PROCEEDINGS

OF THE

Academy of Natural Sciences

OF

PHILADELPHIA

VOLUME LIV

1902

PHILADELPHIA:
THE ACADEMY OF NATURAL SCIENCES
LOGAN SQUARE
1902–1903

The Academy of Natural Sciences of Philadelphia.
March 13, 1903.

I hereby certify that printed copies of the Proceedings for 1902 have been presented to the meetings of the Academy and mailed as follows :—

Pages	1 to 16	mailed	April	22, 1902 ;	presented	April	22, 1902.
“	17 to 48	“	April	23, 1902 ;	“	April	29, 1902.
“	49 to 64	“	May	9, 1902 ;	“	May	13, 1902.
“	65 to 112	“	May	16, 1902 ;	“	May	20. 1902.
“	113 to 144	“	June	3, 1902 ;	“	June	3, 1902.
“	145 to 192	“	June	11, 1902 ;	“	June	17, 1902.
“	193 to 208	“	June	20, 1902 ;	“	June	24, 1902.
“	209 to 240	“	July	11, 1902 ;	“	July	1, 1902.
“	241 to 256	“	July	15, 1902 ;	“	July	11, 1902.
“	257 to 320	“	August	8, 1902 ;	“	August	19, 1902.
“	321 to 384	“	August	23, 1902 ;	“	September	16, 1902.
“	385 to 400	“	September	3, 1902 ;	“	September	16, 1902.
“	401 to 416	“	September	11, 1902 ;	“	September	16, 1902.
“	417 to 496	“	September	30, 1902 ;	“	September	30, 1902.
“	497 to 544	“	October	20, 1902 ;	“	October	21, 1902.
“	545 to 592	“	November	6, 1902 ;	“	November	11, 1902.
“	593 to 624	“	November	21, 1902 ;	“	November	25, 1902.
“	625 to 640	“	December	8, 1902 ;	“	December	16, 1902.
“	641 to 672	“	December	12, 1902 ;	“	December	16, 1902.
“	673 to 736	“	January	20, 1903 ;	“	January	20, 1903.
“	737 to 768	“	February	14, 1903 ;	“	February	17, 1903.
“	769 to 800	“	March	6, 1903 ;	“	March	10, 1903.

EDWARD J. NOLAN,
Recording Secretary.

7174

CONTENTS.

For Announcements, Reports, etc., see General Index.

PROCEEDINGS

OF THE

ACADEMY OF NATURAL SCIENCES

OF

PHILADELPHIA.

1902.

JANUARY 7.

The President, SAMUEL G. DIXON, M.D., in the Chair.

Thirty-two persons present.

Papers under the following titles were presented for publication:

"The Progressive Movement of Gregarines," by Howard Crawley.

"A Collection of Reptiles and Batrachians from Borneo and the Loo Choo Islands," by Arthur Erwin Brown.

The Council reported that the following Standing Committees had been appointed to serve during the ensuing year:

ON LIBRARY.—Dr. C. N. Pierce, Thomas A. Robinson, Henry C. Chapman, M.D., Charles Schaeffer, M.D., and George Vaux, Jr.

ON PUBLICATIONS.—Henry Skinner, M.D., H. A. Pilsbry, Sc.D., Philip P. Calvert, Ph.D., Edward J. Nolan, M.D., and Witmer Stone.

ON INSTRUCTION AND LECTURES.—Benjamin Smith Lyman, Uselma C. Smith, Henry A. Pilsbry, Sc.D., Charles Morris and Philip P. Calvert, Ph.D.

COMMITTEE OF COUNCIL ON BY-LAWS.—Charles Roberts, Isaac J. Wistar, Theodore D. Rand and Arthur Erwin Brown.

JANUARY 14.

The President, SAMUEL G. DIXON, M.D., in the Chair.

Sixteen persons present.

A paper entitled "A New Genus and Three New Species of Chilopods," by Ralph V. Chamberlin, was presented for publication.

JANUARY 21.

The President, SAMUEL G. DIXON, M.D., in the Chair.

Nine persons present.

