Finding that several generic names now in use are preoccupied we make the following substitutions:

For Evenus Simon 1877, "Epeus." (Evenus Hübu. Lep. 1816. Agassiz' Nomencl. Zool. Evenus Lap. Col. 1836. Agassiz' Nomencl. Zool.)

For Sinis Thorell 1878, "Linus." (Sinis Heer. Col. 1862. Scudder's Nomencl. Zool.)

For Scirtetes L. K. 1879, "Damoetas." (Scirtetes Wagn. Mamm. 1841. Agassiz' Nomencl. Zool.)

For Ephippus Thorell 1881, "Zenodorus." (Ephippus Cuv. Pisc. 1829. Agassiz' Nomencl. Zool.)

For Erasmia Keyserling 1882, "Iona." (Erasmia Hope. Lep. 1840, Agassiz' Nomencl, Zool. Erasmia Heine. Aves 1863. Scudder's Nomencl. Zool.)

For Atrytone Keyserling 1882, "Tara." (Atrytone Scud. Lep. 1872. Zool. Record.)

For Hadrosoma Keyserling 1882, "Bootes." (Hadrosoma Fieb. Orth. 1853. Scudder's Nomencl. Zool.)

For Scythropa Keyserling 1883, "Bianor." (Scythropa Chand. Col. 1871. Zool. Record.)

For Drepanephora Keyserling 1883, "Hypoblemum." (Drepanephora Loew. Dipt. 1869. Zool. Record.)

We divide the family Attidae into two sub-families, the Attinae, having the eyes in three rows, and the Lysomanae, having the eyes in four rows.

KEY TO THE GENERA OF THE FAMILY ATTIDAE.[1]

1. Eyes in three rows 3
2. Eyes in four rows 161
3. [2]Trochanter I elongated much longer than the others 5
4. Trochanter I not elongated 13
5. Trochanter I much longer than coxa, shorter than femur 7
6. Trochanter I shorter than coxa (especially ♀), much shorter than femur 9
7. Cephalothorax low; quadrangle of eyes wider than long; tibia I slender and parallel .... [3]**Tara Peckham.**
8. Cephalothorax rather high; quadrangle of eyes almost equal in length and breadth; tibia I more or less dilated.... **Diolenius Thor.**
9. Quadrangle of eyes much longer than wide, and much longer than thoracic part; eyes of second row much nearer lateral than dorsal eyes .... **Lystrocteisa E. S.**
10. Quadrangle of eyes almost equal in length and breadth; thoracic and cephalic parts almost equally long; eyes of second row scarcely further from dorsal than from lateral 11
11. Legs short; anterior tibia strongly compressed and dilated, and conspicuously furnished below with two rows of strong spines, and in the middle line with thick hairs........ **Discocnemius Thor.**
12. Legs long; anterior tibia compressed, parallel, not dilated; armed below with numerous and strong spines in a double row. **Chalcolecta E. S.**
13. Cephalothorax distinctly wider in the middle than at the ends. **Rhombonotus, L. K.**
14. Cephalothorax not distinctly wider in the middle than at the ends 15
15. Body slender, antlike; legs weak 17
16. Body not antlike in form 29
17. Cephalic part higher than thoracic .... **Salticus Latr.**
18. Cephalic part not higher than thoracic 19
19. Abdomen with a distinct constriction 21
20. Abdomen without, or with a very slight constriction 23
21. Cephalic and thoracic parts separated by a constriction. **Janigena Karsch.**

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[1] On account of the vagueness of their definitions, we have been obliged to omit from the Key the genera Phyale, Asaracus, Alcmena, Psecas, and Thiania of C. Koch, and Lycidas, Ligurinus, and Maratus Karsch.

[2] We have here made use of the table given by M. Simon in his *Note sur le Groupe des Diolenii.* This group, so far as is yet known, is confined to Australian and Malesian islands.

[3] Tara = Atrytone Keyserling, preoccupied.

22. A constriction dividing the thoracic part into a shorter anterior and a longer posterior portion................**Synemosyna Hentz.**
23. Sternum prolonged between coxae I.......................... 25
24. Sternum not prolonged between coxae I...............**Agorius Thor.**
25. Pedicle of the abdomen not visible from above..[1] **Damoetas Peckham.**
26. Pedicle visible from above.................................... 27
27. Sternum scarcely as wide as intermediate coxae; labium at least twice as long as wide ....**Leptorchestes Thor.**
28. Sternum wider than intermediate coxae; labium as long as wide. **Synageles F. S.**
29. Clypeus very low in front, high below anterior lateral eyes, extended and a little curved backward on the sides, forming an acute angle below the eyes of the second row....**Ascyltus Karsch.**
30. Sides of clypeus forming no acute angle......................... 31
31. Body short, convex, beetle like; cephalic part not, or scarcely so long as thoracic... 33
32. Body not beetle like in form [2]................................ 35
33. Body strongly convex both longitudinally and transversely; abdomen high and widely truncated in front, where it is received into an excavation of the cephalothorax; eyes of the second row further from the dorsal than from the lateral eyes. **Coccorchestes Thor.**
34. Anterior part of abdomen not overlapped by cephalothorax; eyes of second row half way between dorsal and lateral eyes. **Omoedus Thor.**
35. Cephalic part as long as, or longer than thoracic 37
36. Cephalic part shorter than thoracic 61
37. Eyes of the second row at least half as large as eyes of the third row ....**Cocalus C. K.**
38. Eyes of second row less than one half as large as eyes of the third row.. 39
39. Quadrangle of eyes longer than wide; tibia I greatly dilated. **Chirothecia Tacz.**
40. Quadrangle as wide as, or wider than long; tibia I not dilated.... 41
41. Cephalic and thoracic parts equal.............................. 43
42. Cephalic part longer than thoracic............................. 55
43. Legs III and IV without spines........................**Ballus C. K.**
44. Spines on the four pairs.. 45
45. Third leg longer than fourth................................... 47
46. Third leg shorter than fourth 49

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[1] Damoetas=Scirtetes L. K., preoccupied.

[2] Some of the species of Homalattus White resemble beetles, but in this genus the cephalic part is longer than the thoracic.

47. Quadrangle of the eyes wider behind: third leg much longer than fourth .... [1]**Neaetha E. S.**
48. Quadrangle of eyes wider in front; third leg but little longer than fourth .... **Ciris C. K.**
49. Cephalothorax not wider than third row of eyes at that place ... 51
50. Cephalothorax wider than third row of eyes at that place; lateral eyes of first row well separated from middle eyes... **Pirithous Keys.**
51. Anterior row of eyes curved; lateral widely separated from middle eyes 53
52. Anterior row of eyes almost straight; lateral but little removed from middle eyes .... [2] **Bianor Peckham.**
53. Quadrangle of eyes equally wide in front and behind: metatarsus + tarsus IV longer than patella + tibia; tibial and metatarsal spines to the base, on legs III and IV .... **Portia Karsch.**
54. Quadrangle of eyes wider behind than in front; metatarsus + tarsus IV, equal to or shorter than patella + tibia; only circles of spines at the extremities of the tibiae and metatarsi of legs III and IV .... **Eris, C. K.**
55. Quadrangle of eyes wider in front than behind....... [3] **Iona Peckham.**
56. Quadrangle of eyes not wider in front 57
57. Cephalothorax as high behind as it is long ....**Mago Cambridge.**
58. Cephalothorax not as high behind as long 59
59. First row of eyes straight, touching..........**Neon E. S.**
60. First row of eyes curved, separated by nearly equal distances from each other..........**Homalattus White.**
61. Quadrangle of eyes longer than wide 63
62. Quadrangle of eyes wider than long.......... 65
63. Quadrangle of eyes more than twice as long as wide.. **Ligonipes Karsch.**
64. Quadrangle of eyes one fourth or one fifth only longer than wide.......... [4]**Plexippus C. K.**
65. A more or less prominent tubercle between the dorsal eyes. **Opisthoncus L. K.**
66. No tubercle present.......... 67
67. Cephalothorax short and very high, thoracic part much dilated and falling steeply from cephalic plate; cephalothorax wider than the third row of eyes.......... [5]**Amycus C. K.**
68. Form of cephalothorax unlike the above 69
69. Quadrangle of eyes wider in front than behind.......... 71

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[1] Neaetha=Neera E. S., preoccupied.

[2] Bianor = Scythropa Keyserling, preoccupied.

[3] Iona = Erasmia Keyserling, preoccupied.

[4] See genus Plexippus.

[5] The face in Amycus is very high, but not equally high in the different species.

70. Quadrangle as wide or wider behind 91
71. Tibia + patella III shorter than tibia + patella IV 73
72. Tibia + patella III longer than tibia + patella IV 81
73. Metatarsus + tarsus IV equal to or shorter than patella + tibia IV. 75
74. Metatarsus + tarsus IV longer than tibia + patella IV 77
75. Metatarsus IV spined only at extremity .... **Lauharulla Keys.**
76. Metatarsus IV spined to base .... **Astia L. K.**
77. Cephalothorax wider than third row of eyes 79
78. Cephalothorax not wider than third row of eyes.... **Sinnamora Keys.**
79. Legs moderately long; metatarsus IV with spines...... **Boethus Thor.**
80. Legs extremely long; metatarsus IV without spines ..... **Lagnus L. K.**
81. Eyes of the second row more than ⅓ as large as dorsal eyes; tibiæ spined above .... [1] **Linus Peckham.**
82. Eyes of second row less than ⅓ as large as dorsal eyes; tibiæ not not spined above 83
83. Cephalothorax not wider than third row of eyes 85
84. Cephalothorax wider than third row of eyes 87
85. Cephalothorax narrow in front, wider and rounded behind; quadrangle of eyes scarcely wider than long .... **Prostheclina Keys.**
86. Cephalothorax with sides nearly parallel; quadrangle of eyes one-third wider than long .... **Saitis E. S.**
87. Abdomen very long and slender, much longer than cephalothorax; cephalothorax much wider than third row of eyes ... **Viciria Thor.**
88. Abdomen rather short; cephalothorax but little wider than third row of eyes 89
89. Abdomen about as wide as long; eyes of second row further from lateral than from dorsal eyes .... **Margaromma Keys.**
90. Abdomen slender; eyes of second row half way between lateral and dorsal eyes .... **Therosa Keys.**
91. Quadrangle of eyes equally wide in front and behind; tibia + patella III longer than tibia + patella IV 93
92. Quadrangle of eyes wider behind; or equally wide in front and behind, with tibia + patella III equal to, or shorter than tibia + patella IV 99
93. Eyes of the third row distant by at least double their diameter from the margin of the cephalothorax ...... [2] **Zenodorus Peckham.**
94. Eyes of the third row not, or only a little removed from the margin of the cephalothorax 95
95. Metatarsus + tarsus IV equal to, or shorter than, tibia + patella IV 97
96. Metatarsus + tarsus IV longer than tibia + patella IV. **Ergane Keys.**

[1] Linus = Sinis Thorell, preoccupied.

[2] Zenodorus = Ephippus Thorell, preoccupied.

97. Legs III and IV nearly equal; eyes of third row further from each other than from lateral borders; anterior lateral well separated from large middle eyes .... **Cytaea Keys.**

98. Third legs longer than fourth; eyes of third row equally far from each other and from lateral borders; anterior lateral very near large middle eyes .... **Habrocestum E. S.**

99. Quadrangle of eyes equally wide in front and behind; anterior row of eyes straight 101

100. Quadrangle wider behind; or, if equally wide in front and behind, anterior row curved 117

101. Coxae I touching .... **Hyctia E. S.**

102. Coxae I separated by width of labium 103

103. Tibia IV as large as patella at base, cylindrical, parallel or a little enlarged at extremity 105

104. Tibia IV narrower than patella at base; slightly enlarged and a little compressed at extremity 109

105. Quadrangle of eyes as long as wide; fore central eyes excessively large, at least five times as large as the lateral .... **Mithion E. S.**

106. Quadrangle of eyes wider than long; fore central eyes not excessively large 107

107. Thoracic part a little dilated; coxæ IV longest ...... **Menemerus E. S.**

108. Thoracic part parallel; coxæ I largest .... **Bavia E. S.**

109. Patella III as long as or longer than patella IV; tibia III much shorter than tibia IV, but more robust 111

110. Patella III shorter than Patella IV; tibia III more slender than tibia IV 113

111. Clypeus at least $\frac{1}{3}$ as wide as large middle eyes; patellae always without spines .... **Euophrys C. K.**

112. Clypeus very narrow, scarcely $\frac{1}{5}$ as wide as large middle eyes; patellae armed with two spines .... **Cyrba E. S.**

113. Sternum wider than intermediate coxae; (♂) femur of palpus armed with a strong apophysis .... **Heliophanus C. K.**

114. Sternum of same width or narrower than intermediate coxae; femur of palpus unarmed 115

115. Thoracic part twice as long as cephalic .... **Phlegra, E. S.**

116. Thoracic part only $\frac{1}{3}$ longer than cephalic .... **Attus Walck**

117. Quadrangle of eyes equally wide in front and behind 119

118. Quadrangle of eyes wider behind 133

119. Anterior row of eyes strongly curved, a straight line from the summit of the middle eyes cutting the lateral eyes through, or below the middle .... **Scaea C. K.**

120. Anterior row of eyes slightly curved, a straight line from summit of middle eyes cutting lateral eyes above the middle 121

121. Legs without femoral and tibial spines; (♂) falces long and horizontal .... **Epiblemum Hentz**

122. Legs having femoral and tibial spines on the four pairs.......... 123
123. Eyes of the third row nearer to each other than to lateral borders..**Maevia E. S.**
124. Eyes of the third row equally distant from lateral borders and from each other.. 125
125. Eyes of the second row nearer the dorsal than the lateral eyes, **Selaophora Keys.**
126. Eyes of second row half-way between dorsal and lateral eyes, or nearer the lateral.. 127
127. Cephalothorax only $\frac{1}{6}$ larger than wide; scarcely wider than third row of eyes; first legs not stouter than the others, [1] **Bootes Peckham.**
128. Cephalothorax at least $\frac{1}{5}$ longer than wide; first legs stouter than the others.. 129
129. Cephalothorax considerably wider than third row of eyes; moderately high.. 131
130. Cephalothorax only slightly wider than third row of eyes; very high and convex......................................**Jotus Keys.**
131. Second row of eyes half-way between dorsal and lateral eyes; falces not diverging.................................**Sandalodes Keys.**
132. Second row of eyes nearer the lateral than the dorsal eyes; falces diverging..**Hyllus C. K.**
133. Anterior row of eyes very strongly curved, a straight line from the summit of the middle eyes cutting only the lower borders of the lateral eyes..................................[2] **Ælurillus E. S**
134. Anterior row of eyes straight or only moderately curved, a straight line from the summit of the middle eyes cutting the lateral eyes not below the middle................................ 135
135. Clypeus as wide as large middle eyes.......................... 137
136. Clypeus not so wide as large middle eyes...................... 139
137. Cephalothorax as wide as or barely narrower than long. **Sobara Keys.**
138. Cephalothorax at least $\frac{1}{2}$ longer than wide..........**Mopsus Karsch.**
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[1] Bootes=Hadrosoma Keyserling, preoccupied.

[2] Ælurillus=Aelurops Thorell, preoccupied.

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[1] Thyene=Thya Simon, preoccupied.

[2] Hypoblemum=Drepanephora Keyserling, preoccupied.

[3] Epeus=Evenus Simon, preoccupied.

SUB-FAMILY ATTINÆ.

DIOLENIUS THORELL, 1870.

Syn.: 1870. **Diolenius** THORELL, on Europ. Spid. Part I, p. 203.
1878. " ID., Ragni Malesi e Papuani, Part II, p. 215.
1881. " L. KOCH, Arachniden Australiens, p. 1240.

Thorell (in Europ. Spid., Part I, p. 203,) says that this genus is characterized by the long trochanters of the fore legs.

*TARA N.

Syn.: 1882. **Atrytone** KEYSERLING, Arachniden Australiens, p. 1378.

Cephalothorax low; one quarter longer than wide, in front moderately contracted, behind rounded, wider at the third row of eyes, plane above.

Clypeus very low.

Quadrangle of eyes wider than long, as wide before as behind, placed in front of the middle of the cephalothorax. Dorsal eyes further from each other than from the margin of the cephalothorax. Anterior row of eyes moderately recurved, eyes close together; small medium eyes further from the dorsal eyes than from the lateral anterior eyes.

Falces wide, short, not diverging.

Maxillae dilated in front.

Sternum plane, longer than wide.

Abdomen elongated, above level.

Legs 1, 4, 2, 3, Coxa and trochanter of first pair very much elongated. Patella and tibia of the third shorter than patella and tibia of the fourth; Metatarsus and tarsus of the fourth shorter than the patella and tibia.

LYSTROCTEISA SIMON, 1884.

Lystrocteisa E SIMON. Note sur le Groupe des Diolenii; Comptes Rendus de la Société Entomologique de Belgique. 1884.

Related to Diolenius, but distinct by the following characteristics: ocular quadrangle longer than the thoracic part, much longer than wide, convex in front, flattened in the middle; eyes of the third row very prominent, larger and plainly further apart than the lateral anterior; eyes of the second row much nearer the lateral anterior; trochanter I cylindrical, a little

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**Tara* is substituted for *Atrytone*, the latter name being preoccupied.

shorter than the coxa, much shorter than the femur; femur very wide, claviform; tibia almost globular, compressed below with two rows of long spines; metatarsus slender, with two pairs of long spines.

CHALCOLECTA SIMON. 1884.

Chalcolecta E SIMON. Note sur le Groupe des Diolenii; Comptes Rendus de la Société Entomologique de Belgique. 1884.

Ocular quadrangle at least as long as the thoracic part, of the same form as that of Diolenius; anterior row of eyes less curved than in that genus. Trochanter I shorter than the coxa (particularly ♀) and much shorter than the femur; femur and tibia I very long, compressed, parallel, not dilated, and tibia provided below with two rows of at least 10 + 10 strong spines, alternately shorter and longer; metatarsus shorter than the tibia, ♂ shortened, compressed and angular[1], ♀ cylindrical and provided below with three or four pairs of long spines; relative length of legs 1, 4, 3, 2.

DISCOCNEMIUS THORELL. 1881.

Discocnemius THORELL, Studi sui Ragni Malesi e Papuani, III, p. 428.

Cephalothorax long, moderately high, cephalic part not abruptly higher than thoracic, limited by a transverse depression.

Clypeus very low.

Sternum not narrower than the coxae, not usually projecting between those of the first pair.

Eyes area occupying about half the length of the cephalothorax; quadrangle at least as wide behind as it is long; anterior middle eyes very large; eyes of the second row almost in the middle, between the posterior and the anterior lateral eyes; posterior eyes scarcely or not higher by their own diameter than the anterior lateral eyes.

Maxillae sub-parallel, about twice as long as wide, and about twice as long as the lip. Lip longer than wide, sub-truncated at the extremity.

Legs 4, 1, 2, 3, slender, except the first pair, which is robust (excepting the metatarsus and tarsus); tibia especially wide and compressed, and underneath furnished with a medium longitudinal fascia of dense, long hairs, and two rows of spines, patella and trochanter not usually longer.

Abdomen long.

Spinnerets six, superior and inferior not differing much in length, last joint short.

Type: D. lacertosus.

Related both to Diolenius Thorell and Chirothecia Tacz.

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[1] In the original this sentence reads "metatarse plus court que le tibia, ♂ mutique comprimé et auguleux," etc.

SALTICUS (LATR.) 1804. SIMON.

Syn.: 1804. **Salticus** LATR., Nouv. Dict. d'Hist. Nat., XXIV, p. 135, (ad partem).
1805. **Attus** WALCK., Tabl. d. Aran., p. 22 (ad partem).
1837. **Pyrophorus** C. KOCH, Uebers. d. Arachn.—Syst., 1, p. 29.
1846. **Toxeus** C. KOCH, Die Arachn., XIII, p. 19.
1864. **Salticus** [SALTICA]: Sub-gen. Pyrophorus [Pyrophora] Sim. H. N. D. Araignees, p. 336.
1869. **Pyroderes** ID., Monogr. d. Attid., p. 248 (714).
1870. **Salticus** THORELL, On Europ. Spid. I, p. 208.
1871. " SIM., Rèvis. d. Attid.
1876. " ID., Arachn. de France, III, p. 6.
1877. " THORELL, Studi Ragni Malesi e Papuani, I, p. 213.
1878. " LEBERT, Die Spinnen der Schweiz, p. 296.
1878. " TACZ., Aranéides du Pérou, Bull. Soc. Imp. des Nat. de Moscou, LIII, 4, p. 371.
1879. " L. KOCH, Arachniden Australiens, p. 1055.
1880. " KARSCH, Arachnol. Blätter VIII, Zur Kenntniss der Attiden, *in* Zeitsch, f. d. gesammt. Naturwissensch., LIII p. 395.
1880. **Toxeus** ID , ibid., pp. 393, 394.

Cephalothorax elongated; cephalic part high, parallel, level, almost as wide as long, its posterior angles rounded; thoracic part narrower, lower, on a different plane, rounded or obtusely truncated behind.

Clypeus very narrow, with sparse hair.

Eyes of the face very unequal, sub-touching, in a straight line, with some hairs around them; dorsal eyes as large as the lateral, a little further apart, forming with them a group wider than long, not, or scarcely projecting.

Sternum very narrow, projecting between the anterior coxæ.

Falces (♂) very long, flat above, horizontal; inferior border of the groove with a continuous row of strong teeth. (♀) Falces short, robust, vertical.

Maxillæ long, square at the extremity, with the superior external angle projecting a little.

Lip much longer than wide, almost parallel, truncated or slightly hollowed.

Palpus (♂) slender; tibia as long and wider than the patella; tarsus oval, rather narrow, and truncated; bulb discoidal, occupying only the inferior part of the tarsus. (♀) Palpus with the tibia and tarsus enlarged in the form of an oval palette.

Legs 4, 1, 3, 2: Third and fourth pairs unarmed; tibiæ and metatarsi of the first and second pairs with two rows of inferior spines; tibia of the first much longer than the patella; patella and tibia of the third much shorter than the patella and tibia of the fourth; tarsus and metatarsus of the fourth a little shorter than the patella and tibia.

LEPTORCHESTES (THORELL) 1870. SIMON.

Syn.: 1832. **Synemosyna** HENTZ, On North Amer. Spid., p. 108 (ad partem).

1837. **Salticus** C. KOCH, Uebers. d. Arachn.—Syst., 1, p. 29 (ad partem.)

1869. " SIM. Monogr d. Attid., p. 6 (16), 241 (707) (ad partem).

1870. **Leptorchestes** THORELL, On Europ. Spid., I, p. 209 (ad partem).

1871. " SIM., Révis. d. Attid. (ad partem).

1876. " ID., Arachn. de France, III. p. 10.

1878. " LEBERT, Die Spinnen der Schweiz, p. 297.

1879. " L. KOCH, Arachniden Australiens, p. 1057.

Cephalothorax plane, but little elevated, parallel, rounded or obtusely truncated behind; a slight transverse depression separating the cephalic part.

Clypeus very narrow.

Eyes of the face very unequal, in a straight line, touching. Dorsal eyes of the same size or barely smaller than the lateral, forming with them a group much longer than wide.

Sternum at least as narrow as the intermediate coxæ, projecting between the anterior coxæ.

Lip almost twice as long as wide, parallel, terminating in an obtuse point.

Falces robust, short, vertical in both sexes.

Palpus (♂) not robust; tibia short with an external apophysis; bulb simple.

Legs 4, 1, 3, 2; third and fourth pairs unarmed: (♂) metatarsi of the first and second with some inferior spines; (♀) tibiæ and metatarsi of the first and second presenting two rows of inferior spines; patella and tibia of the third much shorter than patella and tibia of the fourth; metatarsus and tarsus of the fourth shorter than the patella and tibia.

SYNAGELES SIMON. 1876.

Syn.: 1837. **Salticus** C. KOCH, Uebers. d. Arachn.—Syst., I, p. 29 (ad partem).

1869. " SIM., Monogr. d. espèces Europ. de la fam. d. Attides, p. 241 (707) (ad partem).

1870. **Leptorchestes** THORELL, On Europ. Spid. I, p. 209 (ad partem)

1871. " SIM.

1876. **Synageles** ID., Arachn. de France, III, p. 14.

1883. " ID., Arachn. de L'Ocean Atlantique, Ann. Soc. Ent. de France 1862, p. 261.

Cephalothorax flat, but little elevated, very much elongated, parallel, obtusely truncated behind; a slight horizontal depression separating the cephalic part.

Eyes: The dorsal eyes situated a little beyond the middle of the cephalothorax, scarcely projecting above, of the same size as the lateral, and forming with them a group much longer than wide. Eyes of the face very unequal, touching, forming a straight line, surrounded by fine circles of hairs.

Clypeus very narrow; hairs forming the beard sparse.

Sternum oval, more slender at the two extremities, wider in the middle than the intermediate coxae, projecting between the anterior coxae.

Lip at least as wide as long, semi-circular, or in a very obtuse triangle.

Maxillæ extending much beyond the lips but nevertheless rather short and very wide. Square at the extremity.

Legs: Fourth legs the longest; the three anterior pairs equal or almost equal; the two posterior pairs unarmed; (♂) metatarsi of the first and second alone provided with some inferior spines; (♀) tibiae and metatarsi of the first and second presenting two rows of inferior spines; tibia of the first robust, of the same length or scarcely shorter than the patella; patella and tibia of the third much shorter than patella and tibia of the fourth; metatarsus and tarsus of the fourth shorter than patella and tibia.

Falces (♂ ♀) robust, short, vertical.

Palpus (♂) not very robust; tibia very short, provided with an external apophysis; tarsus obtuse oval; bulb simple, reaching at least the superior third of the tarsus; (♀) rather slender; tarsus slightly enlarged and cylindrical.

AGORIUS THORELL. 1877.

Agorius THORELL, Studi sui Ragni Malesi e Papuani, I, p. 216.

Cephalothorax about twice as long as wide, the posterior part plainly narrowing a little, almost vertical towards the sides, rather low, the cephalic part scarcely higher than the thoracic.

Clypeus very low, less than ¼ the diameter of the anterior middle eyes, without thick hairs.

Sternum much wider than the coxæ, not projecting between the coxæ of the first pair.

Eyes: Are a large, occupying almost half the length of the cephalothorax. Quadrangle only a little wider than long, at least as wide in front as behind. Anterior row of eyes rather strongly curved upward, middle eyes plainly visible when the cephalothorax is looked at from above, touching, the lateral well separated from the middle, eyes of the second row small, and a little further from the posterior eyes, which are but little smaller than the anterior lateral eyes, than from these; posterior eyes further from each other than from the margin of the cephalothorax.

Falces small, vertical (at least in ♀).

Maxillae diverging a little, sub-ovaté, the extremities appearing rounded, almost twice as long as the lip, which is a little wider than long, narrowing toward the apex.

Legs exceedingly slender, long: 4, 1, 3, 2; trochanters, at least of the fourth pair, much longer than thick; space between the coxæ of the first pair nearly as wide as the sternum; posterior tibiæ and metatarsi without spines. First pair with patellae very long, almost as long as the femora, and the tibiæ and metatarsi, on the contrary, very short. Two claws, small, slender, bent, strongly curved at the apex, armed with teeth, especially small and short in the tarsi of the first pair; claw tufts distinct.

Abdomen slender, sub-cylindrical; pedicle short, not articulated.

Maxillae longer, sub-cylindrical.

Pubescence fine and sparse.

Type. A. gracilipes.

This genus is related to Synemosyna Hentz, Salticus Latr., Leptorchestes Thor., and especially to Synagels Sim., differing from this genus in not having the sternum produced between the coxae of the first pair, in the quadrangle of the eyes being shorter, and in the structure of the first pair of legs, which resemble those of Diolenius Thor. However, in Diolenius, it is the trochanters which are elongated, not, as in Agorius, the patellae.

[1] DAMŒTAS N.

Syn.: 1879. **Scirtetes** L. KOCH, Arachn. Australiens, p. 1070.

Cephalothorax almost twice as long as wide, slightly rounded on the sides contracted equally toward the anterior and posterior, convex above. Clypeus low, equaling in height the radius of the lateral eye of the first row.

Quadrangle of eyes longer than wide, wider behind than in front; third series of eyes as wide as cephalothorax. First row of eyes slightly recurved, placed close together. Eyes of the third row more widely separated from each other than they are separated from the margin of the cephalothorax. The middle eyes are much further from the posterior eyes than they are from the lateral eyes of the first row.

Maxillae convex, margin in front a little rounded. *Lip* scarcely equals half the length of the maxilla, convex, contracted toward the anterior, the tip rounded and swollen.

Sternum long and contracted, convex, projecting between the first pair of thighs.

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[1] *Damœtas* is substituted for *Scirtetes,* the latter name being preoccupied.

Abdomen twice as long as wide; anterior part limited by a transverse impression, covered by a thin skin; posterior part convex, clothed with a hard dorsal integument.

Legs spined, 1, 4, 2, 3; 1 and 4 equal, and 3 and 4 differ slightly in length; first pair stouter than the others. Patella with the tibia of the third pair shorter than the same articulations of the fourth pair; the metatarsus and the tarsus of the fourth pair are shorter than the patella with the tibia.

JANIGENA KARSCH. 1880.

Syn.: 1846. **Janus** C. KOCH, Die Arachn., XIII, p. 21. (ad partem).

1880. **Janigena** KARSCH, Arachnol. Blätter VIII, Zur Kenntniss der Attiden, *in* Zeitschr, f. d. gesammt. Naturwissensch., LIII p. 393.

The cephalic part sharply marked off, but not higher than the thoracic part, very flat and wide. The quadrangle of the eyes is wider behind than in front, the palpus over-reaches the very short mandible, also in the male in length in wide contrast to Toxeus and Synemosyna. The two single barren typical specimens do not admit of a more exact definition. Type, Janus melanocephalus (K). As the generic name Janus was preoccupied, (Verany, 1844, Gastropoda) Karsch proposed the name Janigena.

Thorell, in his review of the genera of European spiders, p. 36, had called attention to the fact that the name Janus was preoccupied, even before Verany, 1844. (Janus Steph. [Hymenopt] 1835). See remarks on the genus Synemosyna under that genus.

SYNEMOSYNA HENTZ. 1832.

Syn.: 1832. **Synemosyna** HENTZ, on North Amer. Spid., p. 108.

1846. **Janus** KOCH, Die Arachn., XII I, p. 21 (ad partem).

1870. **Leptorchestes** THORELL, on Europ. Spid., I, p. 209 (ad partem).

1876. " SIM., Arachn. de France, III, p. 10 (ad partem.)

1877. **Synemosyna** THORELL, Studi Ragni Malesi e Papuani, I, p. 198.

1878. **Janus** TACZ., Aranéides du Pérou, Bull. Soc. Imp. des Nat. de Moscou. L. III, 4, p. 372.

1879. **Synemosyna** L. KOCH, Arachniden Australiens, p. 1052.

1880. **Synemosyna** KARSCH, Arachnol. Blätter VIII, Zur Kenntniss der Attiden, *in* Zeitschr. f. d. gesammt. Naturwissensch., L. III, p. 395.

1881. " THORELL, Studi Ragni Malesi e Papuani, III, p. 406.

Eyes eight, unequal, in three rows, the first composed of four eyes, the two middle ones largest, the second composed of two small ones placed nearer the first than the third, which is composed of two larger eyes.

Falces short in the females.
Maxillae slightly inclined toward the lip, truncated at the tip.
Lip short, rounded.
Legs slender, fourth pair longest, the other three variable.
Abdomen contracted near the middle: body nodose, elongated.

Type, S. formica Hentz.

S. formica, upon which species Hentz founded this genus, is undoubtedly identical with Janus gibberosus Koch, which was used to form the genus Janus. Both Hentz and Koch had the spider from Pennsylvania. The other species of Janus described by Koch, J. melanocephalus, has been made the type of the genus Janigena by Karsch.

Hentz, when defining his genus Synemosyna, wrote "cheliceres short in emale," and in contrasting it with Myrmecia notes that in the genus (Myrmecia) "the cheliceres are large in this, (Synemosyna) they are small at least in the female." When describing his typical species — S. formica — he states that "the cheliceres are large *only in the male*." All the other species placed by him in this genus, both in the male and female have the cheliceres *short*. Now as a matter of fact both sexes in S. formica have short cheliceres. Mr. Emerton first called attention to the error in his notes to Burgess' edition of Hentz's arachnological writings. We have seen a good many males of this spider and all had the short falces. If S. formica represents Hentz's genus, then nearly, if not all, the species placed here by Messrs. L. Koch, Thorell and Karsch, belong in another genus.

RHOMBONOTUS L. Koch. 1879.

Rhombonotus L. Koch. Arachniden Australiens, p. 1067.

Cephalothorax almost twice as long as wide, contracted equally in front as behind, slightly convex.
Clypeus about the radius of the middle eyes of the first row.
Quadrangle of eyes longer than wide, narrower in front than behind; the third row of eyes placed behind the middle of the cephalothorax and above the lateral declivity of the same, more widely separated from one another than from the margin of the cephalothorax. The first row of eyes slightly recurved and close together. The middle eyes are nearer the lateral eyes of the first row than the eyes of the third row.
Maxillae moderately convex, anterior margin round.
Labium half as long as the maxilla, a little contracted toward the anterior, the tip rounded.
Sternum convex, long, contracted, projecting between the anterior thighs
Legs 4, 1, 2, 3.: the second and third pairs of equal length, the first pair more robust than the others. Patella with the tibia of the third shorter than the patella with the tibia of the fourth. The fourth leg has the metatarsus with the tarsus longer than the patella with the tibia.

Abdomen cylindrical, constricted in front of the middle by a transverse impression.

OMOEDUS THORELL. 1881.

Omoedus THORELL, Studi sui Ragni Malesi e Papuani, III, p. 668.

Cephalothorax high behind, anteriorly a little dilated above, the back therefore wide, slanting in front of the posterior eyes, behind them nearly level, strongly rounded behind, when looked at from above, only slightly convex transversely; the posterior slope almost vertical, and transversely concave.

Clypeus rather high.

Eyes quadrangle much wider than long, not occupying half the length of the cephalothorax; almost rectangular; anterior row usually curved; eyes of the second row half-way between the posterior eyes and the anterior lateral eyes; posterior eyes at least their own diameter higher than the anterior lateral eyes, and further from each other than from the lateral borders.

Sternum wider than the coxae, not projecting between the widely separated coxae of the first pair.

Falces short, sub-vertical.

Maxillae long, narrow at the base, sub-ovate. Lip scarcely or not wider than long, apex somewhat rounded.

Palpi those of the female not dilated nor flattened toward the apex.

Legs rather short, (♀) 4, 3, 1, 2 (or 2, 1?); tibia with patella of the fourth pair longer than tibia with patella of the third.

Abdomen short, a little flattened, the anterior margin truncated, covered with delicate skin.

Spinnerets six, the superior much more slender than the inferior.

Type O. niger.

This genus resembles Coccorchestes Thor., differing from it especially in having the body sub-flattened, not strongly convex. It differs from ordinary Attidae much less than Coccorchestes.

COCCORCHESTES THORELL. 1881.

Coccorchestes THORELL, Studi sui Ragni Malesi e Papuani, III., p. 671.

Cephalothorax slanting in front of the posterior eyes, very high behind them and nearly level or ascending, the posterior margin of the back widely truncated.

Clypeus high, inclined backward.

Eyes quadrangle wider than long, scarcely or not occupying half the greatest length of the cephalothorax; anterior row with the eyes sub-touching, only slightly curved upward, eyes of the second row further from the posterior eyes than from the anterior lateral eyes; posterior eyes more than their own diameter higher than anterior lateral eyes.

Sternum wider than the coxae, not projecting between the separated coxae of the first pair.

Falces short, sub-vertical.

Maxillae short, narrow at the base, wide at the apex, almost ovate triangular. Lip a little longer than wide, rounded at apex.

Palpi of the female a little dilated and usually convex toward the apex.

Legs moderately short, 4, 1, 2, 3 (3, 2), femora robust and compressed.

Abdomen short, almost ovate triangular, high and widely truncated in front, anterior slope convex, and received into the excavation of the cephalothorax, covered with hard shining scales forming a shield.

Spinnerets six, the superior longer and more slender than the inferior.

The whole spider is very convex, both longitudinally and transversely when looked at from above strongly resembling a beetle.

HOMALATTUS WHITE. 1841.

Syn.: 1841. **Homalattus** WHITE, Description of new or little known Arachn., *in* Ann. and Mag. of Nat. Hist., VII, p. 476.

1848. **Rhanis** C. KOCH, Die Arachn., XIV, p. 86.

1870. **Rhene** THORELL, on Europ. Spid. I, p. 37.

1877. **Homalattus** ID., Studi sui Ragni Mal. e Pap., I, p. 289.

1878. **Rhene** TACZ., Aranéides du Pérou, Bull. de la Soc. Imp. de Moscow, LIII, 4, p. 289.

1879. **Homalattus** L. KOCH, Arachniden Australiens, p. 1083.

1880. " KARSCH, Arachnol. Blätter VIII, Zur Kenntniss der Attiden, *in* Zeitsch. f. d. gesammt. Naturwissensch., LIII, p. 396.

Cephalothorax flat, transverse, not so wide as the body, covered like it with papillae.

Eyes eight, on short elevations of thorax; may be considered as placed in three lines, two of which are approximate, the third being distant; the first line, which is somewhat bent, contains four eyes, placed on the front margin of the cephalothorax at nearly equal distances from each other, the two intermediate eyes are much the largest. The second line contains two very minute eyes, somewhat removed from the edge of the thorax; they are placed rather nearer the outer eye of the first line than the outer is to the intermediate; the third line contains two eyes, one on each side of the margin of the thorax, the space between the outer eye and the first line being equal to the distance between the outer eyes of the first line.

Abdomen as broad as long; in front straightish; behind somewhat pointed; the sides rounded; it is flat and compressed, and somewhat convex above.

NEON SIMON. 1876.

Syn.: 1869. **Attus** SIM., Monogr. d. espèces Europ. de la fam. d. Attides, p. 14 (24) (ad partem).
1871. " ID., Revis d. Attid.
1872. **Euophrys** THORELL, on European Spiders, II, p. 404.
1876. **Neon** SIM., Arachn. de France, III, p. 208.
1880. " KARSCH, Arachnol, Blätter VIII, Zur Kenntniss der Attiden, *in* Zeitsch. f. d. Naturwissensch., LIII, p. 397.

Cephalothorax not high; cephalic part a little longer than the thoracic: the latter very slightly contracted and widely truncated.

Eyes of the face touching, forming a straight line. Dorsal eyes at least as large (often larger) than the lateral, very convex, not prominent; as far apart as the lateral eyes, since the sides of the quadrangle are parallel.

Clypeus less than half as wide as the middle eyes, almost glabrous.

Sternum triangular, much wider than the intermediate thighs.

Legs short; those of the fourth pair the longest; those of the first and third pairs nearly equal; those of the second pair the shortest; first pair a little thicker than the others; third and fourth pairs without spines; first and second pairs presenting below two rows of tibial and metatarsal spines usually long and bristle-like. Tibia and patella of the third shorter than tibia and patella of the fourth; tarsus and metatarsus of the fourth very slightly shorter than the patella and tibia.

Falces obliquely inclined, short, slender, taken together narrower than the two middle eyes.

Integument ornamented.

Spinnerets the superior ones longer than the inferior, and more slender; very far apart, leaving visible the inferior ones to the base, formed of two articulations, the second very short.

*IONA N.

Syn.: 1882. **Erasmia** KEYSERLING, Arachniden Australiens, p. 1350.

Cephalothorax one third longer than wide, a little contracted toward the front, behind rounded, not wider at the dorsal eyes, above plain.

Clypeus half the diameter of the large eyes.

Quadrangle of eyes wider than long; wider in front than behind; dorsal eyes placed a little behind the middle of the cephalothorax, almost further from each other than from the margin of the cephalothorax. First row of eyes slightly recurved and very close together. Small median eyes half way between the anterior lateral and the dorsal eyes.

**Iona* is substitued for *Erasmia*, the latter name being preoccupied.

Falces short, not diverging.
Labium half as long as the maxilla; slightly contracted anteriorly.
Sternum oval; one third longer than wide.
Legs 1, 4, 3, 2. Third and fourth equally long. First pair as stout or a little stouter than than the others. Patella and tibia of the third longer than the patella and tibia of the fourth. Metatarsus and tarsus of the fourth longer than the patella and the tibia. Metatarsus of the fourth without spines.
Abdomen long, ovate.

MAGO CAMBBIDGE. 1882.

Mago O. P. CAMBRIDGE. Proc. Zool, Soc., London, May 16, 1882, p. 432.

Cephalothorax as high behind as it is long; the posterior slope curved inwards, but almost perpendicular; profile of upper side of caput slightly convex, and sloping a little forward. The caput is exceedingly large, absorbing, in fact, almost the whole cephalothorax. Looked at from above, its upper surface forms nearly a square; the sides are perpendicular.
Height of clypeus less than the diameter of the fore central eyes.
Ocular area slightly broader than long, and equal in breadth before and behind; fore central pair of eyes very large, and of a dull, pearl-grey hue; fore laterals in a line with base of fore centrals, and of same color; posterior pair a little smaller than fore laterals, and as nearly as possible equally divided from them by the minute, intermediate eye, which is placed a little inside of their straight line.
Legs moderately long, tolerably strong, 1, 3, 2, 4; first pair much the strongest. Armed with spines. and with a small claw-tuft beneath the terminal tarsal claws.
Falces long, straight, divergent, and directed forward; denticulations small; fang of moderate length and strength.
Maxillae long, strong, straight; widened on both sides at the extremities, which are rounded.
Labium long, about two thirds the length of the maxillae, and narrower at the apex than base; apex rounded. The direction of the maxillae and labium is very nearly perpendicular (or at right angles) to the *sternum*, which is small, nearly round, slightly pointed behind and truncated in front; the truncation is very gently curved, the convexity of the curve directed backwards.
Abdomen small, short, oval, very convex before, and fitting up pretty closely to the incurved thorax.

ERIS (C. KOCH). 1846. SIMON.

Syn.: 1846. **Eris** C. KOCH, Die Arachn., XIII, p. 189.
1850. " ID., Uebers. d. Arachn.-Syst., 5, p. 59.
1869. **Attus** SIM., Monogr. d. Attid., p. 6 (16) 14 (24) (ad partem).
1871. " ID., Révis, d. Attid. (ad partem).
1876. **Eris** ID., Arachn. de France, III, p. 197.
1880. " KARSCH, Arachnol. Blätter VIII, Zur Kenntniss der Attiden, *in* Zeitsch. f. d. gesammt. Naturwissensch., LIII, p. 397.
1883. " SIM., Arachn. de l'Ocean Atlantique. Ann. Soc. Ent. de France, 1882, p. 303.

Cephalothorax moderately high, wide, and short; cephalic and thoracic parts of the same length; the latter very much inclined, contracted, truncated or slightly hollowed.

Clypeus moderately high, with hairs.

Eyes of the face very unequal, in a curved line; the lateral widely separated. Dorsal eyes scarcely smaller than the lateral, situated at the widest point of the cephalothorax, and not prominent.

Sternum short, as narrow or narrower than the intermediate coxae. Interval between the anterior coxae often less wide than the lip at the base.

Falces vertical, short, thick.

Legs 1, 4, 3, 2, or 4, 1, 3, 2: first pair more robust than the others, often, in the males, its femur and tibia dilated. Tibia and patella of the third plainly shorter than tibia and patella of the fourth. Tarsus and metatarsus of the fourth of the same length as or scarcely shorter than patella and tibia. Tibial and metatarsal spines on the four pairs; less numerous, and only appearing at the extremities of the articulations on the posterior pairs.

*BIANOR N.

Syn: 1883. **Scythropa** KEYSERLING, Arachniden Australiens, p. 1446.

Cephalothorax a little longer than wide, sides rounded, before and behind equally contracted, high and convex, not wider than the dorsal row of eyes.

Clypeus low.

Quadrangle of eyes behind wider than long, in front contracted, reaching the middle of the cephalothorax. Anterior row substraight; the lateral a little separated from the middle eyes. Dorsal eyes further from one another than from the margin of the cephalothorax. The small median eyes are nearer the anterior lateral than the dorsal eyes.

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* *Bianor* is substituted for *Scythropa*, the latter name being preoccupied.

Falces vertical, not diverging.
Maxillae twice as long as the labium, dilated and rounded in front.
Labium not longer than wide.
Sternum twice as long as wide.
Legs 1, 4, 3, 2. First pair stouter than the others. Patella and tibia of the third shorter than the patella and tibia of the fourth; metatarsus and tarsus of the fourth a little shorter than the patella and tibia. Metatarsi of the fourth spined only at the apex.
Abdomen oviform; one fourth longer than wide.
Spinnerets as usual; superior and inferior equally long.

PIRITHOUS KEYSERLING. 1883.

Syn.: 1882. **Eulabes** KEYSERLING, Arachniden Australiens, p. 1387.
1883. **Pirithous** KEYSERLING, Arachniden Australiens, p. 1477.
Cephalothorax a little longer than wide, sides rounded, behind slanting and contracted, above moderately high and plane, wider at the dorsal row of eyes.
Clypeus low.
Quadrangle of eyes wider than long, behind wider than in front, almost reaching the middle of the cephalothorax. First row of eyes strongly recurved, lateral eyes from the large middle eyes widely separated. small medium eyes further from the dorsal eyes than from the anterior lateral. Dorsal eyes further from one another than from the margin of the cephalothorax.
Falces diverging.
Maxillae long, a little dilated in front.
Labium longer than wide, not longer than half the length of the maxilla.
Sternum small and a little longer than wide.
Abdomen oval.
Legs spined, 1, 2, 4, 3, or 1, 4, 2, 3; first pair stouter than the others; patella and tibia of the third shorter than the patella and tibia of the fourth. Metatarsus and tarsus of the fourth shorter than the patella and the tibia. Metatarsi of the fourth spined.

The generic name Eulabes was preoccupied.

[1] NEAETHA SIMON. 1885.

Syn : 1869. **Attus** SIM., Monogr. d. espêces Europ. de la fam. d. Attides, p. 14 (24) (ad partem).
1871. " ID., Revis. d. Attid.
1876. **Neera** ID., Arachn. de France, III, p. 199.
1885. **Neaetha** ID., Etude sur Arachn. recueillis en Tunisie, Paris, Imp. Nat. 1885.

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[1] Neatha = Neera, preoocupied.

Cephalothorax high; cephalic and thoracic parts of the same length; the latter very much inclined, contracted, truncated, or slightly hollowed.

Eyes: those of the face but little separated, forming a straight line. Dorsal eyes a little smaller than the lateral, not prominent, situated at the widest point of the cephalothorax, further apart than the lateral since the sides of the quadrangle diverge behind.

Clypeus almost half as wide as the middle eyes, with thick hairs.

Sternum oval, of the same width as the intermediate thighs.

Legs 3, 1, 4, 2, or 1, 3, 4, 2; first pair much more robust, with the femur compressed, dilated above, and claviform; patella and tibia of the first thick and cylindrical. Tibia and patella of the third much longer than tibia and patella of the fourth; metatarsus and tarsus of the fourth as long or scarcely shorter than the tibia and patella. Tibial and metatarsal spines on the four pairs; the metatarsus of the fourth having only a circle of terminal spines.

Falces vertical, not long.

CIRIS C. KOCH. 1848.

Syn.: 1848. **Ciris** C. KOCH, Die Arachn., 14, p. 85.
1850. " ID., Uebers. d. Arachn. Syst., 5, p. 69.
1877. " THORELL, Studi Ragni Malesi e Papuani, I., p. 283

Cephalothorax short, flat above, scarcely longer than it is wide.

Eyes of the face in a straight row.

Falces strong, thick, not long, wrinkled, shining, vertical.

Palpus of the female of not unusual form, the tarsus tapering oval.

Legs short, nearly equally long,

Abdomen very short, almost circular.

Spinnerets drawn in and scarcely visible.

Thorell remarks that Ciris is near to Ballus (C. Koch) and more especially to Neera Simon, in that the eye area is large, occupying one half the cephalothorax; while it differs from Neera in having the quadrangle of the eyes not wider, but a little narrower hehind than in front, and the third pair of legs only a little longer than the fourth. Studi Ragni Malesi e Papuani, I, p. 285.

BALLUS (C. KOCH). 1850. SIMON.

Syn.: 1837. **Euophrys** C. KOCH, Uebers. d. Arachn. Syst., I, p. 33 (*ad partem.*
1846. **Marpissa** ID., Die Arachn. XIII, p. 53 (*ad partem*).
1850. **Attus:** sub.-gen. Ballus ID., Uebers. d. Arachn. Syst., 5 p. 68.
1869. " SIM., Monogr. d. Attid., p. 6 (16) 14 (24) (*ad partem*).
1870. **Ballus** THORELL, On Europ. Spid., I, p. 212.

1871. **Attus** Sim., Révis d. Attid.
1876. **Ballus** Id., Arachn. de France, III, p. 201.
1876. **Oedipus** Menge, Preussische Spinnen, IX, p. 482.
1877. **Ballus** Thorell, Ragni Malesi e Papuani, p. I, 286.
1878. " Lebert, Die Spinnen der Schweiz, p. 301.
1881. " Thorell, Ragni Malesi e Papuani, III. 665.
1882. " L. Koch and Keyserling, Arachn. Australiens, p. 1335.

Cephalothorax flattened: cephalic and thoracic parts of the same length; the latter contracted, inclined, truncated or slightly hollowed behind.

Clypeus less than half as wide as the large middle eyes.

Eyes of the face sub-touching, forming a straight or barely curved line. Dorsal eyes of the same size as the lateral, not prominent, situated at the widest point of the cephalothorax, much further apart than the lateral.

Sternum attenuated at both extremities, a little wider than the intermediate coxae.

Falces short, plane, or a little flattened in front.

Palpus (♂) not very long, and not robust; tibia shorter than patella, with an external terminal apophysis, slender, tarsus oval, relatively narrow.

Legs short; the fourth pair longest, the first pair much the most robust, with femur and tibia much dilated, often flattened and claviform. Tibia and patella of the third much shorter than tibia and patella of the fourth; metatarsus and tarsus of the fourth usually shorter than tibia and patella. Legs of the two posterior pairs entirely without spines (except æesiens); legs of the two first pairs having below two rows of tibial and metatarsal spines.

Integument covered with moderately long pubescence, simple, rarely scaly.

CHIROTHECIA Taczanowski. 1878.

Chirothecia Taczanowski, Bulletin de la Société Impériale des Naturalistes de Moscou, Tome LIII, 1878, No. 4, p. 362.

Cephalothorax low, flattened on the back; head much longer than wide, perfectly plane above; thoracic part shorter than the cephalic, a little lower behind.

Eyes of the third row placed very far back; those of the second row nearer the anterior than to the posterior eyes, and nearer each other than are the anterior and posterior lateral eyes. The tops of the anterior eyes are in a perfectly straight line; the middle eyes are very large, occupying the entire width of the face; the external eyes of this row are considerably larger than the eyes of the other rows.

Falces large, short and almost vertical in the female; long, horizontal, and armed with a long recurved hook in the male.

Legs ordinary and slender excepting those of the first pair which are thicker than the others, with the tibia enlarged and hollowed on its internal border to form a moderately deep groove; each of the borders of this groove has three long spines each articulated on an elevation which is low but much larger than the spine, and some irregularly distributed bristles; at the bottom of the groove is found a comb composed of wide, flattened hairs, which are crowded closely together, and disposed in a simple row.

Figure small.

This curious genus, in which the first legs are much thicker than the others, with the tibia greatly enlarged, resembling at the first glance the claws of crayfish and yet more those of chelifers, is characterized also by the extreme flatness of the cephalothorax, by the length of the cephalic part, and by the eyes of the last row being placed very far back.

COCALUS C. KOCH. 1846.

Syn.: 1846. **Cocalus** C. KOCH, Die Arachn., 13, p. 180.
1850. " ID., Uebers. d. Arachn. Syst., 5, p. 48.
1877. " THORELL, Studi Ragni Malesi e Papuani, I, p. 254.
1878. " ID., ibid., II, p. 283.
1881. " ID., ibid., III, p. 492.

Eyes of the first row all close together in a straight line. The two middle eyes are large, the outer, in diameter, scarcely half as large as the middle eyes; the eyes of the third row looking sideways, standing in a quadrangle with the first row, and as large as the lateral eyes of that row; the eyes of the second row only a little smaller than these, and placed half way between them.

Falces long, slender, vertical, cylindrical, with a rather short fang.

Palpus rather long, the first three joints slender, the fourth wide and short, the tarsus large, swollen, the bulb entirely covered; the bulb simple, with protuberances (einfach knotig), projecting a little forward.

The cephalothorax of this spider departs from all known species. The headplate forms an ascending slope from the first row of eyes, and ends in a roof-shaped ridge from which the thorax falls in a steep slope, to the hinder edge; the sides of the cephalothorax, however, are almost vertical, and therefore when looked at from above, it appears narrow. The abdomen is much narrower than the cephalothorax and cylindrical. The spinnerets are, in comparison with other genera, long and slender, the two upper and the two lower however, have but half the length of the two middle ones. The legs are rather long, the first and fourth pairs almost equally long, the second pair somewhat shorter than the first, and the third somewhat shorter than the second. All are rather slender.

[1] LINUS N.

Syn.: 1878. **Sinis** THORELL, Studi sui Ragni Malesi e Papuani, II p 269.

Cephalothorax not much longer than wide, and very high, sloping steeply in front.

Clypeus at least half as high as the middle anterior eyes.

Sternum sub-ovate, wider than the coxae.

Eyes: quadrangle rather large, occupying about ⅗ of the length of the cephalothorax, not much wider than long, a little narrower behind than in front, and but little narrower behind than the cephalothorax at that place. The anterior row of eyes, which is plainly visible when looked at from above, is a little curved upward. Middle anterior eyes very large, at least three times larger than the lateral eyes, and separated from them by only a small interval; eyes of the second row rather large, more than a third as large as the posterior eyes, and placed half-way between these, and the anterior lateral eyes; the posterior eyes, which are placed more than their own diameter higher than the anterior lateral eyes, are further from the lateral borders than from each other.

Falces short, not.

Maxillae sub-ovate, diverging, narrow at the base, almost twice as long as the lip; lip a little longer than wide.

Legs long, 1, 4 (in ♀ 4, 1), 2, 3, metatarsi and tarsi very narrow; first pair only a little more robust than the others, tibiae much longer than patallae; tibiae also spined above; posterior metatarsi with spines throughout their length.

Abdomen sub-ovate.

Spinnerets ordinary, two articulations, the superior the longer.

Type: S. fimbriatus (Dol.).

This genus is nearly related to Cocalus (C. L. KOCH).

HYCTIA SIMON. 1876.

Syn.: 1869. **Marpissus** SIM., Monogr. d. espèces Europ. de la fam. d. Attides, p. 7 (17) (ad part.).

1871. " ID., Rèvis. d. Attid.