A paper entitled "A New Pseudophyllus from Sumatra," by James A. G. Rehn, was presented for publication.

The deaths of Caleb C. Cresson, a member, and of Alpheus C. Hyatt, a correspondent, were announced.

JANUARY 28.

The President, SAMUEL G. DIXON, M.D., in the Chair.

Thirty persons present.

Papers under the following titles were presented for publication:

"Contributions to the Life-Histories of Plants, No. XVI," by Thomas Meehan.

"New Land Mollusca from Japan and the Bonin Islands," by Henry A. Pilsbry.

The death of Charles Roberts, on the 22d inst., having been announced, the following minute was adopted:

The Academy deeply regrets the death of its member, Charles Roberts, who, since his first association with the society manifested his interest in its welfare so constantly and practically. The qualities which characterized him as a model citizen in his connection with public interests, his strict integrity, clearness of judgment and self-sacrificing devotion to duty were of the highest value in one concerned with the administration of the affairs of the Academy; as a member of the Council, he has been judicious as an adviser and helpful in all that made for the advancement of science. The Academy tenders its sincere condolence to his widow.

The following were elected members: J. Chester Bradley, Marian G. Nimlet, Alfred C. Harrison, Jr., H. N. Hiller, M.D., Judson Daland, M.D., Owen S. Paxson, F. Ehrenfeld, and Burnett Smith.

The following were ordered to be printed:

THE PROGRESSIVE MOVEMENT OF GREGARINES.

BY HOWARD CRAWLEY.

I. Introduction.

While making observations on living specimens of *Stenophora juli*,[1] incident to a study of the life-history of this gregarine, I became impressed by the fact that Schewiakoff's currently accepted explanation for the progressive movement of gregarines does not satisfactorily account for all of the phenomena which the animals display. I was working at the time in the Zoological Laboratory of Harvard University, and at the suggestion of the Director, Prof. E. L. Mark, an investigation of gregarine movements of all sorts was undertaken. I desire to take this opportunity to express my sincere gratitude to Prof. Mark for the valuable aid which he rendered me.

The work was done almost exclusively on living animals, after the method used by Schewiakoff, which will be described below. *Stenophora juli*, from the intestine of *Julus*, and *Echinomera hispida*, from the intestine of *Lithobius*, were the species studied.

II. Historical and Critical.

The movements displayed by gregarines are of two kinds. The one, which consists of contractions of the body, is readily explainable by the existence of the muscular layer. The other, for which I shall use the term progression, is a movement of translation, during which the animal glides from place to place. It is usually described as taking place without the slightest bodily movement. This supposition, combined with the fact that gregarines possess no motor organs, rendered their progression apparently causeless, and until 1894, when Schewiakoff published his paper, it was regarded as one of the unsolved problems of biology. Prior to this date, biological literature contains but two suggested solutions of the problem. Lankester (1872, p. 347) says: "On slitting up a large

---

[1] The nomenclature used in this paper is that given by Labbé (1899).

Sipunculus, and allowing its abundant pink perivisceral fluid to run into a glass dish, my attention was attracted by two white flakes, of about an eighth of an inch in length, which were swimming actively in the liquid. Their movement was like that of some planarians, and seemed to depend on the undulation of their lateral margins, which were plainly to be seen in a state of vibration. These white flakes turned out to be specimens of *Monocystis sipunculi.*"

It is probable, however, that the movements here seen were nothing but the violent contortions which gregarines frequently show when first removed from their native environment. Such contortions might readily cause progression were the animals floating freely in a fluid. Moreover, Lankester himself appears never to have laid much stress on this single observation, for to my knowledge it is not referred to again in any of his later contributions on the Gregarinida.

Frenzel (1891 p. 287 *et seq.*) suggested that the progression of gregarines is due to a chemotactic affinity between them and their food. Such an explanation, however, is manifestly inadequate.