1876, **Hyctia** ID., Arachn. de France, III, p. 18.

Cephalothorax elongated, almost parallel; thoracic part scarcely at all enlarged, at least a third longer than the cephalic part. Cephalic part flat, not inclined, limited by a wide depression, not deep, bent behind.

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[1] *Linus* is substituted for *Sinis*, the latter name being preoccupied.

Eyes of the face very unequal, touching, at least the middle eyes, forming a straight line; dorsal eyes almost as large as the lateral, not further apart, the sides of the head thus being parallel; the square almost as long as wide; the dorsal eyes much further from each other than from the lateral borders.

Clypeus scarcely a third as wide as the middle eyes.

Sternum small, narrow, twice as long as wide; thighs longer than wide, those of the first pair much thicker and longer than the others, tou hing.

Legs 1, 4, 2, 3; first pair very long and robust; femur dilated and compressed; patella and tibia cylindrical, the latter always a third the longer; these two articulations longer (♂) or almost as long (♀) as the cephalothorax; tarsus and metatarsus slender, shorter than the patella and tibia; tarsus a third shorter than the metatarsus. [1] Second, third, and fourth legs short and slender. Tarsus and metatarsus of the fourth shorter, or almost as long as the patella and tibia. On the anterior pairs two inferior rows of tibiae and metatarsal spines; on the posterior pairs two inferior tibial spines, and one or two metatarsal spines.

Falces robust, longer than the face, (♀) vertical, (♂) lightly inclined forward.

Palpus (♂) slender; femur narrow and a little curved; tarsus oval, not large; bulb simply rounded above, prolonged into a point behind.

Abdomen narrow, elongated.

MITHION Simon. 1884.

Mithion E. Simon, Arachnides recueillis a Khartoum; Bulletin de la Société Zoologique de France, T. IX.

Cephalothorax much elongated, almost parallel; thoracic part at least a third the longer; cephalic part almost plane, little elevated, not inclined, with posterior depression lacking, or very slight.

Eyes of the face touching, with their tops in a straight line, extremely unequal, the median at least five times the larger, very convex and prominent. Dorsal eyes as large as the lateral, not, or scarcely further apart. Quadrangle as long as wide, parallel. Dorsal eyes much further from one another than from the lateral borders.

Clypeus having scarcely a quarter the diameter of the midde eyes.

Falces (♀) very short, almost square and vertical.

Sternum oblong oval, narrowing in front and behind, of the same width in the middle as the intermediate thighs. Thighs I separated by the width of the labium at the base, much thicker than the others; thighs II thicker than III; III and IV almost equal.

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[1] Simon's description reads "first, third and fourth;" doubtless an error.

Patella and tibia I shorter than the cephalothorax, tibia scarcely longer than patella and as thick; tibia and patella IV a little longer than tibia and patella III; tarsus and metatarsus IV almost as long as patella and tibia; tibia IV at least a third longer than patella, cylindrical, neither attenuated or enlarged at the extremity. Spines short and serial on the tibiae and metatarsi I and II; slender on pairs III and IV; metatarsi III and IV with a whorl of terminal spines; and with two or three small spines toward the middle; spinnerets very long, particularly the superior ones, cylindrical.

This new genus resembles Marpissa, and still more Hyctia, differing from them in having the anterior thighs separated at the base by the width of the labium. It is closely related to the genus Icius E. S, but is distinguished from it by the quadrangle of the eyes being as long as wide and parallel, while in Icius it is plainly wider than long, and a little wider behind than in front, by the anterior median eyes being yet more large and prominent, and finally by the presence of several spines (one underneath and two internal lateral) on the posterior metatarsi, besides the terminal circle. It presents also a certain resemblance to the genus Thya, having the same kind of coloring, the scaly hairs, and the tufts of hairs in the form of horns on the cephalothorax, but it is far removed from it by the form of the cephalothorax and the proportions of the articulations of the two pairs of posterior legs.

MARPTUSA (THORELL), 1877. SIMON.

Syn.: 1837. **Dendryphantes** C. KOCH, Uebers. d. Arachn.-Syst., 1, p. 31 (ad partem).

1846. **Marpissa** ID., Die Arachn., XIII, p. 56 (ad partem).

1869. **Marpissus** SIM., Monogr. d. Attid., p. 6 (16), 7 (17) (ad partem).

1870. **Marpessa** THORELL, on Europ. Spid., I, p. 213 (ad partem).

1876. **Marpissa** SIM , Arachn. de France, III, p. 23.

1877. **Marptusa** THORELL, Ragni Malesi e Papuani, I, p. 221 (ad partem).

1878. " ID., ibid., II, p. 24 (ad partem).

1878. **Marpessa** LEBERT, Die Spinnen der Schweiz, p. 201 (ad partem).

1878. **Marpissa** TACZ., Aranéides du Pérou, Bull. Soc. Imp. d. Nat. de Moscou, LIII, 4, p. 217.

1879. **Marptusa** L. KOCH, Arachnidea Australiens, p. 1092 (ad partem).

1881. " THORELL, Studi Ragni Malesi e Papuani, III, p. 432 (ad partem).

Cephalothorax long; thoracic part a little dilated, at least a third the longer; cephalic part entirely plane, limited behind by a transverse depression.

Clypeus about half as wide as the middle eyes.

Eyes of the face rather unequal, forming a straight or scarcely curved line, a little separated; interval of the lateral wider than that of the middle, and yet not more than half their diameter. Dorsal eyes as large or almost as large as the lateral, a little further apart, since the sides of the head diverge a little behind; quadrangle at least a quarter wider than long; dorsal eyes much further from each other than from the lateral borders.

Sternum narrow, twice as long as wide. Anterior coxae almost touching, their interval much less wide than the lip; all the coxae longer than wide, those of the first pair thicker and a little longer than the others.

Palpus (♂) with the tarsus much enlarged in the form of a palette, and projecting beyond the bulb on all sides.

Legs of the first and second pairs equal or almost equal; those of the third and fourth a little shorter, equal or almost equal. First pair very robust; femur dilated and compressed; patella and tibia cylindrical, equal, or tibia barely longer (M. radiata ♂); these two articulations always shorter than the cephalothorax; tarsus and metatarsus more slender and shorter than patella and tibia; tarsus a little shorter than the metatarsus. Tarsus and metatarsus of the fourth shorter than the patella and tibia. Continuous inferior rows of tibial and metatarsal spines; tibial spines less numerous and less regular on the posterior pairs; usually the metatarsi of the fourth with only a terminal circle of spines.

In the Arachniden Australiens (p. 1093) Koch has used this genus in a different sense from both Simon and Thorell. The two latter define the clypeus as *about* half the middle eyes of the first row. Dr. Koch on the contrary extends the definition to include species where the middle eyes are equal to the clypeus or even overhanging the falces. Judging from the excellent figures which Koch gives, the spiders included in this genus form a very heterogenous group.

MENEMERUS SIMON, 1869.

Syn.: 1848. **Euophrys** C. KOCH, Die Arachn., XIII, p. 200 (ad partem).
1869. **Menemerus** SIM., Monogr. d. Attid., p. 6 (16), 196 (662).
1870. " THORELL, On Europ. Spid., I, p.214 (ad partem).
1870. **Marpessa** ID.. ibid., p. 213 (ad partem).
1876. **Menemerus** SIM., Arachn. de France, III, p. 30.
1877. " THORELL, Studi Ragni Malesi e Papuani, I, p .228 (ad partem).
1878. " ID., ibid., II., p. 237 (ad partem).
1879. " L. KOCH, Arachniden Australiens, p. 1123.

1881. **Menemerus** THORELL, Studi Ragni Malesi e Papuani, III, p. 500 (ad partem).
1883. " L. KOCH and KEYSERLING, Arachniden Australiens, p. 1461.
1883. " SIM, Arachn., de l'Ocean Atlantique. Ann. Soc. Ent. de France, 1882, pp. 261, 284, 303.

Cephalothorax elongated; thoracic part a little dilated, at least a third the longer; cephalic part flat, or very slightly convex, limited by a wide and shallow transverse depression.

Clypeus scarcely half the anterior middle eyes.

Eyes of the face rather unequal, forming a line slightly curved (rarely straight), a little separated, particularly the lateral eyes. Dorsal eyes a little smaller (sometimes as large; M. falsificus) than the lateral, not further apart, since the sides of the head are straight; quadrangle a quarter or a fifth only (M. semilimbatus) wider than long; dorsal eyes as far from one another as from the lateral borders (M. semilimbatus) or further from one another.

Sternum almost twice as long as wide; attenuated in front. Anterior thighs separated by the width of the lip at the base; all the thighs longer than wide; those of the first pair the longest.

Legs (♂) 1, 4, 2, 3, or 4, 1, 2, 3; (♀) 4, 1, 2, 3. Legs of the first pair thickest; femur compressed; patella and tibia cylindrical, the latter longer (except M. falsificus); tarsus and metatarsus more slender and much shorter than the patella and tibia; tarsus shorter than the metatarsus. Tarsus and metatarsus of the fourth shorter than patella and tibia; patella and tibia of the fourth much longer than patella and tibia of the third: tibia of the fourth cylindrical and parallel. Tibial and metatarsal rows of inferior spines on the four pairs.

Palpus short; femur very much dilated, almost as wide as long; convex above; patella and tibia short and almost equal; tarsus rather small, very convex.

Abdomen oval, a little flattened.

This seems to differ from Attus only in the slightly lesser width in proportion to the length of the quadrangle of the eyes.

DENDRYPHANTES (C. KOCH), 1837. SIMON.

Syn.: 1837. **Dendryphantes** C. KOCH, Uebers. d. Arachn.-Syst., I, p. 31 (ad partem).
1850. " ID., ibid., 5 p. 60 (saltem ad partem).
1869. **Attus** SIM., Monogr. d. Attid., p. 6 (16), 14 (24) (ad partem).
1870. **Dendryphantes** THORELL On Europ. Spid., I, p. 214.
1870. **Marpessa** ID., ibid., p. 213 (ad partem).
1871. **Attus** SIM., Révis. d. Attid. (ad partem).

1876. **Dendryphantes** SIM., Arachn. de France, III, p. 35.
1878. " LEBERT, Die Spinnen der Schweiz, p. 303 (ad partem).
1878. " TACZ., Aranéides du Pérou *in* Bull. Soc. Imp. d. Nat. de Moscou LIII, 4, p. 309.
1880. " KARSCH, Arachnol Blättter VIII, Zur Keuntniss der Attiden, *in* Zeitsch. f. d. gessamt. Naturwissensch., LIII, p. 397.
1883. " SIM., Arachnides de l' Ocean Atlantique, Ann. Soc. Ent. de France, 1882, p. 260

Cephalothorax moderately high; thoracic part plainly dilated, at least a third the larger; cephalic part level, often a little limited by a transverse depression.

Clypeus less than half as wide as the large middle eyes.

Eyes of the face rather unequal, in a line considerably curved; the middle eyes not touching; the lateral separated by an interval often equal to half their diameter. The dorsal eyes almost as large as the lateral, a little further apart, since the sides of the head diverge behind. Quadrangle a third wider than long. Dorsal eyes further from one another than from the lateral borders.

Sternum elongated, rather narrow. Anterior coxae separated by the width of the lip, and much thicker than the others; coxae of the fourth pair a little longer than the intermediate pairs.

Falces robust and vertical in both sexes.

Palpus (♂) rather slender; patella longer than tibia; tarsus narrow, oval, truncated at the extremity.

Legs (♂) 1, 2, 4, 3, or 4, 1, 2, 3; (♀) 4, 1, 2, 3, or rarely 4, 1, 3, 2; the first and (som times) second pairs more robust with compressed femora. Tibia and patella of the first shorter than the cephalothorax; (♂) tibia longer; (♀) tibia and patella equal. Tibia and patella of the third much shorter than tibia and patella of fourth. Tarsus and metatarsus of the fourth plainly shorter than tibia and patella. Tibia of the fourth cylindrical and parallel; metatarsus of the fourth with only a circle of spines at the extremity.

PSECAS C. KOCH, 1850.

Psecas C. KOCH, Uebers. d Arachn. Syst., 5, p. 49.

Eyes like the genus Marpissa.

Falces rather long, cylindrical, vertical.

Palpus in the male rather short, the tarsus glossy, the bulb pointed at the extremity.

Head and thorax nearest in form to the genus Marpissa. The face in front is as low, and is scarcely higher than the middle eyes of the first row. The falces are somewhat longer and in the only example that I have seen somewhat hidden under the palpus, so that the form is only imperfectly to be seen. The legs differ essentially from all the genera of the Salticidae, in that the tarsal joint is very short in proportion to the metatarsal. The legs are somewhat robust, the first and fourth pairs the longest and about equal in length, the second and third pairs growing somewhat shorter by degrees. The middle spinnerets are long, decidedly longer than usual, the others only half as long; in this the genus unites with Cocalus, to which altogether, it bears some likeness.

BŒTHUS THORELL, 1878.

Syn.: 1878. **Bœthus** THORELL, Studi sui Ragni Malesi e Papuani, II, p. 220.
1881. " ID., ibid., III., p. 431.

Cephalothorax short, high, sloping steeply in front, the cephalic part not narrower anteriorly.

Clypeus about ¼ as high as the middle eyes.

Sternum much wider than the coxae.

Eyes: quadrangle large, occupying more than ⅖ (not indeed half) of the length of the cephalothorax, a little wider than long, wider in front than behind, where it is only a little narrower than the cephalothorax at that place. The anterior row of eyes, which is plainly visible when the cephalothorax is looked at from above, is only slightly curved upward; the middle anterior eyes are large, very prominent and sub-touching, the lateral much smaller, and a little larger than the posterior eyes, which are placed more than their own diameter higher than the lateral eyes, and are a little further from the lateral borders than from each other. Eyes of the second row rather large, placed almost in the middle between the posterior and the lateral eyes, and as high as the latter.

Falces as usual, sub-vertical.

Maxillae long and narrow, more than twice as long as the lip. Lip almost equally long and wide, widely truncated at extremity.

Legs moderately long, rather slender, 4, 1, 2, 3. First pair a little more robust than the others, tibiae and metatarsi with a few spines underneath, which are long and adpressed; tibia but little longer than metatarsus. Tibia with patella of fourth, longer than tibia with patella of third. Posterior metatarsi with spines throughout their length. The two tarsal claws moderate, not curved, slightly convex on the back, pectinated with many short teeth. Scopula dilated a little at the apex.

Abdomen long, a little flattened.

Spinnerets the superior, rather long, with two joints, which are conical, and at least as long as wide, the inferior ones sub-conical thicker and shorter than the superior.

Type: B. spinimanus.

In the general form of the body this genus stands about half-way between Attus (Walck) Thorell and Euophrys (C. Koch) Thorell, being distinguished from the former by its low clypeus, and from the latter by the posterior eyes being a little further from the margin of the cephalothorax than from each other; and agreeing in the form of the abdomen more with Marptusa Thorell; the form and armature of the first pair of legs, however, separates it widely from these genera; in this respect it is more like Synemosyna and Diolenius.

PLEXIPPUS (C. KOCH), 1846. KEYSERLING.

Syn.: 1846. **Plexippus** C. KOCH, Die Arachn., XIII, p. 93.
1877. " THORELL, Studi Ragni Malesi e Papuani, I, p. 262.
1878. " ID., ibid., II, p. 240.
1880. " KARSCH, Arachnol. Blätter, VIII, Zur Kenntniss der Attiden, *in* Zeitsch. f. d. Naturwissensch. LIII, p. 398.
1881. " THORELL, Studi Ragni Malesi e Papuani, III, p. 526.
1883. " L. KOCH and KEYSERLING, Arachniden Australiens, p. 1425.

Cephalothorax moderately high, descending steeply to the posterior border, slightly convex over the back, a fourth or a fifth longer than wide, gently rounded on the sides, and only a little wider at the third row of eyes.

Eyes of the face in a moderately bent row, the lateral half as large as the middle eyes and only slightly separated from them. The eyes of the third row smaller than the lateral eyes of the first row. The small median eyes nearer the anterior than the posterior lateral eyes. [1]The quadrangle longer than wide, and a little wider behind than in front, not reaching the middle of the cephalothorax. The eyes of the third row further from each other than from the lateral borders.

Sternum somewhat wider than the coxae of the second pair.

Falces rather long, stout, vertical, locked together, almost cylindrical, rough with transverse wrinkles, and having a dull lustre; the fang rather short and bent.

Lip not longer than wide.

Palpus rather long, somewhat slender; (♂) the tarsus scarcely longer than the metatarsus, but little swollen, with the extremity directed downward, and with a moderately large bulb.

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[1] In all the species described by Keyserling under this genus the quadrangle is wider than long.

Legs: patella and tibia of the third shorter than those joints in the fourth pair; metatarsus and tarsus of the fourth somewhat shorter, or more often as long as patella and tibia of the fourth. Spines on all the legs, those on the metatarsi of the fourth throughout their length.

In this genus the relative length of the legs is very variable. In the species described by Thorell (Studi Ragni, III, pp. 526–642) we find the following formulæ: ♂ 1, 3, 4, 2; 3, 4, 1, 2; 3, 1, 4, 2; 1, 3, 2, 4, $\overline{3\ 4}$ 1 2; 1, 2, 3, 4; ♀ 3, 4, 1, 2; 1, 4, 3, 2; $\overline{1, 4, 3, 2}$. The same is true of the height of the clypeus. In these species the height varies from less than $\frac{1}{4}$ to $\frac{1}{3}$, to $\frac{1}{2}$ and in one spider almost equals the diameter of the large middle eyes.

[1] ZENODORUS N.

Syn.: 1881. **Ephippus** THORELL, Studi sui Ragni Malesi e Papuani, III, p. 643.

1883. " KEYSERLING, Arachniden Australiens, p. 1422.

Cephalothorax high, on both sides in front, especially in the male, dilated and inflated.

Clypeus at least half as high as diameter of middle eyes. Quadrangle of eyes usually occupying $\frac{1}{3}$ of the length of the cephalothorax, nearly equally wide in front and behind, about a quarter wider than long, and narrower than the cephalothorax at that place by three or four times the diameter of the posterior eyes. The line bordering on the upper edges of the anterior eyes is more or less strongly curved upward; the lateral anterior eyes separated by less than their diameter from the large middle eyes, eyes of the second row almost in the middle between the anterior lateral and the posterior eyes; posterior eyes further from the lateral borders than from each other.

Sternum rather short, wider than the coxæ, not projecting between the coxæ of the first pair.

Falces vertical, ordinary.

Maxillæ parallel, sub-ovate, at least half longer than the lip.

Legs: third pair longer than the others (except in some males which have the first leg longer than the others), much longer than the fourth pair; patella with the tibia of the third longer than patella with the tibia of the fourth. (In the males the first pair of legs is enlarged, and densely haired, at least underneath.)

Abdomen sub-ovate.

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[1] *Zenodorus* is substituted for *Ephippus*, the latter name being preoccupied.

Spinnerets ordinary: the second joint of the superior, wider than long, and obtuse.

Type: Z. d'Urvillei (Walck.).

EURYATTUS THORELL. 1881.

Euryattus THORELL, Studi sui Ragni Malesi e Papuani III, p. 660.

Cephalothorax short, dilated anteriorly, not high.

Clypeus very low, not ¼ of the diameter of the middle eyes.

Eyes small; quadrangle very short, about twice as wide as long, and a little wider behind than in front. The anterior row usually curved upward, the middle eyes widely separated, the lateral eyes separated from the middle eyes by their own diameter; eyes of the second row a little further from the posterior eyes than from the anterior lateral eyes; the posterior eyes are placed much higher than the lateral anterior eyes, and are as far or farther from each other as from the lateral borders.

Sternum not much wider than the coxae, not projecting between the coxae of the first pair.

Falces ordinary, sub-vertical.

Maxillae parallel, sub-ovate; lip longer than wide, rather widely truncated at the apex.

Legs those of the first pair longer than the others; the third pair not much longer than the fourth; tibia with the patella of the third longer than tibia with patella of the fourth. The tibiae have spines above; the posterior metatarsi have spines throughout their length.

Abdomen sub-ovate.

Spinnerets: ordinary, the second joint of the superior one being the shortest.

Type: E. porcellus (Thor.).

By the greater space, says Thorell, between the anterior middle and lateral eyes and by the line which touches the upper borders of the first row of eyes being straight and by the lowness of the clypeus this genus is easily distinguished from Ephippus Thorell.

PHIDIPPUS C. KOCH. 1846.

Syn.: 1846. **Phidippus** C. KOCH, Die Arachn., 13, p. 125.

1850. " ID., Uebers. d. Arachn.-Syst., 5, p. 53.

1864. **Crytonota** (sub.-gen. Phidippus) SIM., H. N. d. Araignées, p. 324 (*ad partem*).

1877. **Phidippus** THORELL, On Araneae of Colorado, Bull. U. S.

1878. " TACZ., Les Aranèides de Pèrou, Bull. de. la. Sociètè Impèriale des Naturalistes de Moscou, LIII, 4, p. 333.

Eyes: The first row rather strongly bent, the two middle eyes moderately large, somewhat smaller than is usual, near together, the outer ones in diameter scarcely half as large, placed somewhat away from the middle eyes. The eyes of the third row nearly as large as the outer eyes of the first row, on little hills; the eyes of the second row very small, near to the outer eyes of the first row.

Mandibles stout, standing away from each other toward the extremity, wrinkled transversely, somewhat shining; the fang nearly as long as the upper part of the mandible, strong and bent.

Palpus: That of the female rather long, not stout, entirely of the customary shape, well covered with long hairs; the male palpus moderately stout, shorter jointed, the tarsus oval, thick, bent, the bulb projecting strongly in front.

The species belonging to this genus are all handsome, the mandibles of all having more or less metallic reflections. The head is high, the sides dilated with a short angular plate. The thorax is short and steeply sloping, in most examples, when not rubbed one notices upright brushes or fringes of hair between the upper eyes. The abdomen is rather large in the female, but in the male narrower than the cephalothorax. The spinnerets do not stand far forward. The legs are rather stout, the two first legs the longest, particularly long in the male; the second and fourth pairs are about equally long, the fourth being a little the longer; the third pair is the shortest.

PHILÆUS THORELL 1870. SIMON.

Syn.: 1837. **Dendryphantes** C. KOCH, Uebers. d. Arachn. Syst., 1, p. 31 (ad partem).
1837. **Calliethera** ID., ibid., p. 30 (ad partem).
1846. **Philia** ID., Die Arachn., XIII, p. 54, 56.
1846. **Phidippus** ID., ibid., p. 125 (ad partem).
1846. **Plexippus** ID., ibid., p. 93 (ad partem).
1869. **Attus** SIM., Monogr. d. Attid., p. 6 (16), 14 (24) (ad partem).
1869. **Dendryphantes** ID., ibid., p. 168 (634), (ad partem).
1870. **Philæus** THORELL, on Europ. Spid., I, p. 217 (♂).
1870. **Attus** ID., ibid., p. 218 (♀).
1876. **Philæus** SIM., Arachn de France, III, p. 45.
1877. " KEYSERLING, Spinnen aus Uruguay. Vienna, 1877-78. p. 617.
1878. " LEBERT, Die Spinnen der Schweiz, p. 305.
1879. " L. KOCH, Arachniden Australiens, p. 1080.
1880. " KARSCH, Arachnol. Blätter VIII, Zur Kenntniss der attitden, *in* Zeitsch, f. d. Naturwissensch, LIII, p. 397.

Cephalothorax very high; thoracic part dilated, at least a third the longer; cephalic part plane or slightly convex, inclined, limited by a very weak transverse stria.

Clypeus less than half as wide as the middle eyes.

Eyes of the face rather unequal, in a moderately curved line; the middle not touching; the lateral separated by an interval equal to half their diameter. Dorsal eyes almost as large as the lateral, scarcely further apart. Quadrangle at least a third wider than long. Dorsal eyes equally distant from each other and from the lateral borders.

Sternum long, rather narrow. Anterior coxae separated by the width of the lip, thicker than the others.

Falces robust, longer and often a little oblique in the males.

Palpus (♂) very slender; patella and tibia equal or the latter the longer, tarsus oval, narrow, obtusely truncated at the extremity.

Legs. (♂) 1, 2, 4, 3, (♀) 4, 1, 3, 2. Anterior pairs more robust. Tibia and patella of the first male almost as long, female shorter than the cephalothorax; male tibia longer, female tibia and patella equal; tarsus and metatarsus more slender and shorter than the tibia and patella. Tibia and patella of the third much shorter than tibia and patella of the fourth; tarsus and metatarsus of the fourth plainly shorter than patella and tibia (sometimes of the same length in the males). Metatarsus of the fourth armed with spines to the base. Tibia of the fourth cylindrical and parallel.

SIMAETHA Thorell. 1881.

Simaetha Thorell, Studi Sui Ragni Malesi e Papuani III, p. 520.

Cephalothorax short, high, the dorsum strongly convex longitudinally, above, toward the middle dilated and very wide, in front moderately wide, posteriorly very perceptibly narrower.

Clypeus low.

Eyes: area occupying about $\frac{2}{5}$ of the length of the cephalothorax; the quadrangle very wide, much wider than long, wider behind than in front; anterior row of eyes curved upward; middle eyes not touching, separated from the lateral eyes by an interval at least equal to their diameter; eyes of the second row further from the posterior eyes than from the anterior lateral eyes; posterior eyes not further from the lateral borders than from each other.

Sternum scarcely or not wider than the coxae of the first pair; these coxae separated by less than the width of the lip.

Legs (♂) 1, 4, 2, 3; rather robust, without many spines; legs of the first pair more robust than the others, femora compressed anteriorly and and strongly bent above; tibia with patella of the fourth leg longer than tibia with patella of the third.

Abdomen short.

Spinnerets as usual, superior longer and more slender than the inferior; with two joints, which are sub-cylindrical, about as long as wide.

Type: S. thoracica.

This genus, says Thorell, agrees with Philaeus in the distance between the middle and lateral eyes of the first row, but differs from it especially in the form of the cephalothorax; in the latter respect it approaches Bellus (C. L. Koch) and Homalattus (White), but differs from them since the quadrangle of the eyes only occupies $\frac{2}{5}$, not $\frac{1}{2}$, the length of the cephalothorax.

[1] THYENE SIMON, 1885.

Syn.: 1850. **Plexippus** C. KOCH, Uebers d Arachn.-Syst. 5, p. 51 (ad partem.)
1869. **Attus** SIM., Monogr. d. espèces Europ. de la fam. d. Attides, p. 14, (24) (ad partem).
1871. " ID., Révis d. Attid.
1876. **Thya** ID, Arachn. d. France, III, p. 51.

Cephalothraax but slightly elevated; thoracic p rt ve y strongly dilated and rounded, at least a third the longer; cephalic part plane and inclined, not limited behind; a very short and fine longitudinal stria between the dorsal eyes.

Eyes of the face very unequal, forming a line slightly curved; the median eyes not touching; the lateral eyes separated by an interval almost as wide as their diameter. Dorsal eyes scarcely smaller than the lateral, much further apart, since the sides of the head diverge behind; these eyes p ojecting widely above; quadrangle at least a third wider than long; dorsal eyes further from one another than from the lateral borders. *Clypeus* about half the diameter of the middle eyes.

Sternum elongated, contracted in front; anterior thighs separated by the width of the lip; the two anterior pairs (particularly the first), the thickest; the fourth a little longer than the third.

Legs (♂) 1, 3, 4, 2; (♀) 4, 3, 1, 2; first pair the most robust; femur compressed and claviform; tibia and patella very thick and cylindrical, male as long, female shorter than the cephalothorax, male tibia a little longer, female tibia and patella equal. Tibia and patella of the third at least as long as patella and tibia of the fourth (only by the greater length of the patella). Tarsus and metatarsus of the fourth a little shorter than the tibia and patella. Tibia of the fourth cylindrical and parallel. Short, robust, conical tibial and metatarsal spines on the two first pairs, forming inferior rows; spines equally short, more slender, and not serial on the posterior parts; metatarsus of the fourth provided with spines throughout the length.

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[1] *Thyene* is substituted for *Thya*, the latter name being preoccupied.

Falces robust, short, conical and vertical in both sexes.

Palpus rather slender; tibia and patella almost equal; tarsus oval; narrow.

AMYCUS C. KOCH. 1846.

Syn.: 1846. **Amycus** C, KOCH, Die Arachn., 13, p. 182.
1878. " TACZ, Araneides du Pérou, Bull. de la Soc. Imp. des Nat. de Moscow LIII, 4, p. 345.
1880. " L. KOCH. Arachniden Australiens, p. 1170.

Eyes: the first row is high over the mouth and strongly bent, the two middle eyes large, the side eyes in diameter not half as large. The eyes of the third row just as large as the side eyes of the first; those of the second row very small, half way between these two.

Mandibles very long, nearly equally thick, somewhat curved on the inner corner of the extremity, toothed, the fang rather large.

Palpus: that of the male slender, the second joint bent, the third cylindrical, plainly longer than the fourth, the tarsus long in front, swollen, the bulb covered from above.

Cephalothorax short and very high, falling steeply from the cephalic plate, rather flat, with distinct elevations at the eyes; also the face is very high, but not equally high in the different species, and the first row of eyes high above the mouth. The abdomen is somewhat longer than the cephalothorax, narrow, oblong oval, and equally with the cephalothorax, (the latter, however, only partially) covered thickly with scaly hairs. The spinnerets are slender and rather long, the legs also are long; of these the third pair is the longest, then follows the first, then the second and after this the fourth.

One of the species described by C. Koch and all the Australian species described by L. Koch under this genus have the eyes of the second row nearer the anterior than the posterior side eyes and the legs 1, 3, 2, 4, not 3, 1, 2, 4. See note by Dr. Koch, p. 1170 of the Arachniden Australiens. The species placed in this genus by Dr. L. Koch seem to us (judging by his plates) to belong to at least two if not three different genera.

ASARACUS C. KOCH. 1846.

Asaracus C. KOCH, Die Arachn., XIII, p. 188.

Eyes form and position as in Phidippus.

Palpus of the male slender, rather long, the second joint long, gently, slightly bent, the third and fourth short, not longer than thick, the tarsus moderately long, humped at the proximal end, somewhat raised in knots, in the middle on the back somewhat contracted, the bulb covered from above.

Falces very stout, very iridescent, large, strong, convex in front, the sides somewhat widened into a corner, standing away from each other at the extremities, with a long, strong fang.

This genus has a likeness to the genus Amycus; but the palpus, and particularly the falces are differently shaped; also the third pair of legs is not so long as the last pair. The first pair was broken, in the only example that up to this time has come under my observation. Head, thorax, and abdomen agree with those of the above mentioned genus.

LIGONIPES KARSCH. 1878

Ligonipes KARSCH, Diagn. Attoid. aliquot nov. Novae Holl., *cet.*, *in* Mittheil. d. Münchener Entom. Ver., 1878, p. 26.

Cephalothorax more than twice as long as wide, not high, level.

Eyes of the third row not far in front of the middle of the cephalothorax.

Legs of the first pair remarkable; femora, patellae, and tibiae very much dilated, compressed, the tibiae having stiff short hairs on the inner side, their form being that of a hoe. Second, third and fourth pairs more slender.

Abdomen narrow.

LIGURINUS KARSCH. 1878.

Ligurinus KARSCH, Diagn. Attoid. aliquot nov. Novae Holl., *cet.*, *in* Mittheil d. Münchener Entom. Ver., 1878, p. 27.

The genus Ligurinus is much like genus Hyllus C. Koch, and yet is easily distinguished from it; the forehead is a little higher than the anterior eyes, and is so widely ornamented with dense oblique hairs that if the cephalothorax is looked at from above the eyes are entirely hidden.[1]

LYCIDAS KARSCH. 1878.

Lycidas KARSCH, Diagn. Attoid. aliquot nov. Novae Holl., *cet.*, *in* Mittheil. d. Münchener Entom. Ver., 1878, p. 25.

Cephalothorax high, gradually descending in three parts, cephalic part level. Posterior part sloping obliquely, rounded on the sides.

Eyes: quadrangle wider than long; eyes of the first row touching, the lateral being about a quarter smaller than the middle eyes, but a little larger than the eyes of the third row; eyes of the second row the smallest of all.

Clypeus: middle eyes of the first row distant from the margin of the clypeus by a space which nearly equals their diameter.

Legs: anterior legs short, robust; posterior legs, more slender, those of the third pair longest.

Abdomen looked at from above, almost triangular, pointed behind.

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[1] The presence of dense hairs ornamenting the forehead, would seem to be so completely *adaptive* a characteristic as scarcely to be a sufficient basis upon which to found a genus.

MARATUS KARSCH. 1878.

Maratus KARSCH, Diag. Attoid. aliquot nov. Novae Holl., *cet.*, *in* Mittheil. d. Münchener Entom. Ver., 1878, p. 27.

Cephalothorax not long, high.

Eyes: those of the third row, a little in front of the middle of the cephalothorax. Eyes of the second row half way between the posterior and the anterior lateral eyes. Quadrangle of the eyes a little wider in front than behind.

Legs slender.

Abdomen flat, with parallel sides, quadrangular, longer than wide. Body hairy.

MOPSUS KARSCH, 1878.

Syn: 1878. **Mopsus** KARSCH, Diagn. Attoid. aliquot nov, Novae Holl., *cet. in* Mittheil d. Münchener Entom. Ver, 1878. p. 31.

1881. " THORELL, Studi sui Ragni Mal. e Pap., III, p. 462.

Mopsus is very like the genus Ascyltus in appearance, but the clypeus is not dilated on the sides, is higher and not so wide, grows a little narrower above, and is covered above on the anterior cephalic margin and on the sides, with long, slender hairs.

Cephalothorax: Cephalic part higher and shorter than in Ascyltus. Thorax sloping obliquely behind the dorsal eyes.

Eyes: Those of the first row curved backward, touching, placed below the frons. Those of the second row placed further from the lateral eyes and a little within the quadrangle.

Falces nearly perpendicular to the face.

The species placed by Koch & Keyserling (Archinden Australiens, p. 330) in this genus were subsequently made the basis of the genus Sandalodes, Arachniden Australiens, p. 1476.

ASCYLTUS KARSCH. 1878.

Syn : 1878. **Ascyltus** KARSCH, Diagn. Attoid. aliquot nov. Holl.. *cet. in* Mittheil. d. Münchener Entom. Ver., 1878, p. 29.

1881. " L. KOCH and KEYSERLING, Arachniden Australiens, p. 1319.

Cephalothorax not high, rounded, wider in front, narrow behind, cephalic part not inclined.

Clypeus transversely vertical on the sides, somewhat extended, forming an acute angle, dilated, the extreme edge of the dilatation ornamented with some long hairs.

Eyes of the first row placed in front of the forehead. Quadrangle wider than long.

Falces nearly straight; (♀) rounded, smaller, (♂) longer, a little flattened bove, sharp on the edges, diverging.

Legs:[1] first and second pairs more robust and longer than the others; third and fourth pairs more slender, shorter, having spines.

Abdomen narrower than the cephalothorax; elongated.

Spinnerets long.

HYLLUS (C. KOCH). 1846. KEYSERLING.

Syn; 1846. **Hyllus** C. KOCH, Die Arachn., xiii, p. 161.
1846. **Deineresus** WHITE, Ann. and Mag. of Nat. Hist., 18, p. 179.
1877. **Hyllus** THORELL, Studi Ragni Malesi e Papuani, I, p. 258.
1878. " ID., ibid II, p. 264.
1878. " TACZ., Aranéides du Pérou Bull. Soc. Imp. des Nat. de Moscou, LIII, 4, p. 336.
1882. " L. KOCH and KEYSERLING, Arachniden Australiens, p. 1339.

Cephalothorax low and flat, a fifth longer than wide, much wider at the third row of eyes, rounded behind, convex on the back.

Clypeus one fourth as wide as the large middle eyes

Eyes of the face in a line a little curved backward, lateral half as large as the middle eyes and separated from them. Eyes of the second row further from the dorsal than from the lateral eyes. Quadrangle wider than long, equally wide in front and behind, placed before the middle of the cephalothorax. Eyes of the third row further from each other than from the lateral borders.

Sternum moderately convex, a third longer than wide.

Falces large, long, somewhat curved, diverging; the fang very long, somewhat fine, very pointed; on the inner side, before the bent point, a little corner.

Maxillae rounded at the extremity.

Lip more than half as long as the maxillae, growing narrower toward the extremity.

Palpus (♂) slender, almost filiform, the second joint the longest and somewhat bent; the third and fourth equally long, both conical; the last joint bent; the bulb covered from above.

Legs (♂) 1, 2, 4, 3, (♀) 1, 4, 2, 3; the first legs much longer and thicker than the others, which are nearly equal. Patella with tibia of the third not longer than patella with tibia of the fourth; metatarsus with the tarsus of the fourth shorter than patella with tibia. Metatarsus of the fourth with spines throughout its length.

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[1] Ascyltus pencillatus Karsch, has the legs (♂) 1, 4, 3, 2, (♀) 4, 1, 3, 2. L. Koch and Keyserling, Arachniden Australiens, p. 1319.

ICIUS SIMON. 1873.

Syn.: 1850. **Marpissa** C. KOCH, Uebers. d. Arachn.-Syst., 5, p. 47 (ad partem).
1850. **Icelus** ID., ibid, p. 55.
1869. **Attus** SIM., Monogr. d. Attid., p. 14 (24) (ad partem).
1870. **Marpessa** THORELL, on Europ. Spid., I, p. 213 (ad partem).
1871. **Attus** SIM., Révis. d. Attid.
1873. **Icius** ID.
1876. " ID., Arachn. de France, III, p. 54.
1877. " KEYSERLING, Spinnen aus Uruguay. Vienna, 1877–78, p. 621.
1878. " THORELL, Studi Ragni Malesi e Papuani, II, p. 232 (ad partem).
1879. " L. KOCH, Arachniden Australiens, p. 1127.
1881. " THORELL, Studi Ragni Malesi e Papuani, III, p. 461 (ad partem.)

Cephalothorax rather elongated; thoracic part parallel, or very slightly enlarged, at least a third the longer; cephalic part plane, slightly elevated, often inclined, limited by a transverse depression which is straight or slightly bent forward.

Clypeus scarcely a quarter as wide as the large middle eyes.

Eyes of the face very unequal, touching, or the lateral ones a little separated, forming a straight line. Dorsal eyes as large, or almost as large as the lateral, a little further apart since the sides of the quadrangle diverge very slightly behind; quadrangle only a quarter wider than long; dorsal eyes much further from each other than from the lateral borders.

Sternum contracted in front, scarcely wider than the intermediate thighs. Anterior thighs separated by the width of the lip, much thicker than the others; thighs of the second and third pairs equal, those of the fourth a little longer.

Falces (♀) short, rather thick, almost square, vertical; (♂) longer, a little inclined forward, their external border presenting an elevated, longitudinal ridge.

Palpus (♂) slender; tibia shorter than the patella, provided with a small superior external apophysis; tarsus narrow and long.

Legs (♂) 1, 4, 3, 2; (♂) 4, 1, 3, 2; those of the first pair more robust; tibia and patella at least a quarter shorter than the cephalothorax; tibia the longer, and slender. Tibia and patella of the fourth much longer than the tibia and patella of the third; tarsus and metatarsus, male, almost as long, female, sensibly shorter tibia and patella. Tibia of the fourth scarcely a quarter longer than the patella, cylindrical, and a little more slender at the extremity. Spines short, rather robust, and serial on the tibia of the first; slender and very far apart on the second, third and fourth legs; metatarsi of the third and fourth having only terminal spines.

SANDALODES KEYSERLING. 1883.

Syn.: 1882. **Mopsus** KEYSERLING, Arachniden Australiens, p. 1333 (ad partem).
1882. **Acompse** ID., Arachniden Australiens, p. 1326 (ad partem).
1883. **Sandalodes** ID., " " p. 1476.

Cephalothorax scarcely a fifth longer than wide, moderately high, rounded on the sides, considerably wider than the third row of eyes, becoming gradually smaller behind and in front, ascending steeply from the posterior margin to the third row of eyes, the cephalic part sloping forward. The middle line is just behind the third row of eyes; the *clypeus* is one fourth as wide as the anterior middle eyes.

Quadrangle of the eyes wider than long, as wide in front as behind, reaching only to the first third of the cephalothorax. The first row moderately bent, and the eyes rather near together. The eyes of the second row half-way between the posterior and the anterior lateral eyes. The posterior eyes further from each other than from the lateral borders.

Falces vertical, not diverging, and short.

Maxillae widely separated at their extremities, only a third longer than the lip.

Lip longer than wide.

Sternum long and narrow, narrower than the coxae of the second pair.

Legs, 1, 4, 3, 2; all set with spines, the first pair thicker than the others. Patella and tibia of the third shorter than patella and tibia of the fourth; metatarsus and tarsus of the fourth also shorter than the patella and tibia of the fourth; metatarsus of the fourth with spines throughout its length.

Abdomen fully twice as long as wide.

This genus has great similarity to Icius, and is distinguished from that genus principally by its narrow sternum.

BAVIA SIMON. 1877.

Syn: 1877. **Bavia** SIMON. Amm. Soc. Entomol. de France, (5), vii. pp. 60–62.
1879. **Acompse** L. KOCH. Arachniden Australiens, p. 1352.

Cephalothorax not very long; thoracic part a little longer, not dilated, rounded; cephalic part plane, but slightly elevated, almost a regular quadrangle; the swellings above the eyes strong.

Eyes of the face very unequal, almost touching, in a straight line. Dorsal eyes as large as the lateral, not further apart since the sides of the head are straight.

Clypeus scarcely a third as wide as the middle eyes.

Sternum scarcely wider than the intermediate thighs. Anterior coxae separated by the width of the lip, much longer and more robust than the others.

Falces rather short, a little projecting, not ridged.

Lip twice as long as wide.

Legs (♂) 4, 1, 2, 3, those of the first pair much more robust; patella and tibia of the first as long as the cephalothorax, tibia much longer than patella; patella and tibia of the fourth much longer than patella and tibia of the third, much more slender; tarsus and metatarsus of the fourth a little shorter than patella and tibia; patella and tiba of the third equal; tibia of the fourth much longer than the patella; trochanters of the fourth long and diverging. On the first pair two inferior rows of short and robust tibial and metatarsal spines; on the second pair a single row of two internal tibial spines coming near together at the top; on the third pair two rows of lateral spines; the anterior having a single one, the posterior two; all the patellae, the metatarsi of the third and fourth, and the tibia of the fourth completely unarmed.

This genus is near *Maevia* and *Icius*; it is distinguished from them by the form of the cephalothorax, of which the cephalic part is relatively much longer, and by the posterior legs, which lack spines on the tibiae and metatarsi.

MAEVIA (C. KOCH) 1848. SIMON.

Syn.: 1848. **Maevia** C. KOCH, Die Archn., XIV, p. 69 (ad partem).
1876. " SIM., Archn. de France, III, p. 60.
1877. " THORELL, Studi Ragni Malesi e Papuani, I, p. 241 (ad partem).
1878. " TACZ., Aranéides du Pérou, Bull. Soc. Imp. des Nat. de Moscou, LIII, 4, p. 227.
1880. " KARSCH, Arachnol. Blätter VIII, Zur Kenntniss der Attiden, *in* Zeitsch. f. d. Naturwissensch., LIII, p. 398.
1881. " THORELL, Studi Ragni Malesi e Papuani, III, p. 467 (ad partem).

Cephalothorax elongated, very high; thoracic part enlarged, at least a third the longer; cephalic part slightly convex, and a little hollowed between the dorsal eyes.

Clypeus narrow, rarely ⅓ as wide as the large middle eyes.

Eyes of the face very unequal, forming a straight or almost straight line; the middle touching, the lateral well separated. Dorsal eyes as large as the lateral, equally far apart, quadrangle scarcely a quarter wider than long. Dorsal eyes nearer one another than the lateral borders.

Sternum almost rounded, wider than the intermediate coxae. Anterior coxae separated by at least the width of the lip.

Falces (♂) much longer than the face, vertical, parallel, a little diverging only at the extremity, cylindrical, not ridged.

Palpus (♂) short, resembling that of Heliophanus except the femar which is unarmed.

Legs 1, 4, 3, 2; the first and second pairs a little more robust; tibia of the first longer than patella, these two articulations at least as long as the cephalothorax. Tibia and patella of the fourth much longer than tibia and patella of the third; tarsus and metatarsus, male, as long as patella and tibia. Posterior legs having only very few spines a terminal circle only on the metatarsus (sometimes however a pair of median spines on that articulation).

In the species placed by Thorell in this genus (Stadi Ragni Malesi e Papuani, III, pp. 467-492) the legs vary as follows: (♂) 2, 1, 4, 3; 1, 4, 3, 2; 4, 3, 1, 2; 4, 1, 3, 2; (♀) 4, 3, 1, 2. The firrt formula, 2, 1, 4, 3, makes the second leg the longest. Simon in his Arachnides de France, III, p. 1, gives as one of the characteristics of the family Attide, "2d pair of legs never the longest." We find the variation in the clypeus of Thorell's species to run from scarcely ¼ to about ½ the height of the large middle eyes.

OPISTHONCUS L. Koch. 1880.

Opisthoncus L. Koch, Arachniden Australiens, p. 1184.

Cephalothorax longer than wide, high, declining toward the posterior, sides moderately rounded, cephalic part slightly contracted in front, having a smooth, low protuberance, between the third row of eyes, more or less prominently adorned.

Clypeus very low.

Quadrangle of eyes wider than long, behind and in front equally wide, or behind a little wider. First row of eyes almost straight or slightly curved, middle eyes close to the lower margin of the clypeus, close to each other, and moderately distant from the lateral. Second row of eyes smallest, and from the lateral eyes of the first row less distant than from the eyes of the third row, and placed either not higher, or only a little higher than these; eyes of the third row, more widely separated from each other than from the margin of the cephalothorax.

Sternum long, contracted.

Maxillae long, contracted at the base, dilated toward the anterior; anterior margin rounded.

Labium more than one half the length of the maxillae, contracted toward the anterior, apex truncated.

Legs 1, 2, 4, 3 or 1, 4, 2, 3: 2, 3, 4 of almost equal length. First pair of legs more robust than the others, and in the male much longer than in the female. Patella and tibia of the third pair shorter that these joints in the fourth pair; the patella with the tibia is longer than the metatarsus with the tarsus in the fourth pair.

VICIRIA THORELL. 1877.

Viciria THORELL, Studi Sui Ragni Malesi e Papuani, I, p. 233.

Cephalothorax about a third longer than wide, moderately high.

Clypeus at least half as wide as the anterior middle eyes.

Sternum rather short, not twice as long as wide, wider than the coxae, not projecting between coxae of the first pair of legs, which are separated by at least the width of the lip.

Eyes: those of the first row plainly visible when the cephalothorax is looked at from above; this row slightly curved upward. Middle anterior eyes large, very prominent; the lateral eyes are rather small, and are separated by an interval greater than their own diameter from the middle eyes. Quadrangle of the eyes a little wider in front than behind, not occupying half the length of the cephalothorax, much narrower behind than is the cephalothorax at that place. Eyes of the second row minute, about in the middle, or a little in front of the middle, between the anterior lateral and the posterior eyes. Posterior eyes placed about their own diameter higher than the anterior lateral eyes, and further from the lateral borders than from each other.

Falces directed downward and more or less forward.

Maxillae long, diverging a little, and slightly curved outward, about half longer than the lip; lip nearly half longer than wide, plainly narrowing toward the rounded or sub-truncated extremity.

Palpus slender, in the female neither dilated nor flattened at the extremity.

Legs rather long, slender or moderately stout, first pair, at least in some cases, more robust than the others; third pair (sometimes excepting the first), longer than the others; tibia with the patella of the third longer, or at least not shorter than tibia with patella of the fourth. Tibiae much longer than patellae. Metatarsi of the fourth spined throughout their length.

Abdomen long and slender.

Spinnerets six, long and cylindrical.

Type: V. Pavesii.

Viciria differs from Maevia (Koch) Sim. in the tibia and patella of the third being longer or at least not shorter than the tibia and patella of the fourth, and in the greater prominence of the large middle eyes, and the greater space between them and the lateral eyes.

EPIBLEMUM (HENTZ) 1882. THORELL.

Syn.: 1832. **Epiblemum** HENTZ, On North America Spiders, p. 108 (ad partem).
1837. **Calliethera** C. KOCH, Uebers. d. Arachn. Syst. I, p. 30 (ad partem).
1850. " ID., ibid, 5, p. 45 (ad max. part.).
1864. **Cyrtonota** sub-gen. Calliethera Sim., H. N. d, Araignees, p. 324, 327 (ad part.).
1868. **Calliethera** [Calletherus] ID., Monogr. d, espéces Europ. de la fam. d Attides, p. 6 (16) 180 (646 (ad max. part.).
1870. **Epiblemum** THORELL, on Europ. Spid. I, page 210.
1876. " LEBERT, Die Spinnen der Schweiz, p. 297.
1876. **Calliethera** SIM., Arach. de France, III, p. 62.
1883. " " " de l' ocean Atlantique, Ann. Soc. Ent. de France, 1882, p. 261.

Eyes eight, unequal, in three rows, the first composed of four, the two middle ones somewhat larger, the second composed of two very small ones placed nearer the third row, which is composed of two larger ones.
Falces very long, slender, horizontal, in both sexes, fang nearly as long.
Maxillae parallel, wide at base, narrow above the insertion of the palpi, cut obliquely on both sides toward the point.
Lip conical.
Legs 1, 4, 2, 3 or 1, 4, 3, 2.
Type: E Scenicum (faustum) Cl.

When Hentz, in 1832, formed the genus Epiblemum, he founded it on Epiblemum faustum; while Koch in 1837 founded the genus Calliethera on Aranea scenica. E. faustum and A. scenica are undoubtedly identical. This species is probably a comparatively recent importation f om Europe. Hentz is wrong in saying that the falces are horizontal in both sexes. They are vertical in the female of E. faustum.

THIANIA C. KOCH. 1846.

Syn.: 1846. **Thiania** C. KOCH, Die Arachn., XIII, p. 171.
1877. " THORELL, Studi Ragni Malesi e Papuani, I, p. 251.

Eyes of the first row close over the front edge of the head. The two middle eyes of this row very large, occupying nearly the whole height of the head. The eyes of the third row smaller than the lateral eyes of the first row; the small median eyes placed a little beyond the middle, nearer the hind eyes.

Falces of the male somewhat short, rather flat above.

Palpus moderately long and somewhat stout, the two first joints as usual, the third and fourth very short, oval, the small bulb covered from above.

The species belonging to this genus resemble those of the genus Calliethera. Eyes, falces, and palpus, however, make a plain and constant division. The scaly covering of the abdomen is highly colored, taking the form of transverse bands.

HASARIUS Simon. 1871.

Syn.: 1846. **Plexippus** C. Koch, Die Arachn., XIII p. 93 (ad partem).
1850. **Euophrys** Id., Uebers. d. Arachn. Syst., 5, p. 60.
1850. " sub-gen, Maturna ibid., p. 65.
1869. **Attus** Sim., Monogr. d. Attid., p. 14 (24).
1869. **Plexippus** Id., ibid., p. 177 (643).
1870. **Attus** Thorell, on Europ. Spid., I, p. 218 (ad partem).
1871. " Sim., Révis. d. Attid,
1871. **Hasarius** Id., ibid.
1876. " Id., Arachn. de France III, p. 77.
1880. " Karsch, Arachnol. Blätter VIII, zur Kenntniss der Attiden, *in* Zeitsch. f. d. Naturwis ensch. LIII, p. 398.
1881. " L. Koch and Keyserling, Arachniden Australiens, p. 1272.
1883. " Sim., Arachn. de l' Ocean Atlantique, Ann. Soc. Ent. de France, 1882, p. 284.

Cephalothorax rather long, high. Thoracic part sensibly dilated, at least a third the longer. Cephalic part slightly convex and inclined, limited by a very faint depression, which is straight or bent forward.

Eyes of the face rather unequal, forming a line very slightly curved; the middle eyes scarcely separated, the interval of the lateral, wider. Dorsal eyes a little smaller or as large as the lateral, a very little further apart, since the sides of the quadrangle diverge a little behind; quadrangle at least a third wider than long; dorsal eyes a little further from each other than from the lateral borders.

Clypeus usually wider than half the middle eyes, with thick hairs.

Sternum elongated, rather narrow. Anterior thighs separated by the width of the lip; all the thighs longer than wide, those of the first pair thicker and sometimes longer than the others, which are almost equal.

Legs usually (♂) 1, 3–4, 2; (♀) 3–4, 1, 2; the first and second pairs more robust, with femoral joints compressed. Tibia and patella of the first a little shorter than the cephalothorax, these two articulations equal, or the tibia a little the longer; tarsus and metatarsus shorter, more slender, almost of the same length. Femora of the third and fourth equal; tibia and patella of the third a little longer than tibia and patella of the fourth or often of the same, length. Tarsus and metatartus of the fourth of the same length as the tibia and patella. Tibia of the fourth parallel, or slightly enlarged at the extremity. Femoral, tibial, and metatarsal spines on the four pairs; metatarsus of the fourth with spines throughout its length.

Falces as long or longer than the face, vertical, often deep set[1] in both sexes, never ridged.

Palpus (♂) robust and short (except H. Adausoui); tibia shorter than patella and provided with external apophyses; tarsus longer than the preceding articulations and wide (except H. Adausoni); bulb simple, reaching almost the extremity of the tarsus; hook rarely apparent.

The species described by Messrs. Koch and Keyserling under this genus have the following variations in the leg formula: female, 1, 2, 3, 4; 1, $\overline{2, 3, 4}$; 1, 4, 3, 2; 1, 3, 4, 2; 1, $\overline{2, 3}$, 4; 4, 3, 1, 2; $\overline{4, 3}$, 1, 2; male, 1, 2, $\overline{3, 4}$; 1, 3, 2, 4; 1, 3, 4, 2; 1, 4, 3, 2; 1, $\overline{4, 3}$, 2; $\overline{1, 4}$, 3, 2; 4, 3, 1, 2; $\overline{4, 3}$, 1, 2; 3, 4, 1, 2; 4, 1, 3, 2. In the same species the clypeus varies in height from $\frac{1}{5}$ to $\frac{1}{2}$ the large middle eyes. It is interesting to note that while in the species described by Keyserling there seems to be a very constant relation between the length of the whole body and the longest pair of legs, the length of the longest legs being only very little greater or less than the total length, H. chrysostomus, male, has its total length 7 mm., and its longest leg 11.6 mm. H. vittatus, male, a fair representative of the other species, has its total length 4.2 mm., and its longest leg 3.8 mm. The greater proportional length of the longest legs in H. chrysostomus is correlated with other structural modifications which seem to separate it from the other species of this genus. The same remarks are applicable also to H. lautus.

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[1] The French word is "renfoncée."

PELLENES SIMON. 1876.

Syn: 1850. **Euophrys:** sub. gen. Pales C. Koch, Uebers. d. Arachn.-Syst., 5, p. 64.

1869 **Attus** SIM., Monogr. d. espéces Europ. de la fam. d. Attides p. 14 (24) (ad partem.)