Schewiakoff (1894), as the result of a painstaking study, came to the conclusion that gregarines progress by means of the extrusion of gelatinous fibres. These fibres are derived from a layer of substance which is deposited between the cuticle and the ectoplasm. They pass out to the exterior through slit-like openings through the cuticle which occur in the grooves between the longitudinal thickenings. Upon their emergence, they do not project radially from the surface of the gregarine, but run backward until the posterior end of the animal is reached. Somewhat hardened by the action of the surrounding watery media, they then project backward and free of the animal. This extrusion, which takes place over the entire surface of the gregarine, results in the formation behind it of a hollow cylinder, the walls of which have by now acquired a certain amount of rigidity. The posterior end of this cylinder, impinging upon some resistant body, becomes fixed. The extrusion continuing, the cylinder lengthens, and the gregarine is pushed passively forward.

Schewiakoff undertook his studies in the light of Lauterborn's discovery that diatoms progress by means of the extrusion of gelatinous threads. There is a difference in the progressive movements of these two groups of organisms in that diatoms move indifferently in two directions, whereas gregarines always move forward. But in both cases the movement takes place without visible cause, and when Lauterborn showed that diatoms progress by means of the extrusion of threads of an invisible substance, a presumption was established that the cause for gregarine progression was to be sought for along similar lines.

Accordingly, Schewiakoff undertook a study of living gregarines. As mounting media, he employed either normal salt solution or an albumin solution of the following formula:

Egg-albumin, ...	20 cc.
Distilled water, ...	200 cc.
Sodium chloride, ...	1 gr.

Powdered carmine, Chinese black and, in some cases, native sepia were added to the fluid, so that invisible extrusions from the gregarines could be detected.

The results were to show that gregarines usually caught up and pulled after them a number of particles of carmine, etc., thus demonstrating the presence of a sticky substance. Further, as a gregarine progressed through a medium thickly filled with carmine particles, there was always left behind it a clear trail. Schewiakoff says that this does not happen with other Protozoa, and so furnishes proof that gregarines leave something behind them. This substance was wholly invisible under ordinary circumstances, but very delicate manipulation enabled him to stain it and to demonstrate that gregarines actually are followed by long fibres of extreme tenuity. Stress was laid upon the fact that carmine particles in the neighborhood of a motionless gregarine could be seen to show molecular movements; next to slip backward along the surface of the animal and to collect in a lump at the posterior end, and that only after this had taken place would the animal progress.

In the course of what follows, there will be frequent occasion to refer to Schewiakoff's statements, and the conclusions that he draws from them, in much greater detail. I have given above only his results, and a few of the more important observations upon which these results were based. His explanation of the cause of gregarine progression has been accepted by most authors, yet in some cases with a considerable amount of reserve. Lang (1901, p. 127) and Doflein (1901, p. 161) accept it without comment. Calkins

(1901, p. 149) says: "although very improbable at first sight, it is the only one thus far that fits the case." Wasielewski (1896, p. 22) rejects it, while Delage et Hérouard (1896, footnote on p. 261) say: "Pour bizarre qu'elle paraisse, il faut bien l'accepter jusqu'à nouvel ordre, car elle repose sur des faits observés et on n'en connait aucun autre à lui substituer."

Schaudinn (1900) and Siedlecki (1899) are credited with having confirmed Schewiakoff, the former by Lang (1901, p. 128) and the latter by Calkins (1901, p. 149).[2] Schaudinn (pp. 222–224) gives data which show that the sporozoïtes and merozoïtes of *Coccidium schubergii* extrude fibres of a gelatinous substance. These fibres carry backward such small particles as may be in the immediate vicinity of the coccidians, and form a trail behind them. In so far as the extrusion of a gelatinous substance is concerned, Schaudinn's observations unquestionably confirm those of Schewiakoff, but, as will be seen later, they do not necessarily show that this gelatinous substance is the cause of progression.

Siedlecki (1899, p. 521) says: "Es lässt sich aber bei *Monocystis ascidiæ* leicht noch ein anderer Bewegungsmodus beobachten: ohne irgendwie ihre Gestallt zu wechseln gleitet sie nämlich plötzlich vorwärts. Die Ursache der Bewegung liegt, wie es Schewiakoff für andere Gregarinen beschrieben hat, in einer plötzlichen Ausscheidung von Schleim aus dem Hinterende des Körpers, und es ist leicht festzustellen, wie das Thier durch einen aus ihm plötzlich herauswachsenden Schleimfaden vorwärts geschoben wird." This can scarcely be regarded as a confirmation of Schewiakoff.