1870. " THORELL, On Europ. Spid. I., p. 218 (ad partem).

1871. " SIM., Revis d. Attid.

1876. **Pellenes** SIM., Arcahn. de France, III, p. 90.

Cephalothorax rather long, high; thoracic part distinctly dilated, at least a third the longer; cephalic part sightly convex; inclined, limited by a depression which is bent forward.

Eyes of the face rather unequal, forming a line which is straight or slightly curved forward; the middle eyes but little separated; the interval of the lateral eyes wider. Dorsal eyes a little smaller than the lateral and further apart, since the sides of the quadrangle diverge behind. Quadrangle about a third wider than long. Dorsal eyes further from one another than from the lateral borders.

Clypeus at least half as wide as the middle eyes.

Stermum long; anterior thighs separated by the width of the lip and thicker than the others; the lateral almost equal, longer than wide.

Legs (♂) 1, 3, 4, 2; (♀) 3, 1, 4, 2; first legs much the most robust, with compressed femora; tibia and patella of the first shorter than the cephalothorax; male, these two articulations equal; female, tibia a little the longer, tarsus and metarsus more slender and shorter than the two preceding articulations. almost equal. Femur, patella, and tibia of the third much longer and a little thicker than the femur, patella and tibia of the fourth; tarsus and metarsus of the fourth generally a little shorter than the patella and tibia of the third strongly enlarged, from the base of the extremity tibia; tibia of the fourth almost parallel or a little enlarged. Femoral, tibial and metatarsal spines on the four pairs, very short, and serial on the tibiae and metatarsi of the first and second; metatarsus of the fourth, with spines to the base.

Falces as long, or a little shorter than the face. Vertical or inclined backward in both sexes.

Palpus (♂) robust and short; tarsus oval, wider and at least as long as the two preceding; bulb generally simple, reaching almost the end of the tarsus; tibia shorter than the patella, provided with a superior external apophysis, directed forward, usually received into a little depression of the tarsal border and hidden from above.

ERGANE KEYSERLING. 1881.

Ergane KEYSERLING, Arachniden Austrol'ans, p. 1260.

Cephalothorax longer than wide, a little wider in the middle than in front, behind rounded, above high and convex, sloping in front.

Clypens less than half the diameter of the large eyes.

Quadrangle ofeyes wider than long, placed before the middle of the cephalothorax, as wide iu front as behind. Dorsal eyes from one another and from the margin of the cephalothorax almost equally distant. Small median eyes half way between the dorsal eyes and the lateral eyes of the ffrst row. First row of eyes curved.

Sterum oblong.

Falces short and touching.

Maxillae dilated in front, not twice longer than the lip.

Legs spined. 1–3, 4, 2, 3, 1, 2, 4, 1, 4, 3, 2, or 4, 3, 1, 2. Legs of the first pair a little stouter than the others. Patella and tibia of the third longer than the patella and tibia of the fourth. The fourth pair has the metatarsus and the tarsus longer than the patella with the tibia.

Abdomen ovate, longer than wide.

Spinnerets, inferior and superior equally long.

PHYALE C. KOCH. 1846.

Syn.: 1846. **Phyale** C. KOCH, Die Arachn., XIII, p. 193.
1878. " TACZ., Aranéides du Pérou, Bull. Soc. Imp. des Nat. de Moscou, LIII, 4, p. 315.

Eyes of the first row bent, the two middle eyes nearly touching, very large, close over the front edge of the head, the side eyes of this row in their diameter not half so large as the middle eyes; the eyes of the third row somewhat smaller than the outer eyes of the first row and almost forming a square with them; the eyes of the second row unusually small, half way between the eyes of the third row and the outer eyes of the first row.

Falces short, stout, swollen, shining, scarcely longer than thick, fang not long.

Palpus of the female of the customary form, somewhat covered with short hair; that of the male unknown.

All high colored beautiful little spiders. The head is flat above and rather long, the cephalothorax usually nearly as long as wide; the sides of the cephalothorax are gently rounded, and steeply falling; the head is not much higher than the middle eyes in front, the clypens being narrow and somewhat retreating. The abdomen is usually oval, almost always rather short, not thicker than cephalothorax. Cephalothorax and abdomen are closely covered with scaly hairs above, these giving the color. The spinnerets are very short. The legs are moderately long, the first and second pairs being the shortest, but the stoutest, usually having the femur thickened; they are about one and a half times as long as the thorax; the third pair somewhat exceeds the second in length, and the fourth is plainly longer than the second; above, the first joints, and in part the tipiae are covered with brightly colored scaly hairs; the hair of the other joints is fine and light, and the spines very fine.

JOTUS KEYSERLING. 1881.

Jotus KEYSERLING, Arachniden Australiens, p. 1243.

Cephalothorax about one-fifth part longer than wide, in front a little more contracted than in the middle, rounded behind, above high and convex.

Clypeus less than half the diameter of the large eyes.

Quadrangle of eyes wider than long, equally wide in front and behind and not occupying half the length of the cephalothorax. Anterior eyes near together, forming a row slightly curved upward. Small median eyes half way between the dorsal eyes and the lateral eyes of the first row. Dorsal eyes almost as far from each other as from the margin of the cephalothorax.

Sternum slightly convex, ovate, much longer than wide.

Falces short and diverging, in front commonly plane.

Maxillae rather long, in front dilated and rounded.

Labium more than half the length of the maxilla.

Legs moderately long, spined, 4, 3, 1, 2, or 4, 1, 3, 2, or 1, 4, 3, 2. First pair a little stouter than the others. Patella and tibia of the third shorter than the patella and tibia of the fourth. The fourth pair has the metatarsus and tarsus not longer than the patella and tibia.

Abdomen longer than wide, rounded in front, behind pointed.

Spinnerets rather long, inferior and superior equally large and long.

HABROCESTUM SIMON. 1876.

Syn.: 1869. **Attus** SIM., Monogr. d. espéces Europ. de la fam d. Attides. p. 14 (24) (ad partem).

1871. " ID., Revis. d. Attid.

1876. **Habrocestum** ID., Arachn. de France, III, p. 131.

1882. " KEYSERLING, Arachniden Australiens, p. 1401.

Cephalothorax rather short, very high; thoracic part often convex, but slightly dilated on the side, only a third the longer. Cephalic part slightly convex, very much inclined, limited by a faint depression which is straight or bent forward.

Eyes: those of the face, rather unequal, but little separated, forming a line straight or slightly curved forward. Dorsal eyes a little smaller than the latteral, not further apart, little or not at all prominent above; quadrangle scarcely a third wider than long; dorsal eyes almost equally distant from each other and from the lateral borders. *Clypeus* about half as wide as the middle eyes.

Sternum small, long, narrower than the intermediate thighs. Interval between the anterior thighs less than the width of the lip at the base.

Legs 3, 4, 1, 2; the first legs like those of Æ lurops. Femur, patella and tibia of the third much longer than the same articulations in the fourth pair. Tibiae of the third and fourth much enlarged from the base to the extremity and a little compressed. Tarsus and metatarsus of the fourth as long as patella and tibia.

Falces weak, scarcely as long as the face, vertical or obliquely directed backward in both sexes.

Palpus short and robust as in Ælurops.

HELIOPHANUS (C. KOCH.) 1833. SIMON.

Syn.: 1833. **Heliophanus** C. KOCH, *in* Herr.-Schaeff, Deutschl. Ins., 119, 1, 2.
1837. " ID,, Uebers. d. Arachn.-Syst., p. 29.
1864. " [**Heliophana**] SIM., H. N. d. Araignees, p, 332.
1868. " SIM., Monogr., d. espéces Europ. de la fam. d. Attides, p. 6 (16), 201 (667).
1868. **Callethera** [**Callietherus**] ID., ibid., p. 6 (16), 180 (646) (ad partem).
1870. " THORELL, Europ. Spid. I, p. 211.
1876. " SIM., Arach. de France, III, p. 140.
1878. " LEBERT Die Spinnen der Schweiz, p. 298.

Cephalothorax high; thoracic part dilated, at least a third the longer. Cepholic part slightly convex, a little inclined, limited by a depression which is usually wide, straight, or bent backward; thoracic part presenting indistinct diverging striae.

Clypeus scarcely one fourth as wide as the large middle eyes, without hairs.

Eyes of the face very unequal in a straight or slightly curved line; dorsa eyes a little smaller than the lateral and not further apart. Quadrangle a third or a quarter wider than long.

Sternum wider than the intermediate coxae, often unequal. Anterior coxae separated by the width of the lip at the base.

Falces rather robust, vertical, never ridged.

(♂) *Maxillae* wide at the extremity; their superior external angle presenting one or two conical projections.

(♂) *Palpus* short; femur, robust, armed below with a simple or bifid apophysis; patella long and a little convex; tibia shorter armed with external apophyses, slender and slightly developed; tarsus narrow and elongated, terminating in a point, projecting beyond the bulb.

Legs 4, 1, 2, 3, or 4, 1, 3, 2, slightly unequal. Tibia and patella of the first shorter than the cephalothorax; metatarsus more slender than tibia and patella of the fourth. Patella (alone) of the third as long and often a little more robust than patella of the fourth; tibia of the fourth almost parallel and cylindrical. Femoral, tibial, and metatarsal spines on the four pairs; no patellary spines.

CYRBA Simon. 1876.

Syn.: 1869. **Attus** Sim., Monogr. d. espéces Europ. de la fam. d. Attides, 14 (24) (ad part)
1871. " Id., Révis d. Attid.
1876. **Cyrba** Id., Arachn. d. France, III, p. 165.
1883. " Keyserling, Arachniden Australiens, p. 1436.

Cephalothorax but slightly elevated; thoracic part not dilated, a little contracted, about a third the longer; cephalic part plane, inclined, limited by a very faint transverse depression, cut by a longitudinal stria.

Eyes: those of the face very unequal, almost touching, forming a straight line. Dorsal eyes scarcely smaller than the lateral, not prominent, and not further apart. Quadrangle almost a third wider than long; dorsal eyes further from each other than from the lateral borders. *clypeus* very narrow, with hair.

Sternum oval, wider than the intermediate thighs. Anterior thighs sepaparated by at least the width of the lip; thighs of the fourth longer.

Legs 4, 1, 3, 2; first pair much more robust, particularly the femur and the tibia. Tibia of the first a little longer than the patella; the two articulations shorter than the cephalothorax; tarsus and metatarsus more slender and almost as long as the two preceding articulations. Tibia and patella of the third much shorter than the tibia and patella of the fourth. Tibia of the fourth almost parallel; tarsus and metatarsus of the fourth as long or almost as long as tibia and patella. Femoral, tibial and metatarsal spines on the four pairs; two patellary spines on the two posterior pairs.

Falces rather weak, vertical, of the same length as the face.

Palpus (♂) femur slender; tibia with apophyses; tarsus oval. (♀) Tibia and patella a little dilated; tarsus pointed.

The species placed by Keyserling in this genus have the legs 4, 3, 1, 2, or 4, 3, $\overline{12}$.

[1] ÆLURILLUS Simon. 1885.

Syn.: 1850. **Euophrys** (Sub-gen. Dia) C. Koch, Uebers. d. Arachn. Syst., 5, p. 64.

1869. **Attus** (6th gr.) Sim., Monogr. d. espèces Europ. de la fam. d. Attides, p. 54 (44).

1870. **Ælurops** Thorell, on European Spiders, I, p. 219.

1871. **Attus** (6th gr.) Sim., Rèvis d. Attid.

1876. **Ælurops** Id., Arachn. de France, III, p. 134.

1876. " Lebert, Die Spinnen der Schweiz, p. 309 (ad partem).

[2] *Cephalothorax* very high; thoracic part strongly dilated, twice as long as the cephalic. Cephalic part slightly convex, inclined, limited by a slight transverse depression, generally straight.

Clypeus as wide or almost as wide as the middle eyes.

Eyes of the face rather unequal, well separated, particularly the lateral, in a line so much curved that a straight line from the top of the middle eyes cuts the lateral eyes below the center. Dorsal eyes smaller than the lateral, further apart. Quadrangle at least a third (often more) wider than long. Dorsal eyes as near or nearer to one another as to the lateral borders.

Sternum long, very narrow, particularly in the males. Anterior coxae separated by about the width of the lip. Coxae of the first, second, and third pairs equal in length and thickness, and a little longer than wide; coxae of the fourth a little longer than the others.

Falces not very robust, shorter than the face, inclined backward in both sexes.

Palpus (♂) short and thick; femur compressed; patella and tibia short and almost equal; tibia always with two small superior external apophyses; tarsus wider, oval and a little compressed, passing beyond the bulb.

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[1] *Ælurillus* is substituted for *Ælurops*, the latter name being preoccupied.

[2] This is Simon's definition of the genus Ælurops Thorell.

Legs 3, 4, 1, 2, or 3,4, 1, 2, rarely 4, 3, 1, 2. The two anterior pairs shorter and more robust; tibia and patella of the first equal and much shorter than the cephalothorax: tarsus and metatarsus almost equal, a little (scarcely in the males) shorter than the patella and tibia. Femur patella and tibia of the third, of the same length or scarcely longer than the same articulations in the fourth pair. Tibia of the third (and of the fourth, though less) enlarged from base to extremity; tarsus and metatarsus of the fourth as long as patella and tibia. Femoral, tibial and metatarsal spines on the four pairs; patellary spines on the third and fourth. Metatarsus of the fourth with spines to the base.

YLLENUS SIMON. 1869.

Syn.: 1869. **Yllenus** SIM., Monogr. d. Attid., 166 (632).
1870. " THORELL, On Europ. Spid., I, p. 219 (ad partem).
1876. " SIM., Arachn. de France, III, p. 127.
1878. " LEBERT, Die Spinnen der Schweiz, p. 313 (ad partem).

Cephalothorax rather long; very high; thoracic part strongly dilated, twice as long as the cephalic. Cephalic part slightly convex, inclined, limited by a very slight depression.

Clypeus almost as wide as the middle eyes, with thick hairs.

Eyes of the face quite unequal, well separated, particularly the lateral forming a line strongly curved, the summit of the middle eyes being on a level with the center of the lateral eyes, or very slightly higher. Dorsal eyes smaller than the lateral, and further apart, not prominent. Quadrangle at least a third wider than long; dorsal eyes further from each other than from the lateral borders.

Sternum short, narrower than the intermediate coxae. Interval between the anterior coxae not quite so wide as the lip. Anterior coxae thicker than the others; second, third and fourth coxae equal in thickness; fourth coxae longest.

Falces weak, shorter than the face, vertical in both sexes.

Palpus short, very robust and massive; patella and tibia well developed tarsus relatively small, often compressed and raised into a ridge.

Legs 4, 3, 1, 2; first and second pairs shorter and much more robust, particularly the first; tibia and patella of the first equal, and much shorter than the cephalothorax: tarsus and metatarsus equal and much shorter than patella and tibia; femur, patella and tibia of the third much shorter than the same articulations of the fourth pair. Tibia of the fourth a good deal enlarged from base to extremity, and compressed; tarsus and metatarsus of the fourth much shorter than patella and tibia; trochant rs of the fourth leg very long, visible from above. Femoral, tibial and metatarsal spines on the four pairs; patellary spines on the third and fourth; metatarsus of the fourth with spines to base.

Integument entirely covered with thick pubescence.

Nearest Ælurops Thorell, agreeing with that genus in having the upper part of the frons so prominent that the anterior eyes are hidden from above; and differing from it in that the tibia of the fourth leg is at least as long as the metatarsus with the tarsus.

SAITIS SIMON. 1876.

Syn.: 1869. **Attus** (gr. 10) SIM., Monogr. d. espèces europ. de la fam. d. Attides, p. 96 (562).
1876. **Saitis** SIM., Arachn. de France, III, p. 168.
1877. " THORELL, Studi sui Ragni Mal. e Pap. I, p. 225.
1882. **Thorellia** L. KOCH and KEYSERLING, Arachniden Australiens, p. 1352.
1883. **Saitis** ID., ibid., p. 1434.

Cephalothorax moderately long, almost parallel; thoracic part a third the longer, not dilated; cephalic part plane and a little inclined, limited by a very slight depression.

Clypeus very obliquely inclined, scarcely half as wide as the middle eyes.

Eyes of the face very unequal, scarcely separated, in a straight line. Dorsal eyes very convex, scarcely smaller than the lateral, and a little nearer together. Quadrangle a third wider than long; dorsal eyes further from each other than from the lateral borders.

Sternum moderately wide, contracted in front. Anterior coxae separated by the width of the lip; fourth coxae a little the longest.

Falces a little shorter than the face, and narrower, not robust, and inclined.

Legs (♂) 3, 4, 1, 2; the first and second pairs almost equal and much shorter than the others; (♀) 4–3, 1, 2. Tibia and patella of the first a third shorter than the cephalothorax and almost equal, of the same length as the tarsus and metatarsus which are equal. (♂) Femur, patella, tibia and metatarsus of the third longer and much more robust than those of the fourth pair, ornamented with long hairs, which are very thick and disposed in longitudinal lines; (♀) third and fourth legs a little more alike. Tibia and patella of the fourth a little longer than the metatarsus, tibia of the fourth longer than the patella, parallel and cylindrical. Very long femoral, patellary (♀ on the posterior pairs), tibial and metatarsal spines; on the fourth pair metatarsal spines throughout the length of the articulation.

ATTUS (WALCK.) 1805. SIMON.

Syn.: 1805. **Attus** WALCK., Tabl. d. Aran. p. 22 (ad partem).
1850. **Europhrys** C. KOCH, Uebers. d. Arachn. Syst., 5, p. 60 (ad partem).
1869. **Attus** SIM., Monogr. d. espèces europ. de la fam. d. Attides, p. 6 (16), 14 (24), (ad partem).
1870. " THORELL, On Europ. Spid., I, p. 218 (ad partem).
1870. **Ælurops** ID., ibid. p. 219 (ad partem).
1871. **Attus** SIM., Révis. d. Attidae (ad partem).
1876. " ID., Arachn. de France, III, p. 101.
1877. " THORELL, Studi sui Ragni Malesi e Papuani, I, p. 280 (ad partem),
1878. " ID.. ibid. II, p. 290 (ad partem).
1878. " LEBERT, Die Spinnen der Schweiz, p. 306 (ad partem).
1881. " THORELL, Studi sui Ragni Malesi e Papuani, III, p. 509 (ad partem).

Cephalothorax high; thoracic part a little dilated, a third, or only a quarter (*A. saltator*) the longer. Cephalic part plane or a little convex, inclined forward, limited by a slight depression which is straight or slightly bent.

Clypeus equal to half the large middle eyes, or a little narrower, rarely wider (*A. floricola* ♂).

Eyes of the face rather unequal, a little separated, at least the lateral, and usually in a slightly curved line; dorsal eyes usually a little smaller than the lateral, as far or a little further apart; quadrangle scarcely a third wider than long; dorsal eyes equally far or a little further from each other than from the lateral borders.

Sternum elongated, as narrow as the intermediate coxae (except *A. attellanus* ♂).

Falces weak, vertical, as long or shorter than the face.

Palpus normal.

Legs 4, 1, 2, 3, rarely 1, 4, 2, 3; remarkable for the pre-eminence of the second pair over the third. Tibia and patella of the first as long (*A. Wagæ, frigidus*) or most often shorter than the cephalothorax; (♀) these two articulations equal; (♂) tibia longer; tarsus and metatarsus more slender (except *A. cingulatus*) and shorter (often barely) than the two preceding articulations. Fourth legs much longer than the third in all their articulations, principally the femur and the tibia; tibia at least a third longer than the patella, slightly enlarged from the base to the extremity and a little compressed; tarsus and metatarsus of the fourth much shorter than the patella and tibia (except some males: *A. floricola*, etc.). Femoral, tibial and metatarsal spines on the four pairs and throughout the length of the articulations.

PHLEGRA SIMON. 1876.

Syn: 1850. **Euophrys** (sub-gen. Parthenia) C. KOCH, Uebers. d. Arachn.-Syst. 5, p. 65.

1869. **Attus** (9th gr.) SIM., Monogr. d. espèces Europ. de la fam. d. Attides, p. 85 (551).

1870. **Ælurops** THOR., On European Spiders, I, p. 219 (ad partem).

1871. **Attus** (10th gr.) SIM.; Rèvis d. Attid.

1876. **Phlegra** ID., Arachn. de France, III, p. 120.

Cephalothorax very long, parallel in the cephalic part, a little dilated beyond; thoracic part at least twice the longer. Cephalic part plane and inclined not, or barely limited behind.

Eyes: those of the face very unequal; the middle eyes almost touhcing; the lateral a little separated, forming a line almost straight, or perceptibly curved. Dorsal eyes a little smaller than the lateral eyes, not, or very slightly further apart. Quadrangle a quarter wider than long; dorsal eyes a little further from one another than from the lateral borders.

Clypeus always more than half as wide as the middle eyes, often fully as wide (♂), with hairs.

Sternum contracted in front, at least twice as long as wide, as wide or slightly wider than the intermediate thighs. Anterior thighs separated by the width of the lip; thighs of the first, second and third legs almost equal; those of the fourth longer.

Legs 4, 1, 3, 2, or 4, 3, 1, 2. Tibia and patella of tha first at least a quarter shorter than the cephalothorax, these two articulations being equal in length and thickness, and a little longer than the tarsus and metatarsus, the latter being equal and more slender. Femur, tibia and patella of the fourth much longer than those of the third pair, exactly of the same length as the tarsus and metatarsus; tibia of the fourth much longer than the patella, slightly enlarged and compressed at the extremity. Posterior metatarsi armed to the base with very long spines.

Falces vertical or obliquely inclined backwards, shorter than the face in both sexes.

OEDIPUS MENGE. 1877.

Syn.: 1869. **Attus** SIM., Monogr. d. Attid., p. 6 (16) 14 (24) (ad partem).

1876. **Ballus** ID., Arachn. de France, III, p. 201 (ad partem).

1877. **Oedipus** MENGE, Preussische Spinnen, IX, p. 482.

Cephalothorax oblong; higher than wide between the dorsal eyes; the convex cephalic part inclined forward, the hind part descending abruptly. The forehead and large middle eyes are so oblique that from directly above only the upper margin of the eyes is visible.

The *clypeus* is still more oblique.

Eyes like those of Dendryphantes.

Legs also like Dendryphantes except that the femur and tibia of the first pair are more robust. Number of claw-teeth small.

Palpus (♂) with a sharp apophysis on the inner side of the fourth joint The palpal tube makes a single turn and then passes into the sac-like bulb. The point of the hook lies on a small tongue-shaped leaf.

Epigynum (♀) closely resembling D. nudis; the openings of the spermathecal tubes lie on the inner half of the chitinous arched enclosure, and end, after many turnings, close to the outer half of the orifice.

Spinnerets like those of Dendryphantes.

The species live in moss under fallen leaves and bushes.

SCARTES MENGE. 1877.

Scartes MENGE, Preussische Spinnen, IX, p. 494.

Cephalothorax oblong; the cephalic part with the forehead widely projecting; higher than wide, rounded on the sides, sloping steeply behind, the margin marked with a slight furrow.

Clypeus strongly retreating.

The large middle anterior *eyes* stand forward, the lateral anterior in a curve, somewhat removed from them. The small median eyes and the hind side-eyes stand rather on the side than on the top of the head.

The *palpus* (♂) has on the lower edge of the inner side of the second joint a deep-lying hook shaped apophysis with one small and one large tooth at the end. The fourth joint has on the inner side a short leaf-like apophysis; the fifth joint is long and has a small oval depression for the palpal organ, and the forepart long and curved over, the end of the palpal organ has four rounded corners, and is extended at one corner into a long awl-shaped projection, which consists of the palpal tube (Eindringer) and the covering which accompanies it to the very point. The awl-shaped projection is at one place narrowed; the palpal-tube passes, after a short winding course, into the sack-like bulb.

I have found the female only in the immature stage, where the epigynum shows only two openings for the future spermathecal tubes.

Abdomen oval. The whole body finely haired.

Legs 4, 3, 1, 2, with long slender claws and two pairs of spines on the metatarsi of both first legs.

Spinnerets with small tubes.

They live under heath plants.

EUOPHRYS (C. KOCH) 1834. SIMON.

Syn.: 1834. **Euophrys** C. KOCH, *in* Herr.-Schaeff., Deutschl. Ins., 123, (ad part.:) 7, 8.
1837. " ID., Uebers. d. Arachn.-Syst., 1, p. 33 (ad partem).
1848. **Attus** ID., Die Arachn., XIV, (ad part.:) p. 44-49.
1850. " ID., Uebers. d. Arachn.-Syst., 5, p. 68 (ad partem).
1869. " SIM., Monogr. d. Attid., p. 6 (16), 14 (24) (ad partem).
1870. **Euophrys** THORELL, on Europ. Spid., I, p. 216, (ad partem).
1871. **Attus** SIM., Revis. d. Attid. gr. 15 (ad partem).
1876. **Euophrys** ID., Arachn. de France, III, p. 170.
1878. " LEBERT, Die Spinnen der Schweiz, p. 302.
1878. " TACZ, Araneides du Perou. Bull. Soc. Imp. des Nat. de Moscou, LIII, 4, p. 280.
1883. " L. KOCH and KEYSERLING, Arachniden Australiens, p. 1430.
1883. " SIM., Arachnides de l'Ocean Atlantique, Ann. Soc. Ent. de France, 1882, p. 261.

Cephalothorax rather high; thoracic part dilated, a third or a quarter longer than the cephalic which is usually plane, little inclined, limited by a badly defined impression, cut by a small, very short longitudinal stria; thoracic part often having some diverging striae faintly indicated.

Clypeus half the middle eyes, or wider, with, usually, sub-ocular, and longer buccal hairs; the latter are often rooted in a membranous part which separates the border of the clypeus from the falces.

Eyes of the face very unequal, forming a straight, or rarely, a slightly curved line; dorsal eyes of the same size, or a little smaller than the lateral, not or scarcely projecting, and not further apart, since the sides of the square are straight; square a quarter wider than long; dorsal eyes further from one another than from the lateral borders.

Sternum oval, usually wider than the intermediate coxae. Anterior coxae separated by at least the width of the lip; coxae of the fourth pair longest.

Falces weak, vertical or inclined backward (renfoncees), shorter than the face.

Legs 4, 3, 1, 2 or 4, 1, 3, 2, rarely 1, 4, 3, 2. First and sometimes second pairs more robust than the others, particularly in the males, the femora being compressed and claviform. Patella and tibia of the first almost always shorter than the cephalothorax and slightly unequal; tarsus and metatarsus shorter and more slender than the two preceding articulations. Tibia and patella of the third (together) a little, (often scarcely) shorter than the tibia and patella of the fourth; tibia of the third much shorter, and a little thicker, than tibia of the fourth; patella (alone) longer than patella of the fourth; tarsus and metatarsus of the fourth as long or scarcely shorter than patella and tibia; tibia of the fourth, slightly enlarged at the extremity and a little compressed. Femoral, tibial, and metatarsal, but no patellary spines.

ALCMENA C. KOCH. 1846.

Syn.: 1846. **Alcmena** C. KOCH, Die Arachn., XIII, p. 176.
1880. " KARSCH, Arachnol. Blätter VIII, Zur Kenntniss der Attiden, *in* Zeitsch. f. d. Natur Wissensch., LIII, p. 397.

Eyes of the first row as in Euophrys. The eyes of the third row plainly smaller than the outer eyes of the first row, and further removed from them, the eyes of the second row very small, nearer to the outer eyes of the first row than to the eyes of the third row.

Falces in the male large, convex, smooth, twice as long as the face; in the female smaller.

Palpus without distinctive characteristic.

This genus stands very near to the genus Euophrys, but the position of the eyes and the large falces separate it essentially. Moreover the cephalothorax and abdomen are thinner, that is to say narrower and longer, and also are covered closely with shining scales, which give the color and marking. The female palpus has nothing unusual; that of the male I know only from young animals with immature bulbs; these are not different from those of Euophrys.

[1] HYPOBLEMUM. N.

Syn.: 1882. **Acmaea** KEYSERLING, Arachniden Australiens, p. 1420.
1883. **Drepanephora** ID., Arachniden Australiens, p. 1477.

Cephalothorax one-third or one-fourth longer than wide, sensibly contracted toward the front, behind rounded, wider at the dorsal eyes, rather low, slightly convex above.

Clypeus low.

Quadrangle of Eyes, wider than long, in front moderately contracted, not reaching the middle of the cephalothorax. First row of eyes curved upward; the lateral are separated by half their own diameter from the large eyes. Dorsal eyes are further from one another than from the margin of the cephalothorax, small median eyes are half way between the lateral anterior and the dorsal eyes.

Falces short.

Maxillae dilated and rounded in front.

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[1] *Hypoblemum* is substituted for *Drepanephora*, the latter name being preoccupied.

Labium contracted toward the front, a little longer than wide, scarcely longer than half the length of the maxilla.
Sternum convex, one third longer than wide, toward the posterior dilated.
Legs spined, 3, 4, 2, 1. Fourth pair more slender than the others. Patella and tibia of the third longer than the patella and tibia of the fourth; metatarsus and tarsus of the fourth not longer than the patella and the tibia, metatarsi spined throughout their length.
Abdomen sub-ovate, twice as long as wide.
Spinnerets moderately long, superior and inferior of equal length.

SELAOPHORA KEYSERLING. 1882.

Selaophora KEYSERLING, Archniden Australiens, p. 1374.

Cephalothorax not high, about one-third longer than wide, contracted in front, behind wide and rounded, scarcely wider than the dorsal row of eyes, convex above.
Clypeus scarcely as high as half the diameter of the large eyes.
Quadrangle of eyes wider than long, as wide before as behind, situated in front of the middle of the cephalothorax. Anterior row of eyes nearly straight, not touching. Small median eyes a little nearer the dorsal eyes than the lateral anterior. Dorsal eyes further from each other than from the margin of the cephalothorax.
Falces short and not diverging.
Maxillae twice as long as the labium.
Labium contracted in front and not longer than wide.
Abdomen long.
Legs spined 4, 3, 1, 2. Patella and tibia of the third shorter than patella and tibia of the fourth. Metatarsus aud tarsus of the fourth not longer than the patella and tibia.

SOBARA KEYSERLING. 1882.

Sobara KEYSERLING, Arachniden Australiens, p. 1365.

Cephalothorax longer than wide, contracted toward the front, rounded behind, moderately high, cephalic part plane,
Clypeus as high as the diameter of the large eyes.
Quadrangle of eyes wider than long, wider behind than in front not so long as the half of the cephalothorax, anterior row of eyes a little curved upward, middle eyes not touching, lateral eyes separated from these; small median eyes half way between the anterior lateral and dorsal eyes; dorsal eyes from each not wider than from the margin of the cephalothorax.
Falces rather long and slender, not diverging.
Maxillae wide at apex, contracted at the base.

Labium contracted in front, longer than half the length of the maxilla margin in front straight.

Sternum plane, rounded.

Abdomen long and contracted.

Legs spined, 1, 4, 2, 3 or 4, 3, 1, 2. First pair of legs scarcely stouter than the others. Patella and tibia of the third shorter than the patella and tibia of the fourth. Metatarsus and tarsus of the fourth not longer than the patella and tibia.

THEROSA KEYSERLING. 1882.

Therosa KEYSERLING, Arachniden Australiens, p. 1413.

Cephalothorax one quarter longer than wide, not contracted in front rounded behind, a little wider at the dorsal eyes, above convex.

Clypeus very low.

Quadrangle of eyes wider than long, wider in front than behind, and placed far in front of the middle of the cephalothorax. Dorsal eyes a little further from one another than from the margin of the cephalothorax. First row of eyes curved, close together; small median eyes half way between the anterior lateral and the dorsal eyes.

Falces short and not diverging.

Maxillae dilated and rounded in front.

Labium rounded in front and half as long as the maxilla.

Sternum twice as long as wide, contracted more in front than behind.

Abdomen long and contracted.

Legs spined 4, 3, 1, 2. First pair not shorter than the others. Patella and tibia of the third as long as the patella and tibia of the fourth; metatarsus and tarsus of the fourth not shorter than the patella and tibia.

MARGAROMMA KEYSERLING. 1882.

Margaromma KEYSERLING, Arachniden Australiens, pp. 1347, 1466.

Cephalothorax one fifth part longer than wide, contracted in front, behind wide and rounded, high above, wider at the dorsal eyes.

Clypeus half the diameter of the large eyes.

Quadrangle of eyes wider than long, forming a trapezium, contracted behind. Dorsal eyes almost as far from each other as from the margin of the cephalothorax. First row of eyes recurved and near to each other. Small median eyes further from the anterior lateral than from the dorsal eyes.

Falces short and not diverging.

Maxillae rather long in front, dilated and rounded.

Labium contracted in front, not more than half the length of the maxilla.

Sternum sligtly convex, a little longer than wide.

Abdomen short and ovate.

Legs spined, 3, 4, 1, 2. First pair not stouter than the others. Patella and tibia of the third a little longer than the patella with the tibia of the fourth. Metatarsus and tarsus of the fourth not longer than the patella and tibia.

PROSTHECLINA Keyserling. 1882.

Prosthеclina Keyserling, Arachniden Australiens p. 1368.

Cephalothorax one fifth longer than wide, contracted in front, a little wider and rounded behind, equally wide at the dorsal eyes.

Clypeus half the diameter of the large eyes.

Quadrangle of eyes scarcely wider than long, behind a little contracted and almost reaching the middle of the cephalothorax. Anterior row of eyes almost straight, eyes close together. Dorsal eyes from each other scarcely further than from the margin of the cephalothorax; small median eyes half way between the anterior lateral and the dorsal eyes.

Falces short, not diverging.

Maxillae dilated and rounded in front.

Labium contracted in front, half as long as the maxilla.

Sternum oval and moderately convex.

Abdomen ovate.

Legs 4, 3, 1, 2 or 1, 4, 3, 2. Patella and tibia of the third as long as the patella and tibia of the fourth.[1] Metatarsus and tarsus of the fourth longer than the patella and tibia.

LAGNUS L. Koch. 1879.

Lagnus L. Koch, Arachniden Australiens, p. 1073.

Cephalothorax a little longer than wide, high; lateral and posterior, margins rounded. Cephalic part convex.

Clypeus low.

Quadrangle of eyes in front a little wider than long and wider than behind; first row of eyes recurved, close together, the median very large. Middle eyes equally distant from the lateral anterior and the posterior eyes. Eyes of the third row placed in front of the middle of the cephalothorax and less distant from each other than from the margin of the cephalothorax.

Maxillae dilated toward the front, lateral margin with the anterior margin being lengthened to form an angle.

Lip convex, contracted in front, longer than half the length of the maxilla, lip rounded.

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[1] Written "third" but evidently a misprint for fourth.

Sternum hardly longer than wide, plane.

Abdomen long, sensibly narrowed toward the posterior.

Palpi (♂) elongated, equal in length to the first pair of legs.

Legs spined 1, 4, 3, 2, first pair stouter than the others. Patella and tibia of the third shorter than the patella and tibia of the fourth. Metatarsus and tarsus of the fourth evidently longer than the patella and the tibia.

SCAEA L. KOCH. 1879.

Scaea L. KOCH. Arachniden Australiens, p 1142.

Cephalothorax longer than wide, slightly contracted behind, high and convex, toward the anterior declining, third row of eyes high above the sides.

Quadrangle of eyes wider than long, equally wide in front and behind, and placed in front of the middle of the cephalothorax. Middle row of eyes as far from the lateral eyes of the first row as from the eyes of the third row and placed not higher than these; eyes of the third row further from the margin of the cephalothorax than from each other.

Sternum ovate cordate.

Abdomen broadly ovate.

Legs patella with the tibia of the third pair shorter than the same joints of the fourth pair. The metatarsus with the tarsus of the fourth pair are shorter than the patella with the tibia.

[1] BOOTES N.

Syn: 1882. **Hadrosoma** KEYSERLING. Arachniden Australiens, p 1418.

Cephalothorax short, one-sixth longer than wide, in front not contracted, behind rounded and a little contracted, scarcely wider at the dorsal eyes, above convex.

Clypeus more than half the diameter of the large eyes.

Quadrangle of eyes wider than long, as wide before as behind, almost reaching the middle of the cephalothorax. Dorsal eyes further from one another than from the margin of the cephalothorax. Small median eyes half way between the anterior lateral and the dorsal eyes. First row of eyes slightly recurved and the lateral eyes separated from the middle eyes.

Falces short and not diverging.

Maxillae dilated and rounded in front.

Labium rounded in front, not longer than wide, half as long as the maxilla.

Sternum oval and a little convex.

Abdomen level, a little longer than wide.

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[1] *Bootes* is substituted for *Hadrosoma*, the latter name being preoccupied.

Legs spined 4, 1, 3, 2. First pair not stouter than the others. Patella and tibia of the third shorter than the patella and tibia of the fourth. Metatarsu and tarsus of the fourth not larger than the patella and tibia.

CYTÆA KEYSERLING. 1882.

Cytæa KEYSERLING, Arachniden Australiens, p. 1380.

Cephalothorax one-third or fourth part longer than wide, slightly contracted toward the front, behind rounded, a little wider at the third row of eyes, above slightly convex, not high.

Clypeus a third of the diameter of the large eyes.

Quadrangle of eyes wider than long, behind and in front equally wide or a little narrower behind, placed far in front of the middle of the cephalothorax. Dorsal eyes further from each other than from the margin of the cephalothorax. Anterior row of eyes recurved and more or less close together. Small median eyes half way between the anterior lateral and dorsal eyes.

Falces short and not diverging.

Maxillae dilated and rounded in front.

Labium rounded in front, not more than half as long as the maxilla.

Sternum oval, longer than wide.

Legs spined. 1, 3, 4, 2, or 4, 3, 1, 2; first pair stouter than the others. Patella and tibia of the third longer than the patella and tibia of the fourth; metatarsus and tarsus of the fourth not shorter than the patella with the tibia. Metatarsus of the fourth spined to the apex.

SINNAMORA KEYSERLING. 1883.

Syn.: 1882. **Tanypus**[1] KEYSERLING, Arachniden Australiens, p. 1415.
1883. **Sinnamora** ID., Arachniden Australiens, p. 1477.

Cephalothorax about one-fifth longer than wide, toward the posterior moderately dilated, contracted in front, a little wider at the dorsal row of eyes, above high, slanting before and behind.

Clypeus as high as one-fourth the diameter of the large eye.

Quadrangle of eyes wider than long, wider in front than behind, almost reaching the middle of the cephalothorax. First row of eyes recurved, close together. Dorsal eyes less distant from one another than from the margin of the cephalothorax. Small median eyes half way between the anterior lateral and the dorsal eyes.

Falces short, not diverging.

Maxillae dilated and rounded in front.

Labium longer than wide, more than half as long as the maxilla.

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[1] The generic name "Tanypus" was pre-occupied.

Sternum rounded, plane and a little longer than wide.

Abdomen long and contracted.

Legs spined, 4, 1, 3, 2. First pair hardly stouter than the others. Patella and tibia of the third shorter than the patella and tibia of the fourth; metatarsus and tarsus of the fourth a little longer than the patella and the tibia. Metatarsus of the fourth commonly spined throughout its length.

LANUARULLA KEYSERLING. 1883.

Lauharulla KEYSERLING, Arachniden Australiens, p. 1431.

Cephalothorax one-fourth longer than wide, not wider in the middle than in front, scarcely wider at the third row of eyes, high and convex.

Clypeus very low.

Quadrangle of eyes wider than long, a little contracted behind, almost reaching the middle of the cephalothorax. Eyes of the first row close together, slightly curved or almost straight. Dorsal eyes a little smaller than the anterior lateral and further from one another than from the margin of the cephalothorax. Small median eyes are nearer the anterior lateral than the dorsal eyes.

Sternum heart-shaped, scarcely longer than wide.

Falces vertical, short, and not diverging.

Maxillae more than twice as long as the labium.

Labium wider than long, rounded in front.

Legs 4, 1, 3, 2. First pair not stouter than the others. Patella and tibia of the third shorter than the patella and tibia of the fourth. Metatarsus and tarsus of the fourth not longer than the patella and tibia. Matatarsi of the fourth pair spined only at the apex.

Abdomen short, as long as wide.

Spinnerets as usual, superior not longer than the inferior.

ASTIA KOCH. 1879.

Astia L. Koch. Arachn. Australiens, p. 1152.

Cephalothorax contracted in front, wider and rounded toward the posterior, opposite the third row of eyes wider, one quarter longer than wide.

Quadrangle of eyes wider than long, forming a trapezium contracted behind. Third row of eyes as far from one another as from the margin of the cephalothorax. Middle row of eyes nearer the front lateral than the posterior eyes, and placed perceptibly higher than these.

Sternum ovate-cordate.

Abdomen ovate, truncated in front, sensibly contracted toward the apex.

Patella and tibia of third pair shorter than the patella and tibia of the fourth pair. Metatarsus with the tarsus of the fourth pair shorter than the patella with the tibia.

SUB-FAMILY LYSSOMANAE.

LYSSOMANES Hentz. 1832.

Syn.: 1832. **Lyssomanes** Hentz. Sillimen's Journal of Science and Arts XXI pp. 99–152.
1844. " " Journal Boston Soc. Nat. Hist.. IV pp. 386–396.
1875. " " Occasional Papers Boston Soc. Nat. Hist. II. The Spiders of the United States, Edited E. Burgess, p. 48.

Cheliceres moderately strong; maxillae parallel, short, rounded.

Lip conical, slightly truncated at tip.

Eyes eight, unequal in four rows, the first composed of two very large eyes the second of two smaller ones, placed farther apart, on a common elevation with the two forming the third, which is narrower, the fourth about as wide, composed of two eyes placed on separate elevations

Feet, first pair largest, then the second, then the third, the fourth being the shortest.

JELSKIA Taczanowski. 1872.

Syn.: 1872. **Jelskia** Tacz , Aran. de la Guyane française, Horae. Soc. Ent. Rossicae, VIII. 1871, pp. 128–132.
1878 " Id., Aranéides du Pérou, Bull. de la Soc. Imp. des Nat. de Moscou, LIII. 4, p. 373.

Cephalothorax long, with the cephalic part distinct from the thoracic, and higher.

Eyes eight, in four rows; the first pair very large, occupying the entire height of the face, very near together but not touching, directed forward; eyes of the second row half as large, situated above those of the anterior row, a little further back, and separated from each other so as to form an almost regular quadrangle with the anterior eyes; like them directed forward and a little upward; the eyes of the third row small, situated on the horizontal face of the back, nearer to one another than the others, and directed upward; those of the fourth row as large as those of the second, placed behind on the middle of the back, not quite so far apart as these last, directed obliquely backward.

Falces cylindrical, slender, short, and vertical, with the hook short and strongly bent.

Palpus long and slender; the femur as long as the tarsus; the patella and and tibia equal, as slender as the femur, and not so long; the tarsus long, passing considerably beyond the bulb, which is globular, terminating in a curved hook which is coverrd above by the tarsus.

Legs very long, slender, and unequal; relative length 1, 4, 2, 3; the first pair much longer than the others, between which the difference is slight.

Abdomen long, slender, cylindrical, with short spinnerets.

[1] EPEUS N.

Syn: 1877. **Evenus** SIMON, Am. Soc. Entomol de France, (5), vii, pp. 58-58

Cephalothorax moderately long; thoracic part scarcely the longer, plainly dilated and rounded, cephalic part plane, high behind, inclined in front, longer than wide.

Eyes: the median anterior eyes very large, almost touching, the entire width of the face; the lateral eyes much smaller, separated, further back, forming a second line. Dorsal eyes as large as the lateral, a little nearer together since the sides of the head converge behind.

Clypeus almost as wide as the radius of the median anterior eyes.

Sternum scarcely wider than the intermediate coxae, rounded above, anterior coxae separated by at least the width of the lip, of the same length as the others.

Falces short, vertical, not ridged.

Legs 3, 1, 2, 4, long, the three first pairs of equal thickness, the fourth pair more slender, patella and tibia of the first longer than the cephalothorax, tibia much longer than the patella; patella and tibia of the fourth much shorter than patella and tibia of the third, and more slender; metatarsus and torsus of the fourth at least as long as the patella and tibia; on the first two pairs two inferior rows of very long tibial and metatarsal spines; tibae and metatarsi of the two posterior pairs with slender spines throughout their length. Long tarsal claws, regularly bent, the external one provided with a series of five teeth, longer, more slender, equal, crowded together.

This genus makes the transition from the ordinary Attidae to *Lyssomanes* of Hentz.

ATHAMAS CAMBRIDGE, 1877.

Syn: 1877. **Athamas** CAMBRIDGE, Proc. Zool. Soc., London, pp. 575-7.
1879. " L. KOCH, Arachniden Australiens, p. 1076.

Cephalothorax short, massive, quadrate. Very convex above; the side and hinder slope almost vertical.

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[1] *Epeus* is substituted for *Evenus*, the latter name being preoccupied.

Eyes very unequal in size, disposed in four transverse lines of two each, and almost of same length.

Maxillae rather short, slighty divergent, and much the broadest at their extremities, which are rounded.

Lip short, small, and of a somewhat curviangular form.

Legs rather slender and moderately long; those of the first pair longest; and of the second pair shortest.

Abdomen small, short, oval, and sloping from its most convex part, near the margin to the spinners.

This genus is closely allied to *Lysscmanes* Hentz, as well as to *Jelskia* Tacz. It differs, however, from both in the shortness of the cephalothorax and also of the abdomen. From *Lyssomanes* Hentz it differs in the superior and inferior spinners being of equal length, whereas, in that genus, those of the superior pair are much longer, slender and three-jointed.

Dr. L. Koch's suggestion that Athamas is probably identical with Evenus of Simon (Arachniden Australiens, p. 1076), seems to us an error, since the genera differ in several characteristics. In Cambridge's genus the cephalothorax in front is very *convex*; the sides of the head are *parallel*, the clypeus as *wide* as the middle eyes of the first row; the first leg longest. In the genus of Simon, the cephalic part is *plane*, the sides of the head *converge* behind, the clypeus is only *one half* the diameter of the large middle eye; the third leg longest.

APPENDIX.

We give below definitions of those genera which have been formed since the completion of the preceding paper. Those of Mr. Simon and Count Keyserling we have translated with their notes. We wish, also, to refer to a genus which had heretofore escaped our notice, and of which we have not yet the definition. This is *Chalcoscirtus* Bertkau, formed for *Calliethera infima* E. Sim., cf. Ver. d. Nat. Ver., XXX, 1883, p. 207.

PSEUDICIUS SIMON. 1885.

Syn.: Attus AUCT (ad part.). Dendryphantes E. Sinn., Ar. Fr., III (ad part. *eucarpatus*, etc.) + Calliethera E. Sim., Ar., Karth., 1884 (ad p. *icioides*). Pseudicius E. Sim, Faune Arach. de l'asie Mérid., Bulletin de la Soc. Zool. de France, t. x. 1885.

Related to the genus *Icius* E. Sim., differing in having the eye area parallel above, and the falces in ♂ and ♀ not grooved in the outer sides; tibiae I and II unarmed, or with one spine (*P. badius*), or provided with two minute spines on the inner side; tibiae and metatarsi III and IV unarmed, (excepting with the ordinary terminal spines); ♂ with femur and tibiae I very stout.

I believe it necessary to create this genus for a certain number of species whose characteristics are intermediate between those of *Icius*, and those of *Dendryphantes* and *Calliethera*, but which does not agree entirely with any one of these. The cephalothorax is long and low as in *Calliethera* and *Icius*, the first row of eyes is equally straight, this being the point which separates these genera from *Dendryphantes*, the ocular quadrangle is parallel above, as in *Calliethera;* the armature of the anterior legs is very peculiar; the tibiae are unarmed with the exception of one or two small internal spines on the first pair, but the metatarsi have two pairs of small spines. The integument is covered with simple hairs, never with scales.

This genus has for its type *P.* (*Dendryphantes*) *encarpatus* Walck.; it includes beside. *P. badius* E. Sim., *P. picaceus* E. Sim , from the south of Europe, and *P.* (*Calliethera*) icioides E. Sim., from Khartoum.

PSEUDAMYCUS Simon. 1885.

Amycus V. Hasselt, (*albomaculatus*) (non C. Koch nec L. Koch).
Pseudamycus E. Sim, Arachn. recueillis par M. Weyers á Sumatra, Ex. des Comptes-rendus de la Soc. Ent. de Belgique, 1885.

Very closely related to the genus *Ephippus* Thorell, the cephalothorax and eyes being almost the same, the falces being furnished with one strong tooth on the inferior margin of the groove, and with two, the second being the smaller, on the superior margin (in *Ephippus* the inferior has 1, and the superior 3 or 4 minute teeth), the metatarsi and tarsi III and IV being a little shorter than the patellae with the tibiae (they are a little longer in *Ephippus*), and the tibiae III and IV armed with a dorsal spine below the base.

The genus *Amycus* C. Koch (type *igneus*), found in South America, is easily distinguished by its clypeus being as wide as, or wider than the anterior eyes, and by the inferior margin of the falces being provided with from 3 to 5 teeth.

PTOCASIUS Simon. 1885.

Ptocasius Sim., Arach. recueillis par M. Weyers, à Sumatra, Ex. des Comptes-rendus de la Soc. Ent. de Belgique, 1885.

Related to the genus *Hasarius*, the cephalothorax being almost the same, but the occular area being a little longer above, scarcely one fourth wider than long, parallel or barely wider behind, convex on both sides behind the eyes; eyes as in *Hasarius* excepting that those of the second row are more widely removed from the posterior than from the anterior eyes; labium more attenuated, falces with a pair of teeth (or a bifurcated tooth) on the inferior margin of the groove. which are very unequal, the first being much smaller than the second, the maxillae in the ♂ denticulated on the outer side behind the corner. Legs as in the genus *Hasarius* but with the tibiae and metatarsi I and II armed on both sides with lateral spines, tibiae I and II without dorsal spines, III and IV with a smaller dorsal spine placed behind the base, integuments covered with simple hairs, not with scales.

Equally near to the genus *Cytaea* Keyserl. (in L. Koch, Ar. Austr.) but differing from it in having the cephalothorax shorter and higher, by the superior margin of the falces being provided with two teeth, as in *Hasarius*, while in *Cytaea* there are four small ones, by the two teeth of the inferior margin being very unequal, and finally by the integument being covered with simple hairs, while the *Cytaea* of the hairs are scale-like.

Salticus sinuatus Doleschall (*Plexippus* Th.), *Plexippus laticeps* Thorell, and probably many other species described by Dr. Thorell under the generic name of *Plexippus* belong to the genus *Cytaea*.

It is probable that several of the species described by Keyserling under the name of *Hasarius*, belong in the genus *Ptocasius*, particularly *lineatus*, *albocinctus*, *insularis*, *chrysostomus*, and *mulciber*, which are unknown to us.

STAGETILLUS Simon. 1885.

Stagetillus E. Sim., Arach. recueillis par M. Weyers á Sumatra, Ex. des Comptes-rendus de la Soc. Ent. de Belgique, 1885.

Near the genus *Bavia*, but having the cephalothorax much longer; the thoracic part almost ⅓ longer than the cephalic, the ocular area longer above, a little narrower behind than in front, the sternum plainly wider than the intermediate coxae, and very much narrower in front, the space between the anterior coxae not narrower than the width of the labium, legs 1, 4, 2, 3, the first much stouter that the others, and compressed, tibiae and metatarsi I and II furnished with stout spines disposed in two inferior rows, the posterior legs unarmed, the metatarsi with the tarsi III and IV longer than the patellae with the tibiae, trochanter IV cylindrical and long, scarcely shorter than the coxae, falces short, parallel, almost plane in front, the inferior margin of the groove with 3 or 4 teeth.

AGOBARDUS Keyserling. 1885.

Agobardus Keyserling, Neue Spinnen aus Amerika, VI, p. 33.

Cephalothorax about ⅕ longer than wide, nearly vertical on the sides, narrower in front and behind, and not wider than the third row of eyes, very convex above, falling steeply to the posterior border, and having the cephalic part strongly inclined forward.

Quadrangle of the eyes equally wide in front and behind, and much wider than long, reaching behind to the middle of the cephalothorax. Looked at from in front the first row of eyes seems to be strongly curved, and the side eyes to be separated from the middle eyes by more than their own radius. The small eyes of the second row are about halfway between the fore side eyes and the eyes of the third row, which are equally distant from each other and from the lateral borders.

Falces a little diverging, and as long and stout as the patellae of the first pair of legs.

Labium not longer than wide, and only half as long as the maxillae, which are rounded in front and moderately wide.

Sternum only a little longer than wide, and plainly wider than the coxae.

Legs (♂ 1, 4, 3, 2, and ♀ 4, 3, 1, 2), moderately long, the first pair scarcely stouter than the others, thinly haired and with spines on all the joints; the metatarsus of the fourth has several at the beginning and end. Metatarsus and tarsus of the fourth a little longer than patella and tibia of the fourth, and these joints as long as the patella and tibia of the third.

Abdomen not much longer than wide.

WALA KEYSERLING. 1885.

Wala KEYSERLING, Neue Spinnen aus Amerika, VI, p. 30.

Abdomen long and slender.

Cephalothorax scarcely wider than long, strongly rounded on the sides, much wider than the third row of eyes, contracted behind, not high above, and rather flat. The cephalic part slightly inclined forward.

Clypeus very low.

Quadrangle of the eyes wider than long, somewhat narrower in front than behind, occupying only about $\frac{1}{3}$ of the cephalothorax. Anterior row slightly bent, with the eyes rather near together. Eyes of the third row further from each other than from the lateral borders.

Falces (♂) rather slender, long, and diverging.

Labium longer than wide, $\frac{2}{3}$ as long as the maxillae.

Sternum scarcely longer than wide and scarcely narrower than the coxae of the first pair of legs, much wider than those of the second.

Legs (♂) 1, 4, 3, 2, first pair in the male much longer and stouter than the others. Femur, tibia, and metatarsus of the first and second pairs with spines, which are found only on the femur and at the extremity of the metatarsus on the third and fourth pairs. Patella and tibia of the fourth longer than the patella and tibia of the third; also longer than the metatarsus and tarsus of the fourth.

This genus stands very near to *Hyllus* C. K., but is separated from it by the still shorter cephalothorax, by the absence of spines at the beginning of the metatarsus of the fourth leg, and chiefly in that the patella and tibia of the third are shorter than the patella and tibia of the fourth, and that the quadrangle of the eyes is a little wider behind than in front. It is also somewhat like *Sandalodes* Keys., but is separated from it by the short, wide sternum, and the absence of spines at the beginning of the metatarsus of the fourth. As to *Mospus Keruli* it offers, beside other differences, the height of the clypeus in relation to the eyes, which is the principal difference. (Bei *Mospus Keruli* bietet ausser anderen Verschiedenheiten die Höhe des Clypeus das am meisten in die Augen tretende Merkmal der Unterscheidung).

GANESA PECKHAM. 1885.

Ganesa PECKHAM, Proc. Nat. Hist. Soc. of Wisconsin, March, 1885.