III. Observations.

1. As a necessary preliminary, attention is here called to two points of considerable importance. The first of these concerns the shape of gregarines. The statement that gregarines are flat, like trematodes, is made in some text-books, but this is an error when applied to the Polycystidea. The gregarines of this group are monaxial animals, with a circular cross-section, and any plane passing through the axis divides them into morphologically identical halves. This is shown by sectioned gregarines, and it may readily be seen by watching the living animals.

---

[2] The date, 1900, given by Calkins to Siedlecki's paper is incorrect.

The second point concerns progression. Gregarines are stated to show a "gliding" movement, and this, as we have seen, has been carefully studied. But I have been unable to find in the published literature on these animals any conclusive statement bearing upon the question as to whether gregarines creep or swim. Gliding could readily be effected in either of these two ways. When consideration is taken of their native environment, a very strong presumption is established that gregarines creep, yet certainly the matter is one which necessitates a demonstration.

This demonstration is not at all difficult. In all microscopic mounts, gregarines either lie against the under surface of the cover-glass or upon the slide, which can be shown by raising or lowering the tube of the microscope. Either the upper or under surface of the animals remains in focus until everything else has disappeared from view. This shows that all studies on progression have been made on animals which are in contact with a surface.

Gregarines possess and at times exert the power to progress continuously in straight lines. But more usually the progression is neither straight nor continuous. The animal advances by fits and starts, and the path pursued may be a zigzag or a series of curves. Plate I, fig. 1 shows the positions occupied by a progressing gregarine, *a* being the earliest and *f* the latest. To the right is sketched the line generated by any given point of the animal's body. Under such circumstances the advance is not continuous, but slow and hesitating, and accompanied by frequent stops. There may be an advance of perhaps the body length, followed by a short pause. Upon progression being resumed, it may be in the same or in a slightly different direction. The proper idea will be obtained by supposing the stops to take place anywhere along the broken line shown in the figure.

This mode of progression is very common, and at least in *Stenopohora juli* is much more frequently seen than continuous progression in a straight line. The alterations in the direction of the path are not, however, always so frequent as those shown in fig. 1, and the animal may advance along a series of curves. On the other hand, very short turns are often seen (Plate I, figs. 2, 3 and 4).

While progressing in any of these ways, gregarines may or may not display evident muscular movements. In all published accounts of gregarine progression, the statement is made that the animals glide forward without any alteration in the body form, and this is frequently the appearance. The converse statement, that gliding takes place while the animals are displaying evident muscular contractions, has never, to my knowledge, been made, although the fact itself can scarcely have escaped frequent observation. Yet progression without alteration in the outline of the body is no more frequently seen than progression accompanied by obvious muscular contractions. Gregarines may also progress, in either a straight line or in zigzags, with the body held rigidly in a contorted form. My observations here differ from those of Schewiakoff. On p. 348 he says that progressing gregarines may alter the direction of their progression, and continues: "In solchen Fällen bemerkt man jedes Mal, wenn die Bewegungsrichtung verändert wird, dass an der einen Seite der Gregarine eine Querfalte auftritt. . . . . Die Gregarine wird aus der früheren Bewegungsrichtung nach der Seite hin abgelenkt, auf welcher die Einschnürung am Gregarinenkörper erfolgte. Bleibt die Einschnürung längere Zeit hindurch bestehen, so wird die Bewegung bogenförmig, ja sie kann sogar zu einer spiraligen oder schleifenförmigen werden. Wird die Einschnürung aufgehoben, d. h., die Gregarine wieder gerade gestreckt, so wird die Bewegung von Neuem geradlinig." He believes that the bending of the body is the cause of the turning. For when the body is bent, the extrusion of the gelatinous fibres from the bent side is hindered. The result is a weakening of the propelling force on the bent side, with the natural result of a turning to that side. Straightening of the body brings about a uniform protrusion of the gelatinous fibres on all sides, with a resumption of progression in a straight line.