Cephalothorax very low and flat, slightly contracted in front and behind, twice as long as wide, and a little wider than the third row of eyes, with a depression limiting the cephalic part. Thoracic part twice as long as cephalic, truncated behind.

Eyes forming a quadrangle a little more than ¼ wider than long and equally wide in the front and behind. Anterior eyes all separated, forming a line slightly curved[1] downward, the middle nearly three times as large as the lateral eyes. Eyes of the second row halfway between the dorsal and lateral eyes. Dorsal eyes further from each other than the lateral borders.

Clypeus very low.

Sternum wide and oval, narrower behind than in front. Anterior coxae separated by the width of the labium.

Maxillae less than twice as long as labium, wider at the extremity, parallel.

Labium a little longer than wide, rounded at tip.

Falces nearly vertical, not diverging, robust, short, about as wide as long, narrower at the insertion of the fang.

Legs 1, 4, $\overline{2, 3}$, in both sexes. First leg much the stoutest, with the femur and tibia greatly enlarged, and patella slightly enlarged in both sexes. The patella with tibia of the third shorter than patella with tibia of the fourth; metatarsus with tarsus of fourth shorter than patella with tibia. The third and fourth pairs have no spines.

Abdomen long and slender, flattened above.

ASAMONEA (CAMBRIDGE). 1869. SIMON.

Syn., 1869. Asamonea CAMBR., Ann. Mag. nat. hist., 1869, p. 14.
1885. " E. Sim., Faune Arachnologique de l'Asie Mérid., Bull. de la Soc. Zool. de France, t X., 1885.

We transcribe the following remarks on the genus Asamonea, from E. Simon, (Materiaux pour servir a la faune Arachnologique de l'Asie Méridionale Bulletin de la Société Zoologique de France, t. X, 1885.)

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[1] We speak of the anterior row of eyes as *straight* when a straight line from the top of the middle eyes touches also the top of the lateral eyes; *curved,* when a straight line from the top of the middle eyes cuts the lateral eyes; *curved downward,* when a straight line from the top of the middle eyes passes above the lateral eyes.

The typical species *A. tenuipes* has been described by the Rev. O. P. Cambridge under the generic name of *Asamonea*, but the characters of the genus have never been formulated, the author having been of the opinion, even at the time of its publication, that this new genus was simply synonymous with *Lyssomanes* Hentz. It seems to us that the genus *Asamonea* ought to be re-established, as it differs greatly in reality from the genus *Lyssomanes* by the proportion and the disposition of the eyes and the form of the labium; in *Asamonea* the region occupied by the six dorsal eyes is much wider than long, and the eyes are almost equal, the scarcely smaller ones of the third pair are placed much within and near those of the second, the labium is as wide as long, while in *Lyssomanes* the dorsal ocular area is as long as wide or scarcely wider, the eyes of the third row are much smaller than the others, placed equally far in, but much more behind the eyes of the second row, finally the labium is much longer than wide.

The characters of the genus *Asamonea* may be thus formulated:

Cephalothorax low almost plane above, dorsal eyes 2, 3, 4, occupy a trapeziform area much wider than long, eyes of the third row scarcely smaller than the other eyes, and placed within and behind the eyes of the second row. Maxillae short, almost quadrate. Labium not longer than wide, a little attenuated and truncated. Superior spinnerets much longer than the inferior, biarticulate, the first articulation scarcely shorter than the second. Legs slender, rather long, 1, 4, 2, 3, furnished with long spines; metatarsus IV much longer than the tibiae.

SIMONELLA PECKHAM. 1885.

Simonella PECKHAM, Proc. Nat. Hist. Soc. of Wisconsin, March, 1885.

Body long, slender, nodose.

Cephalothorax more than twice as long as wide, convex above, constricted near the middle; thoracic part twice as long as cephalic.

Eyes very unequal in size, placed in four transverse rows of two each. those of the anterior row almost touching. The quadrangle formed by the second and fourth rows is wider behind than in front, and wider behind than long. Eyes of the third row very small, and nearer to the second than to the fourth row. Eyes of the fourth row on the upper margin of the cephalothorax.

Clypeus less than ½ as wide as the anterior eyes, retreating.

Sternum long, narrow behind. Anterior coxae separated by the width of the labium.

Maxillae twice as long as labium, widest in the middle, tapering toward apex.

Labium as wide as long, truncated at tip.

Falces stout and long, vertical, slightly diverging.

Legs 4, 3, 1, 2, slender, differing but little in thickness, the third and fourth pairs unarmed. Patella with tibia of the third shorter than patella with tibia of the fourth; metatarsus with tarsus of the fourth shorter than patella with tibia.

Abdomen long, slender, much narrower in the middle.

Including *Asamonea* Cambr., *Simonella* makes the sixth genus of the sub-family Lyssomanae, which includes those attidae which have the eyes in four transverse rows. *Janus myrmaciaeformis* Tacz. is nearest to *Simonella*, and Dr. Taczanowski, in describing that species, suggests that it ought to constitute a new genus. It differs, however, from *Simonella*, in that the first row of eyes occupies the whole of the face, and in the quadrangle of the eyes being longer than wide. *Simonella* is easily distinguished by its nodose form from the other genera of this sub-family. In general appearance it most resembles *Synemosyna* Hentz.

PROCEEDINGS OF THE ACADEMY SINCE DECEMBER, 1881.

REPORT OF THE SECRETARY.

TWELFTH REGULAR ANNUAL MEETING,

Held at Madison, Wisconsin.

ROOMS OF WISCONSIN ACADEMY OF
SCIENCES, ARTS AND LETTERS,
CAPITOL, MADISON, WISCONSIN.

FIRST SESSION.

TUESDAY EVENING, December 27th, 1881.

Prof. Davies, General Secretary, read the minutes of the last meetings. Minutes were accepted and adopted.

Profs. W. F. Allen, E. A. Birge, and S. D. Hastings were appointed a committee to whom was referred all nominations for membership.

The Treasurer's report was then read and referred to a committee consisting of Profs. W. F. Allen, A. O. Wright, and R. C. Hindley.

The Treasurer also read the number of years that each member was in arrears for his dues, or also in advance upon his dues in virtue of the arrangement of dues made at the Eleventh Regular Annual Meeting; also the list of members who had failed entirely to respond to the demand for dues, was read.

Professors Butler and Birge and Hon. S. D. Hastings were appointed a committee to consider the legality of the action of the Academy in appointing Prof. Davies, who has been for nine years General Secretary, and George P. Delaplaine who was for eight years Treasurer, of the Academy, Life Members, in virtue of long continued and unremunerated services in their respective offices.

Academy adjourned until 9 o'clock, Wednesday morning.

SECOND SESSION.

December 28, 1881.

Academy met at 9:30 A. M.

As the Secretary was unable to be present on account of sickness, Prof. A. O. Wright was elected Secretary pro tem.

The committee on nominations reported, recommending the following persons:

Prof. E. G. Smith, Beloit College.

Prof. W. R. Higby, Lake Geneva Seminary.

F. J. Lamb, Esq., Madison.

Prof. R. D. Salsbury, Beloit.

Who were duly elected.

The following report was presented:

To the Wisconsin Academy of Jciences, Arts and Letters:

The committee to whom was referred the constitutionality of the resolution presented at the last Annual Meeting of the Academy, constituting Life Members of the Academy in consideration of some eight years of valuable official service, would respectfully report: that they do not regard the resolution as conflicting with the constitution, and they would therefore recommend its adoption.

Respectfully submitted,

SAMUEL D. HASTINGS,
E. A. BIRGE,
JAMES D. BUTLER.

MADISON, December 28, 1881.

This report was accepted and the resolution making General Delaplaine and Prof. Davies Life Members was then adopted.

The Auditing Committee reported approving the Treasurer's report.

Report adopted.

Report adopted and the names so dropped are:

Prof. W. F. Allen then read a paper on "Land Communities among the Ancient Germans."

Prof. E. A. Birge gave a verbal account of a paper on "The Distribution and Function of the Large Ganglion Cells of the Frog's Spinal Cord."

Prof. J. D. Butler read a paper on "Mediaeal German Schools." Discussed by Prof. O. M. Conover and others.

Prof. A. O. Wright, Secretary of the State Board of Charities and Reforms read a paper on "The Increase of Insanity." Discussed by several.

President Chapin gave a brief address relating to the work of the Academy.

The following resolution offered by the Treasurer was adopted:

WHEREAS, Thirty-one members of the Academy have this morning been suspended from membership, for non-payment of annual dues under the rules of the Academy,

Resolved, That any of the persons thus suspended may be restored to membership at any time by paying into the treasury the amounts due at the time of suspension.

The Academy then proceeded to the election of officers with the following result:

President — Prof. R. D. Irving.

Vice-President of the Department of Science — Professor T. C. Chamberlain, of Beloit.

Vice-President of the Department of Letters — Professor W. C. Sawyer, of Appleton.

Secretary — Prof. E. A. Birge, of Madison.

Librarian — Prof. A. O. Wright, of Madison.

Curator of the Museum — Prof. R. C. Hindley, of Racine.

Treasurer — Hon. S. D. Hastings, of Madison.

Prof. W. F. Allen proposed the following amendment to the constitution, which under the rules lies over until the next meeting.

Resolved, That the constitution be amended so as to abolish the Department of Arts.

The election of Vice-President for the Department of Arts was suspended.

The following resolution offered by Prof. W. F. Allen was adopted:

Resolved, That Secretary, Librarian and Curator compose a committee to have charge of the books and collections of the Academy.

The following resolution offered by Prof. R. C. Hindley was adopted:

Resolved, That the Academy favors and will foster to the best of its ability the establishment of Local, Literary and Scientific societies throughout the state.

Resolution offered by Prof. O. M. Conover was adopted, as follows:

Resolved, That the officers of the Academy be requested to unite with those of the State Historical Society in urging upon the Legislature at its next session the importance of providing a suitable fire-proof building for the use of the Historical Library and the collections of the Academy and of the other State Societies.

Academy adjourned for dinner.

THIRD SESSION.

Wednesday afternoon, 2:30 P. M.

In the lecture room of Natural History of Science Hall, University of Wisconsin.

President Irving in the chair.

The following papers by Rev. S. D. Peet, were read by title:

1. On Animism among the Emblematic Mound Builders.
2. On the Fetichism Exhibited in the Village Sites and Burial Places of Emblematic Mound Builders.
3. On the Tablets and Inscribed Plates of the Mound Builders of Ohio and Iowa compared with Aztec, Persian and Hindoo symbols.
4. The Theory that the Mounds of the Ohio Valley were the Foundations of Communistic Houses Refuted.

A paper was read by Mr. R. D. Salisbury, assistant to Prof. Chamberlin, of Beloit, on "The Dispersion of Drift Copper." Discussed by Professors Irving, Butler and Chamberlain.

Prof. Birge gave an extempore lecture on "Recent Observations on Nuclear Division and their Relation to Theoretical Zoology."

Prof. Chamberlin then gave an interesting talk on "American Glacial History in the Light of Recent Investigations," and the "Harmony of Certain Observations with Croll's Hypothesis of the Origin of the Glacial Epoch."

Mr. George Schumm, editor of the *Radical Review*, read a paper on "Proportional Representation in Legislation," which was warmly discussed by many members.

The following resolution was adopted:

Resolved, That the General Secretary be requested to prepare a corrected copy of the constitution and by-laws for publication in Volume V of the transactions, and that he also prepare for publication a copy of all resolutions which refer to the management of the affairs of the Academy that will be of general interest to the members.

Academy adjourned.

EVENING SESSION.

Held in the senate chamber of the capitol.

A large audience greeted Prof. Butler, who kept his hearers interested in his description of his "Visit to the Hawaiian Volcano." This paper was followed by a paper on "Human Liberty Empirically Considered," by Dr. John Bascom.

Adjourned.

THIRTEENTH REGULAR ANNUAL MEETING.

Held at Madison, Wisconsin, December 26th, 27th and 28th, 1882.

ROOMS OF THE AGRICULTURAL SOCIETY,
TUESDAY, December 26th, 7:30 P. M.

The Academy was called to order by Pres. Irving.

The minutes of preceding meeting read and approved.

The Treasurer's report was given, as follows:

Balance on hand, 1881	$826 49
Received from annual dues	31 00
Received from life member (G. H. Paul)	100 00
Total	$957 49
Paid out on warrants	70 08
Balance December, 1882	$887 41

The report was referred to Mr. Lamb, Prof. Butler and Dr. Hoy, who reported favorably on it, and it was received and adopted.

The Publishing Committee reported the publication of Vol. V of the Transactions, that the state had furnished $90 for cuts, which sum was sufficient to pay the expenses of those in the volume.

The President and Secretary made brief verbal reports of matters in their respective offices.

The amendment to the constitution abolishing the Department of Arts was lost, (see p. 345).

The matter of publishing Vol. VI was referred to a special committee consisting of Profs. Irving, Wright, Allen and Dr. Hoy, and their report made the order of business for Thursday morning.

Dr. Hoy, Prof's. Allen and Peckham were appointed a committee on nominations.

Mr. S. W. Willard, of DePere, was elected as an annual member.

Capt. John Nader was unanimously elected Vice President for the Department of Arts.

Adjourned.

WEDNESDAY MORNING, 9:30.

President Irving called the Academy to order.

Messrs. C. R. Vanhise and Wm. Trelease, of Madison, were elected annual members.

Voted: that G. D. Swezey, of Doan College, Crete, Nebraska, have twelve copies of Vol. V., of the transactions.

Voted: that Dr. Hoy have six each of Vols. IV and V.

Voted: that parties applying for copies of the transactions be required to pay postage on the same.

Voted: that each contributor be entitled to eight copies of the volume wherein his paper appears.

Voted: that the Secretary prepare and send to each contributor with his proof sheets a blank to be filled out by him, indicating the number of extra copfes of the paper to be printed at the expense of the author.

Voted: that a committee of two be appointed to consider the formation of branch societies, to report Thursday evening.

Dr. Elmendorf and Prof. Emerson appointed as such committee.

The following papers were then read:

"Who Built the Mounds," and "Who made the Copper Tools," by Dr. P. R. Hoy, of Racine.

"The Mound Builders," by Dr. Day, of Wauwatosa. Discussed by Dr. Butler, Prof. Allen and others.

Mr. D. P. Blackstone, of Berlin, elected an annual member.

AFTERNOON SESSION.

2:30 P. M.

Vice President Sawyer in the chair.

Prof. Emerson's paper on Greek Religion was read and discussed.

Adjourned, 4:30.

EVENING SESSION.

Supreme Court Room, 7:30.

President Bascom in the chair.

Paper, "The Unity of Moral Ideas," by Rev. C. Caverno, Lombard, Ill. Discussed by President Bascom and Mr. Richards.

Adjourned.

THURSDAY MORNING.

9:30.

President Irving in the chair.

Messrs. G. E. Brown, Madison, Wis.; D. H. Morgan, Albany, Wis.; R. G. Norton and S. Mills, Madison, Wis., elected annual members.

The committee on publication of Vol. VI reported and their report was unanimously adopted by article as follows:

RESOLUTIONS.

1. The Standing Committee on Publication are authorized to proceed at once to the preparation of Vol. VI of the Transactions of the Academy. Said volume to have its contents arranged according to meetings and not according to departments.

2. The Secretary of the Academy shall be charged with the special duty of overseeing and editing the publication of future volumes of the Transactions.

3. The Transactions of the Academy hereafter published shall contain: (*a*) a list of officers and members of the Academy; (*b*) the charter, by-laws and constitution of the Academy as amended to date; (*c*) the proceedings of the meetings; and (*d*) such papers as are duly certified in writing to the Secretary as accepted for publication in accordance with the following regulations, and no other:

(4.) Hereafter every author of a paper, whether it is to be read by title only, or in full, shall submit, at the time of reading, a brief abstract in writing, of the contents of the paper (not to exceed one half printed page in extent), which abstract shall in all cases be printed in full in the proceedings of the meetings of the Academy; and no paper shall be received for reading that is not accompanied by such abstract. Provided that for Vol. VI. of the Transactions the Secretary shall procure such abstracts of papers hitherto read.

(5.) Papers to be printed in full or in part in the Transactions must be requested of their authors by a Sub-Committee of the Standing Committee on Publication, which Sub-Committee shall consist of the President and Secretary of the Academy and the Vice-President of the Department in which the paper falls; this Subcommittee to have the authority to request for publication portions only of papers, when it shall deem desirable to them to do so.

(6). In deciding as to the papers to be called for for publication, the committtee shall have spcial regard to its value as a genuine, original contribution to the knowledge of the subject discussed.

(7.) In case the committee shall not feel competent to decidc as to the value of a paper, on account of its special or technical character, it shall be their duty to call upon the author to agree with them upon some prominent specialist or specialists, whose opinion as to its value shall be asked, and shall decide the question of its publication.

(8.) These resolutions shall not be construed so as to restrict the present freedom of members in reading papers before the Academy.

(9.) The Sub-Committee on Publication shall be charged with insisting upon the correction of errors in grammar, phraseology, etc., on the part of authors, and shall call the attention of authors to any other points in their papers, which in their judgment appears to need revision.

(10.) The Publishing Committee are authorized to expend not to exceed one hundred dollars for illustrations to Vol. VI of the Transactions.

ROLAND D. IRVING,
W. F. ALLEN,
P. R. HAY,
A. O. WRIGHT,
Committee.

Papers read:

"The effect of local attractions on the Plumb line and Sea Level," Prof. J. E. Davies, Madison.

"Time and Tide," Capt. John Nader, Madison.

"Nature and Freedom," Prof. J. J. Elemendorf, Racine.

"Sorghum Sugar," M. S. Swenson, M. S., Madison.

Adjourned, 12:30.

AFTERNOON SESSION.

President Bascom in the chair.

Prof. Elmendorf read a paper entitled "The Ideal Man."

Prof. A. O. Wright read a paper on "Pauperism."

Prof. Allen read a paper on "The Sochemanni."

Read by title:

D. P. Blackstone, "The Variations in the attractions due to the figure of the attracting Bodies."

E. A. Birge, "Embryology of Panopaeus Sayi.'

THURSDAY EVENING.

7:30 P. M.

President Bascom's paper, "The Universality of Law," read and warmly discussed by many members.

Mr. Lamb was elected chairman of the meeting.

Report of the Committee on Branch Societies was accepted as follows:

Article one favoring the formation of such societies was adopted and the remainder was referred to a committee consisting of the council and Professors Elmendorf and Emerson to report at the next annual meeting.

Voted: that the Secretary of the Academy be and hereby is instructed to convey to the parties of the Supreme Court the thanks of the Academy for their kindness in opening the court room to its meetings.

Voted: that the Publishing committee be authorized to stitch and cover, at the expense of the Academy a sufficient number of the Transactions of each meeting when printed, to supply exchanging societies, if the same shall appear necesssary to said Committee.

Adjourned 9:30.

MEMBERS OF THE WISCONSIN ACADEMY OF SCIENCES ARTS AND LETTERS.

LIFE MEMBERS.

Dewey, Nelson, Cassville, Wis.
Davies, J. E., Madison, Wis.
Delaplaine, G. P., Madison, Wis.
Case, J. I., Racine, Wis.
Hoyt, John W., Wyoming.
Lawler, John, Prairie du Chien.
Mitchell, J. L., Milwaukee, Wis.
Paul, Geo. H., Milwaukee, Wis
Thorpe, J. G., Eau Claire, Wis.

ANNUAL MEMBERS.

Allen, Wm. F., Madison, Wis.
Allen, W. C., Racine, Wis.
Adsit, Mrs. C. D., Milwaukee, Wis.
Armsby, H. P., Madison, Wis.
Baetz, Henry, Milwaukee, Wis.
Bundy, W. F., Chicago, Ill.
Buck, J. S., Milwaukee, Wis.
Bate, Mrs. Amelia W., Milwaukee, Wis.
Buell, Ira M., Sun Prairie, Wis.
Birge, E. A., Madison, Wis.
Bartlett, E. W., Milwaukee, Wis.
Bascom, John, Madison, Wis.
Butler, J. D., Madison, Wis.
Bashford, R. M., Madison, Wis.
Beach, W. H., Madison, Wis.
Blackstone, D. P., Berlin, Wis.
Chamberlain, T. C., Beloit, Wis.
Chapin, A. L., Beloit, Wis.
Cass, J. E, Eau Claire, Wis.
Conover, Mrs. Sarah F., Madison, Wis.
Daniels, W. W., Madison, Wis.
Day, F. H., Wauwatosa, Wis.

Doyle, Peter, Prairie du Chien, Wis.
Draper, L. C., Madison, Wis.
Dudley, Mrs. Marian V., Milwaukee, Wis.
Elmendorff, Dr., Racine, Wis.
Emerson, Joseph, Beloit, Wis.
Fiske, E. O., Milwaukee, Wis.
Foye, J. C., Appleton, Wis.
Frankenburger, D. V., Madison, Wis.
Freeman, J. C., Madison, Wis.
Gapen, Clark, Madison, Wis.
Giles, Miss Ella A., Madison, Wis.
Gordon, Mrs. Geo., Milwaukee, Wis.
Greene, Thos. A., Milwaukee, Wis.
Holton, E. D., Milwaukee, Wis.
Hoy, P. R., Racine, Wis.
Hardy, Albert, La Crosse, Wis.
Heritage, Lucius, Madison, Wis.
Hastings, S. D., Madison, Wis.
Hutchinson, B. E., Madison, Wis.
Hindley, R. C., Racine, Wis,
Higley, W. K., Chicago, Ill.
Holden, E. S., Berkeley, Cal.
Irving, R. D., Madison, Wis.
Jones, Burr W., Madison, Wis.
Kerr, Alex., Madison, Wis.
King, F. H., River Falls, Wis.
Kumlin, Thure, Busseyville, Wis.
Lamb, F. J., Madison, Wis.
Lapham, Mary S., Oconomowoc, Wis.
Marks, Solon, Milwaukee, Wis.
McLaren, W. P., Milwaukee, Wis.
Meacham, J. G., Sr., Racine, Wis.
Meacham, J. G., Jr., Racine, Wis.
Morgan, D. H., Albany, Wis.
Morris, W. A. P., Madison, Wis.
Mills, Simeon, Madison, Wis.
Nader, John, Madison, Wis.
Norton, R. G., Madison, Wis.
Olin, Mrs. D. A., Racine, Wis.
Orton, H. S., Madison, Wis.
Peckham, G. W., Milwaukee, Wis
Peet, S. D., Clinton, Wis.
Perkins, H. B., Appleton, Wis.
Raymer, Geo., Madison, Wis.
Salisbury, R. D., Beloit, Wis
Sawyer, W. C., Oshkosh, Wis.

Smith, E. G., Beloit, Wis.
Sneiding, Henry, Racine, Wis.
Sprague, A. R., Racine, Wis.
Stair, W. P., Black Earth, Wis.
Swenson, Magnus, Hutchinson, Kan.
Tatlock ,John, Jr., New York, N. Y.
Trelease, Wm., Madison, Wis.
Van Hise, C. R., Madison, Wis.
Van Velzer, C. A., Madison, Wis.
Viebahn, C. Z., Watertown, Wis.
Westcott O. S., Racine, Wis.
Weyburn, L. A. Rockford, Ill.
Whitford, W. C., Milton, Wis.
Williams. S. W., West Depere. Wis.
Willis, Mrs. O. B., Racine, Wis.
Winship, E. B., Racine, Wis.
Wooster, L. C., Whitewater, Wis.
Wright, A. O., Madison, Wis.
Young, A. A., New Lisbon.

DECEASED MEMBERS.

Armitage, W. E., Right Rev. Bishop P. E. Church, Milwaukee, Wis.
Carpenter, S. H., LL.D., Prof. English Language, University of Wisconsin, Madison, Wis.
Conover, O. M., LL. D., Madison, Wis.
De Koven, J., S. T. D., Warden Racine College, Racine, Wis.
Dudley, Wm., Madison, Wis.
Eaton, J. H., Ph. D., Prof. Chemistry Beloit College, Beloit, Wis.
Engelman, Peter, Director German and English Academy, Milwaukee.
Feuling, J. B., Ph. D. Prof. Philology, University Wisconsin.
Hawley, C. T.. Milwaukee, Wis.
Lapham, I. A., LL. D., State Geologist, Milwaukee, Wis.
Little, Thos. H., Supt. Institution for the Blind, Janesville, Wis.
McDill, A. S., M. D., Supt. State Hospital for the Insane, Madison, Wis.
Nicodemus, W. J. L., A. M. C. E. Prof. Engineering, Univ. Wis.
White, S. A., Hon., Whitewater, Wis.
Wolcott, E. B., M. D., Surgeon General, Milwaukee, Wis.

CORRESPONDING MEMBERS,

Abbott, C, C., M. D., Trenton, New Jersey.
Andrews, Edmund, A. M. M. D., Prof. Chicago, Medical College Chicago, Ill.
Barrow, John W. 113 Fast Seventeenth St., New York City.
Bridge, Norman, M. D., Chicago, Ill.

Benton, J. G., M. D., Philadelphia, Penn.
Buchanan, Joseph, M. D., Louisville, Ky.
Burnham, S. W., F. R. A. S , Chicago, Ill.
Byrness, R. M., M. E., Cincinnati, Ohio.
Carr, E. S., M. D., Supt. Public Instruction, California.
Caverno, Rev. Chas., Lombard, Ill.
Ebener, F., Ph. D., Baltimore, Md.
Fallows, Right Rev. Sam'l, Chicago, Ill.
Gatchell, H. P., M. D., Kenosha, Wis.
Gill, Theo., M. D., Smithsonian Institute, Washington, D. C.
Gilman, D. C., Pres. Johns Hopkins University, Baltimore, Md.
Harris, W. T., LL. D., Concord, Mass.
Hopkins, F. N., M. D., Baton Rouge, La.
Holland, Rev. F. M., Concord, Mass.
Horr, M. D., Pres. Iowa Institute of Arts and Sciences, Dubuque, Iowa.
Hubbell, H. P., Winona, Minn.
Jewell, J. S., A. M., M. D., Prof. Chicago Medical College, Chicago, Illinois.
Le Barron, Wm., State Entomologist, Geneva, N. Y.
Marcy, Oliver, LL. D., Prof. Northwestern University, Evanston, Illinois.
Morgan, L. H., LL. D., Rochester, Illinois.
Newberry, J. S., LL. D., Prof. Columbia College, New York,
Orton, E. A. M., Pres Antioch College, Yellow Springs, Ohio.
Paine, Alford S. T. D., Hinsdale, Ill.
Swezey, G. D., Prof., Crete, Neb.
Porter, W. B., Prof., St. Louis, Mo.
Safford, T. H., Director Astron. Observatory Williams College, Williamstown, Mass.
De Vere, Schele M., LL. D., Prof. University of Virginia, Charlotteville, Va.
Shaler, N. S., A. M., Prof. Harvard University, Cambridge, Mass.
Shipman, Col. S. V., Chicago, Ill.
Steele, Rev. G. M., LL. D., Principal of Wilbraham Seminary, Wilbraham, Mass.
Trumbull, J. H., LL. D., Hartford, Conn.
Van de Warker, Eli, M. D., Syracuse, N. Y.
Verrill, A. E., A. M., Prof. Yale College, New Haven, Conn.
Whitney, W. D., Prof. Yale College, New Haven, Conn,
Winchell, Alex., LL. D., Ann Arbor, Mich.
Winchell, N. H., Prof., Minneapolis, Minn.

HONORARY MEMBERS.

Baird, Spencer F. M., M. D., LL. D., Washington, D. C.
Hamilton, Joseph, Hon., Milwaukee, Wis.

TABLE I.

ANALYSIS OF GENERA OF THE FAMILY ATTIDÆ.

	Heigth, Length, and Width of Cephalothorax.			Sides of Cephalothorax.					Posterior Part.	Dorsum.	Cephalic Part.	Thoracic Part.	Clypeus.
	Height.	Length.	As wide as or wider than 3d row of eyes.	Parallel or not.	Contracted in front or behind.	Dilated in front or behind.	Dilated in or behind the middle.	Vertical or rounded.	Slanting, rounded or truncated.	Plane or convex.	Inclined or level.	Length compared with cephalic part.	Height compared with middle anterior eyes.
Sandalodes	Moderately high.	$\frac{1}{5}$ longer than wide	Wider		Both		Middle	Rounded	Slanting		Inclined		$\frac{1}{4}$.
Icius	Not high	Rather long		Sometimes.		Sometimes behind.				Plane	Often inclined.	At least $\frac{1}{3}$ longer	Scarcely $\frac{1}{4}$.
Marptusa		Long					Behind			Plane		At least $\frac{1}{3}$ longer	About $\frac{1}{2}$.
Epiblemum													
Philaeus	Very high						Behind middle			Plane or convex	Inclined	At least $\frac{1}{5}$ longer	
Ballus									Truncated	Plane		Equal to cephalic	Less than $\frac{1}{2}$.
Simæthа	High	Short			Both		Middle			Convex longitudinally			Low.
Dendryphantes	Moderately high.										Level	At least $\frac{1}{4}$ longer	Less than $\frac{1}{2}$.
Attus	High					Behind				Plane or convex	Inclined	$\frac{1}{3}$ or $\frac{1}{4}$ longer	About $\frac{1}{2}$.
Pellenes	High	Rather long				Behind				Convex	Inclined	$\frac{1}{3}$ longer	At least $\frac{1}{2}$.
Menemerus		Long				Behind				Plane or convex		At least $\frac{1}{4}$ longer	Scarcely $\frac{1}{2}$.
Hasarius	High	Rather long					In and behind middle			Convex	Inclined	At least $\frac{1}{5}$ longer	Often more than $\frac{1}{2}$
Boethus	High	Short			Not in front						Inclined		About $\frac{1}{4}$.
Aelurillus	Very high		Little wider				Behind middle			Convex	Inclined	Twice as long	As wide or a'most.
Yllenus	Very high	Rather long					Behind middle			Convex	Inclined	Twice as long	Almost as wide.
Mævia	Very high	Long				Behind						At least $\frac{1}{4}$ longer	Rarely $\frac{1}{3}$.
Viciria	Moderately high.	$\frac{1}{3}$ longer than wide	Much wider									Little longer	At least $\frac{1}{2}$.
Bavia	Not high	Not very long						Rounded		Plane			Scarcely $\frac{1}{3}$.
Euophyrs	Moderately high.						Behind middle				Level or incli'd	$\frac{1}{3}$ or $\frac{1}{4}$ longer	At least $\frac{1}{2}$.
Eris	Moderately high.	Short			Behind				Slanting			Equal to cephalic	Moderately high.
Neon	Not high				Behind							Shorter than cephalic	Less than $\frac{1}{2}$.
Homalattus	Low									Plane	Level	Much shorter than cephalic	
Habrocestum	Very high	Rather short					Behind middle			Convex	Inclined	$\frac{1}{3}$ longer	About $\frac{1}{2}$.
Heliophanus	High						Middle			Convex	Inclined	At least $\frac{1}{4}$ longer	Scarcely $\frac{1}{4}$.
Hyctia		Long		Almost							Level	At least $\frac{1}{3}$ longer	Scarcely $\frac{1}{3}$.
Cyrba	Not high				Behind					Plane	Inclined	About $\frac{1}{3}$ longer	Very low.
Phlegra		Very long					Middle			Plane	Inclined	At least twice as long	More than $\frac{1}{2}$.
Saitis		Moderately long		Almost						Plane	Inclined	$\frac{1}{3}$ longer	Scarcely $\frac{1}{2}$.
Neetha	High				Behind				Truncated			As long as cephalic	Almost $\frac{1}{2}$.
Aegon	Not high						Middle	Rounded		Plane	Inclined	At least $\frac{1}{3}$ longer	About $\frac{1}{2}$.
Plexippus	Moderately high.	$\frac{1}{4}$ or $\frac{1}{5}$ longer than wide					Middle	Rounded	Slanting				
Zenodorus	High					In front							At least $\frac{1}{2}$.
Euryattus	Not high	Short	Wider			In front							Not $\frac{1}{4}$.
Phidippus	High	Short					Middle		Slanting				
Cocalus								Vertica	Slanting		Inclined		
Linus	Very high	Not much longer than wide	Little wider								Inclined		At least $\frac{1}{2}$.
Hyllus	Low	$\frac{1}{3}$ longer than wide	Much wider						Rounded	Convex	Level		$\frac{1}{4}$.
Ciris		Short											
Amycus	Very high								Slanting		Level		
Phyale		Nearly as long as wide						Rounded			Level		Very low.
Thiania													
Chirothecia	Low									Plane	Level	Shorter than cephalic	
Discocnemius	Moderately high.	Long											Very low.
Diolenius													
Ascyltus	Not high				Behind	In front					Level		
Mopsus	Moderately high.								Slanting				
Coccorchestes	High								Truncated		Inclined		High.
Omoedus	High behind								Truncated	Thoracic part convex	Inclined		Rather high.
Rhombonotus		Almost twice as long as wide			Both		Middle			Convex			About $\frac{1}{2}$
Damoetas		Almost twice as long as wide	As wide		Both		Middle	Rounded					Less than $\frac{1}{2}$.
Synemosyna													
Leptorchestes	Not high			Parallel					Rounded or truncated	Plane			Very low.
Synageles	Not high	Very long		Parallel					Truncated				Very low.
Agorius	Low	Twice as long as wide			Behind			Almost vertical					Less than $\frac{1}{4}$.
Salticus	Cephalic p't high	Long											Very low.
Selaophora	Not high	$\frac{1}{3}$ longer than wide	Little wider		In front	Behind				Convex			Scarcely $\frac{1}{2}$.
Hypoblemum	Not high	$\frac{1}{3}$ or $\frac{1}{4}$ longer than wide	Little wider		In front		Middle		Rounded	Convex			Low.
Iona		$\frac{1}{3}$ longer than wide	Not wider		In front				Rounded	Plane			$\frac{1}{2}$.
Therosa		$\frac{1}{4}$ longer than wide					Middle		Rounded	Convex			Very low.
Cytæa	Not high	$\frac{1}{3}$ or $\frac{1}{4}$ longer than wide			In front		Middle		Rounded	Convex			$\frac{1}{3}$.
Tara	Low	$\frac{1}{4}$ longer than wide			In front		Middle		Rounded	Plane			Very low.
Lauharulla	High	$\frac{1}{4}$ longer than wide		Almost						Convex			Very low.
Pirithous	Moderately high.	Little longer than wide			Behind		Middle	Rounded	Slanting	Plane			Low.
Sinnamora	High	$\frac{1}{5}$ l nger than wide			In front	Behind		Rounded	Slanting		Inclined		$\frac{1}{4}$.
Bianor	High	Little longer than wide	Not wider		Both			Rounded		Convex		Not longer	Low.
Astia		$\frac{1}{4}$ longer than wide			In front	Behind	Middle		Rounded				
Jotus	High	$\frac{1}{5}$ longer than wide			In front				Rounded	Convex			Less than $\frac{1}{2}$.
Margomma	High	$\frac{1}{5}$ longer than wide			In front	Behind	Middle		Rounded				$\frac{1}{2}$.
Prosthеclino		$\frac{1}{5}$ longer than wide			In front	Behind			Rounded				$\frac{1}{2}$.
Sobara	Moderately high.	Longer than wide			In front				Round d	Plane			As wide.
Ergane	High	Longer than wide			Both				Rounded	Convex	Inclined		Less than $\frac{1}{2}$.
Scæa	High	Longer than wide								Convex	Inclined		
Lagnus	High	Little longer than wide						Roun ed	Rounded	Convex			Low.
Opisthonocus	High	L nger than wide			In front								Very low.
Bootes		$\frac{1}{6}$ longer than wide	Little wider		Behind				Rounded	Convex			More than $\frac{1}{2}$.
Mago	High behind							Vertical	Truncated	Convex	Inclined		Less than middle eyes.
Oedipus									Slanting	Convex	Inclined		
Scartes									Slanting				
Janigena													
Mithion		Very long				Almost parallel				Cephalic part almost plane.	Not inclined	At least $\frac{1}{3}$ longer	Scarcely $\frac{1}{4}$.
Lystrocteisa													
Chalcolecta													
Lyssomanes													
Jelskia		Long											
Epeus		Moderately long					Behind middle			Cephalic part plane.	Inclined	Scarcely longer than cephalic	Almost $\frac{1}{2}$.
Athamas		Short quadrate						Almost vertical	Almost vertical	Very convex			

TABLE II.

ANALYSIS OF GENERA OF THE FAMILY ATTIDÆ—Continued.

	Eyes in 3 or in 4 rows.	Quadrangle of Eyes.					First Row of Eyes.			Second Row of Eyes.		Third Row of Eyes.		
		As long or longer than wide.	How much wider than long.	Wider in front, or behind.	Width equal in front and behind.	Occupying what proportion of Cephalot'rax.	In a curved or in a straight line.	Middle eyes touching or separated.	Lateral eyes touching or separated.	Nearer to anterior or posterior eyes.	Halfway between anterior and posterior eyes.	Size compared with lateral eyes.	Further from each other or from lateral borders.	Equally distant from each other and lateral borders.
Sandalodes	3		Wider		Equal	$\frac{1}{3}$	Curved	Separated	Separated		Halfway		Each other	
Icius	3		$\frac{1}{4}$ wider	Behind			Straight	Touching	Touching or separated			Smaller or equal.	Each other	
Marptusa	3		At least $\frac{1}{3}$	Behind			Straight or curved.	Separated	Separated			Smaller or equal.	Each other	
Epiblemum	3									Posterior				
Philaeus	3		At least $\frac{1}{3}$	Behind			Curved	Separated	Separated			Smaller		Usually.
Ballus	3			Behind			Straight or curved.	Sub-touching	Sub-touching			Equal		
Simætha	3		Much	Behind		$\frac{2}{5}$	Curved	Separated	Widely separated	Anterior			Each other sometimes.	Sometimes.
Dendryphantes	3		$\frac{1}{3}$	Little behind			Curved	Separated	Separated			Smaller	Each other	
Attus	3		Scarcely $\frac{1}{3}$	Sometimes behind	Sometimes		Straight or curved.	Near together.	Separated			Usually smaller.	Each other sometimes.	Sometimes.
Pellenes	3		$\frac{1}{3}$	Behind			Straight or curved.	Little separated	Separated			Smaller	Each other	
Menemerus	3		$\frac{1}{4}$ or $\frac{1}{5}$		Equal		Straight or curved.	Little separated	Separated			Smaller or equal.	Each other sometimes.	Sometimes.
Hasarius	3		At least $\frac{1}{3}$	Little behind			Little curved	Little separated	Separated			Smaller or equal.	Each other	
Boethus	3		A little	In front		Between $\frac{2}{5}$ and $\frac{1}{2}$	Little curved	Sub-touching			Almost	Smaller	Lateral borders	
Ælurillus	3		At least $\frac{1}{3}$	Behind			Much curved	Separated	Separated			Smaller	Sometimes lat'l borders	Sometimes.
Yllenus	3		At least $\frac{1}{3}$	Behind			Much curved	Separated	Separated			Smaller	Each other	
Mævia	3		Scarcely $\frac{1}{4}$		Equal.		Straight or curved.	Touching	Separated			Equal	Lateral borders	
Viciria	3			Little in front		Not $\frac{1}{2}$	Little curved		Widely separated		Sometimes		Lateral borders	
Bavia	3	As long as wide			Equal		Straight	Separated	Separated			Equal		
Euophyrs	3		$\frac{1}{4}$		Equal		Straight or curved.					Smaller or equal.	Each other	
Eris	3			Much behind			Curved		Widely separated			Scarcely smaller.		
Neon	3				Equal		Straight	Touching	Touching			At least as large.		
Homalattus	3	As long as wide					Curved	Separated	Separated	Anterior				
Habrocestum	3		Scarcely $\frac{1}{3}$		Equal.		Straight or curved.	Separated	Separated			Smaller		Equally.
Heliophanus	3		$\frac{1}{3}$ or $\frac{1}{4}$		Equal.		Straight or curved.					Smaller		
Hyctia	3	As long as wide			Equal.		Straight	Touching				Smaller	Each other	
Cyrba	3		Almost $\frac{1}{3}$		Equal.		Straight	Separated	Separated			Scarcely smaller.	Each other	
Phlegra	3		$\frac{1}{4}$	Sometimes behind.	Sometimes		Curved	Near together.	Separated			Smaller	Each other	
Saitis	3		$\frac{1}{3}$	Little in front			Straight	Separated	Separated			Smaller	Each other	
Neætha	3			Behind			Straight	Separated	Separated			Smaller		
Thyene	3		At least $\frac{1}{3}$	Much behind			Curved	Separated	Widely separated			Smaller	Each other	
Plexippus	3	Longer than wide		Little behind		Not $\frac{1}{2}$	Curved		Separated	Anterior		Smaller	Each other	
Zenodorus	3		About $\frac{1}{4}$		Nearly	Usually $\frac{1}{3}$	Curved		Separated		Almost		Lateral borders	
Euryattus	3		About twice as wide	Little behind.			Usually curved	Much separated	Much separated	Anterior			Sometimes each other.	Sometimes.
Phidippus	3						Curved	Near together.	Separated	Anterior		Smaller		
Cocalus	3						Straight	Near together.	Near together			Equal		Equally.
Linus	3		A little	Little in front		About $\frac{2}{3}$	Curved		Separated		Halfway		Lateral borders	
Hyllus	3		Wider		Equal	Not $\frac{1}{2}$	Curved		Separated	Anterior			Each other	
Ciris	3						Straight							
Amycus	3						Curved			Sometimes anterior	Sometimes halfway	Equal		
Phyale	3		But little		Equal		Curved	Separated			Halfway	Smaller		
Thiania	3									Posterior		Smaller		
Chirothecia	3						Straight			Anterior		Smaller		
Discocnemius	3	As wide behind as long				About $\frac{1}{2}$					Halfway			
Diolenius	3													
Ascyltus	3		Wider											
Mopsus	3						Curved	Touching	Touching	Posterior				
Coccorchestes	3		Wider			$\frac{1}{2}$	Curved	Sub-touching	Sub-touching					
Omoedus	3		Much		Almost	Not $\frac{1}{2}$	Usually curved				Halfway		Each other	
Rhombonotus	3	Longer than wide		Behind		More than $\frac{1}{2}$	Curved	Close together.	Close together	Anterior			Each other	
Damoetas	3	Longer than wide		Behind			Curved	Close together.	Close together	Anterior			Each other	
Synemosyna	3									Anterior				
Leptorchestes	3	Longer than wide					Straight	Touching	Touching			Smaller or equal.		
Synageles	3	Longer than wide				More than $\frac{1}{2}$	Straight	Touching	Touching			Equal		
Agorius	3		A little	Sometimes in front	Sometimes	Almost $\frac{1}{2}$	Curved	Touching	Separated	Anterior			Each other	
Salticus	3	About as long as wide.		Behind			Straight	Sub-touching	Sub-touching			Equal		
Selaophora	3		Wider		Equal	Not $\frac{1}{2}$	Nearly straight	Separated	Separated	Posterior			Each other	
Hypoblemum	3		Wider	Behind		Not $\frac{1}{2}$	Curved		Separated		Halfway		Each other	
Iona	3		Wider	In front		More than $\frac{1}{2}$	Curved	Close together.	Close together		Halfway			Equally.
Therosa	3		Wider	In front		Not $\frac{1}{2}$	Curved	Close together.	Close together		Halfway		Each other	
Cytæa	3		Wider	Sometimes in front	Sometimes	Not $\frac{1}{2}$	Curved				Halfway		Each other	
Tara	3		Wider		Equal	Not $\frac{1}{2}$	Curved	Close together.	Close together	Anterior			Each other	
Lauharulla	3		Wider	In front		Not $\frac{1}{2}$	Curved			Anterior		Smaller	Each other	
Pirithous	3		Wider	Behind		Not $\frac{1}{2}$	Curved		Widely separated	Anterior			Each other	
Sinnamora	3		Wider	In front		Not $\frac{1}{2}$	Curved	Close together.	Close together		Halfway		Lateral borders	
Bianor	3		Wider behind	Behind		Not $\frac{1}{2}$	Curved		Separated	Anterior			Each other	
Astia	3		Wider	In front						Anterior			Sometimes each other.	Sometimes.
Jotus	3		Wider		Equal	Not $\frac{1}{2}$	Curved	Close together.	Close together		Halfway		Lateral borders	
Margaromma	3		Wider	In front			Curved	Close together.	Close together	Posterior			Lateral borders	
Prostheclina	3		Scarcely	In front		Not $\frac{1}{2}$	Little curved	Close together.	Close together		Halfway		Each other	
Sobara	3		Wider	Behind.		Not $\frac{1}{2}$	Curved	Separated	Separated		Halfway		Each other	
Ergane	3		Wider		Equal	Not $\frac{1}{2}$	Curved				Halfway			Almost.
Scæa	3		Wider		Equal	Not $\frac{1}{2}$					Halfway		Lateral borders	
Lagnus	3		Wider in front	In front		Not $\frac{1}{2}$	Curved	Close together.	Close together		Halfway		Lateral borders	
Opisthoncus	3		Wider	Sometimes behind.	Sometimes		Curved	Close together.	Separated	Anterior			Each other	
Bootes	3		Wider		Equal	Almost $\frac{1}{2}$	Curved		Separated		Halfway		Each other	
Mago	3		Little wider		Equal		Straight				Halfway	Smaller		
Oedipus	3			Behind			Curved			Anterior				
Scartes	3						Curved		Separated					
Janigena	3			Behind										
Mithion	3	As long as wide		Sometimes behind.	Sometimes		Straight	Touching				Equal	Each other	
Lystrocteisa	3	Much longer than wide		Behind		More than $\frac{1}{2}$				Anterior		Larger		
Chalcolecta	3					At least $\frac{1}{2}$	Little curved							
Lyssomanes	4				About equal				Separated					
Jelskia	4			In front				Separated	Separated					
Epeus	4			In front				Little separated	Separated			Equal		
Athamas	4													

TABLE IV.

ANALYSIS OF GENERA OF THE FAMILY ATTIDÆ—Concluded.

	Falces.					Legs.								
	Vertical, inclined or horizontal. ♂	Vertical, inclined or horizontal. ♀	Diverging or not diverging.	Robust or weak.	Length.	Relative length of legs, ♂.	Relative length of legs, ♀.	Which leg or legs most robust.	Length of tibia and patella of 1st compared with cep. th.	Length of tibia of 1st compared with patella of 1st.	Length of metatarsus + tarsus of 1st compared with tib. + pat. of 1st.	Length of tib. + pat. of 3d compared with tib. + pat. of 4th.	Length of metatarsus + tarsus of 4th compared with tib. + pat. of 4th	Spines on metatarsus of 4th to base, or only at apex.
Sandalodes	Vertical	Vertical	Not diverging		Short	1423	1423	I				Shorter	Shorter	To base.
Icius	Inclined forward	Vertical		Rather robust	♀ short ♂ longer	1432	4132	I	¼ shorter	Longer		Much shorter	♂ a little, ♀ much sh't'r	Only at apex.
Marptusa						1234	1234	I	Shorter	Longer or equal			Shorter	
Epiblemum	Horizontal	Vertical		Slender	Long	4123	4123							
Philaeus	Often inclined			Robust	♂ longer than ♀	1243	4132	I and II	Shorter	♂ longer ♀ equal		Much shorter	Shorter or equal	To base.
Ballus					Short	4132	4132	I				Much shorter	Often shorter	No spines.
Simætha							1423	I				Shorter		
Dendryphantes	Vertical	Vertical		Robust		1243 or 4123	4123 or 4132	I or I and II	Shorter	♂ longer ♀ equal		Much shorter	Shorter	Only at apex.
Attus	Vertical	Vertical		Weak	Not longer than face	4123 or 1423	4123 or 1423		At least as short	♂ longer ♀ equal		Much shorter	Often shorter	To base.
Pellenes	Vertical or inclined	Vertical or inclined			Not longer than face	1342	3142	I	Shorter	♂ longer ♀ equal	Shorter	Longer	Often shorter	To base.
Menemerus						1423 or 4123	4123	I		Usually longer		Much shorter	Shorter	To base.
Hasarius					At least as long as face	1342	3412	I and II	Shorter	Longer or equal		Longer or equal	Equal	To base.
Boethus	Sub-vertical	Sub-vertical				4123	4123	I				Shorter	Equal	To base.
Ælurillus	Inclined backward	Inclined backward		Not very robust	Shorter than face	3412 3412 or 4312	3412 3412 or 4312	I and II	Much shorter	Equal	Shorter	Longer or equal		To base.
Yllenus	Vertical	Vertical		Weak	Shorter than face	4312	4312	I and II	Much shorter	Equal	Shorter	Much shorter	Much shorter	To base.
Mævia	Vertical		Diverging a little		♂ much l'ng'r than face	1432	1432	I and II	At least as long	Longer		Much shorter	Equal in ♂	
Viciria	Inclined forward	Inclined forward				3rd or 1st longest	3rd or 1st longest	Sometimes I				Longer or equal		To base.
Bavia	Inclined forward	Inclined forward			Rather short	4123		I	As long	Much longer		Much shorter	Shorter	No spines.
Euophyrs	Vertical	Vertical			Shorter than face	4312 4132 or 1432	4312 4132 or 1432	I or I and II	Often shorter		Shorter	Shorter	Shorter or equal	
Eris	Vertical	Vertical		Robust	Short	1432 or 4132	1432 or 4132	I				Shorter	Shorter or equal	Only at apex.
Neon	Inclined	Inclined		Slender	Short	4132	4132	I				Shorter	Shorter	No spines.
Homalattus														
Habrocestum	Vertical or oblique.	Vertical or oblique		Weak	About as long as face	3412	3412					Much longer	Shorter or equal	
Heliophanus	Vertical	Vertical		Rather robust		4123 or 4132	4123 or 4132		Shorter					
Hyctia	Inclined	Vertical		Robust	Longer than face.	1423	1423	I	At least as long	⅛ longer	Shorter		Shorter	
Cyrba	Vertical	Vertical		Not robust	As long as face	4132	4132	I	Shorter	Longer	Shorter	Much shorter	Shorter or equal	
Phlegra	Vertical or inclined	Vertical or inclined			Shorter than face	4132 or 4312	4132 or 4312		¼ shorter	Equal	Shorter	Much shorter	Longer	To base.
Saitis	Inclined	Inclined		Slender	Shorter than face	3412	4312		⅛ shorter	Almost equal	Equal	♂ longer		To base.
Neætha	Vertical	Vertical			Not long	3142 or 1342	3142 or 1342	I				Longer	Shorter or equal	Only at apex.
Thyene	Vertical	Vertical		Robust	Short	1342	4312	I	♂ as long ♀ shorter	♂ longer ♀ equal		Longer or equal	Shorter	To base.
Plexippus	Vertical	Vertical	Not diverging	Robust	Rather long							Shorter	Shorter or equal	To base.
Zenodorus	Vertical	Vertical				1st or 3d longest	1st or 3d longest					Longer		
Euryattus	Nearly vertical	Nearly vertical				1342	1342					Longer		To base.
Phidippus			Diverging	Robust		1423	1423							
Cocalus	Vertical	Vertical		Slender	Long	1423	1423							
Linus	Not extended	Not extended			Short	1423	4123							To base.
Hyllus			Diverging	Robust	Long	1243	1423					Shorter or equal	Shorter	To base.
Ciris	Vertical	Vertical		Robust	Not long	Short, nearly equal	Short nearly equal							
Amycus					Very long	1324 or 3124	1324 or 3124							
Phyale						4312 or 3412	4312 or 3412	I and II						
Thiania					♂ rather short									
Chirothecia	Horizontal	Almost vertical			♀ short ♂ long			I						
Discocnemius						4123	4123	I						
Diolenius														
Ascyltus	Almost vertical	Almost vertical	Diverging		♂ longer than ♀	1st and second longest.	1st and second longest.	I and II						
Mopsus	Almost vertical	Almost vertical												
Coccorchestes	Sub-vertical	Sub-vertical			Short	4123 or 4132	4123 or 4132							
Omoedus	Sub-vertical	Sub-vertical			Short		4312 or 4321					Shorter		
Rhombonotus						4123	1423	I				Shorter	Longer	
Damoetas						1423	1423	I				Shorter	Shorter	
Synemosyna					Short	4th longest	4th longest							
Leptorchestes	Vertical	Vertical		Robust	Short	1432	1432					Much shorter	Shorter	No spines.
Synageles	Vertical	Vertical		Robust	Short	4123	4123			Shorter or equal		Much shorter	Shorter	No spines.
Agorius		Vertical		Weak		4132	4132			Shorter				
Salticus	Horizontal	Vertical		♀ robust	♀ short ♂ long	4132	4132			Much longer		Much shorter	Shorter	No spines.
Selaophora			Not diverging		Short	4312	4312					Shorter	Shorter or equal	
Hypoblemum					Short	3421	3421					Longer	Shorter or equal	To base.
Iona			Not diverging		Short	1432	1432					Longer	Longer	No spines.
Therosa			Not diverging		Short	4312	4312	I not more robust				Equal	Longer or equal	
Cytæa			Not diverging		Short	4312 or 1342	4312 or 1342.	I				Longer	Longer or equal	To base.
Tara			Not diverging		Short	1423	1423					Shorter	Shorter	
Lauharulla	Vertical	Vertical	Not diverging		Short	4132	4132	I not more robust				Shorter	Shorter or equal	Only at apex.
Pirithous			Diverging			1423 or 1243	1423 or 1243	I				Shorter	Shorter	
Sinnamora			Not diverging		Short	4132	4132					Shorter	Longer	
Bianor	Vertical	Vertical	Not diverging			1432	1432	I				Shorter	Shorter	Only at apex.
Astia												Shorter	Shorter	
Jotus			Not diverging		Short	4312 4132 or 1432	4312 4132, or 1432	I				Shorter	Shorter or equal	
Margaromma			Not diverging		Short			I not more robust				Longer	Shorter or equal	
Prostheclina			Not diverging		Short	4312 or 1432	4312 or 1432					Longer or equal	Longer	
Sobara			Not diverging	Slender	Rather long	1423 or 4312	1423 or 4312					Shorter	Shorter or equal	
Ergane			Not diverging		Short	1342, 1432, 3124 or 4312.	1342, 1432, 3124 or 4312.	I				Longer	Longer	
Scæa												Shorter	Shorter	
Lagnus						1432	1432	I				Shorter	Longer	
Opisthoncus						1243 or 1323		I				Shorter	Shorter	
Bootes			Not diverging		Short	4132	4132	I not more robust				Shorter	Shorter or equal	
Mago	Inclined forward	inclined forward	Diverging	Moderately robust.		1324	1324	I						
Oedipus						4123	4123							
Scartes						4312	4312							
Janigena					Short									
Mithion		Vertical			Very short				Shorter	Scarcely longer		Shorter	Almost as long	To base.
Lystrocteisa														
Chalcolecta						1432	1432							
Lyssomanes				Moderately robust.		1234	1234							
Jelskia	Vertical	Vertical		Slender		1423	1423							
Epeus	Vertical	Vertical				3124	3124		Longer	Much longer		Longer	Longer or equal	To base.
Athamas						1st longest 2nd shortest	1st longest 2nd shortest							