According to my observations, however, it is impossible to establish any definite correlation between alterations in the direction of progression and extensive muscular contractions. The animals may turn without the slightest bending of the body. As Schewiakoff says, they may turn and bend to the same side, but, on the contrary, they frequently turn to one side and bend to the other. Further, they may progress in a straight line with the body held rigidly in a contorted form, as stated above.

Progressing gregarines, without their progression being in any ways checked, will often bend and suddenly straighten with a jerk. This movement may take place a number of times and it has a certain bearing on the mode whereby progression is effected. The bending of the body necessarily throws either the anterior or the posterior end of the animal out of the line of progression (figs. 5 and 6). The former case (fig. 5) is not inconsistent with Schewiakoff's views, but the latter is (fig. 6). For such a movement would presumably detach the animal from the gelatinous stalk, yet it is effected with absolutely no pause in the progression.

Observations made on *Echinomera hispida* are equally suggestive. Fig. 7*a–d* shows the several positions successively occupied by a progressing individual of this species in making a turn. It will be seen that the animal bent sharply, so that the axis of the anterior part formed nearly a right angle with that of the posterior part. The narrow posterior part then swung rapidly around until it lay in line with the rest of the animal. It seems impossible to avoid the conclusion that this would have resulted in the breaking loose from any attached stalk, with the consequent cessation of progression. Yet there was not the slightest slackening in the speed of the animal, which was considerable.

2. On encountering obstructions, gregarines may simply slip off to one side or the other. Frequently, however, when an obstruction is met head-on, the protomerite holds its position for the moment and the animal swings to and fro like a pendulum. There may be one or two to several of these swings, after which the progressive movement may be resumed. This may take place without noticeable change in the shape of the body.

I am again obliged to differ with Schewiakoff, who (p. 343) says: "Trifft die Gregarine auf ein Hindernis, so steht sie einige Zeit still; es tritt dann eine Knickung am Körper der Gregarine auf, worauf die Bewegung in einer neuen, durch die Knickung des Vorderendes vorgezeichneten Richtung fortgesetzt wird." This may happen, but, according to my observations, more often there is no alteration in the shape of the body. It apparently depends upon the force with which the gregarine strikes the obstruction, this force being not necessarily powerful enough to cause the animal to bend.

I believe that the swinging to and fro tells strongly against the idea that gregarines are followed by an attached stalk of gelatinous fibres. It is not easy to see how such a swinging could fail to break the animal loose from any such stalk, whereupon it would come to rest. But this does not happen. Such a turn as that shown in fig. 3 may be a matter of only a second or two.

Another case is shown in fig. 4, where *a–f* show six positions successively occupied by a progressing gregarine. It is difficult to see how the gelatinous stalk can explain a progressive movement of this sort, which was seen a number of times.

3. Schewiakoff arrived at his conclusions partly from a study of the action of carmine particles, etc., in the vicinity of progressing gregarines. Such particles are seen to slip backward along the surface of the gregarine, and Schewiakoff believed they were being pushed or carried backward by the extruding gelatinous substance. He states that this takes place just before a gregarine begins to display a progressive movement, and continues during progression. This is true, but these particles show such varied movements that it is probable the extruding gelatin is not in all cases the cause. If the extrusion of gelatinous fibres be the cause of gregarine progression, then the rate at which the gelatinous fibres are passed backward should bear a direct ratio to the speed of the progressing gregarine. The movement of the particles along the animal's surface should mark the rate of extrusion, which should itself condition the rate of progression. But these particles may slip backward either more rapidly or more slowly than the gregarine is progressing. They may also slip rapidly backward along the surface of a gregarine which is not changing place, and further remain at a fixed point on the surface of a progressing individual. As a rule, the slipping is seen in progressing animals, but often it is not. Frequently a progressing individual causes little or no disturbance among the loose particles lying in its path, merely pushing them aside as it advances. The particles may also move forward along the animal's surface. This is seldom seen in progressing gregarines, but is frequent in those which are displaying changes of body form.

The movements of these small particles are so multifarious as to suggest that they are due to different causes. It is probable that surface tension is in part responsible. At the same time, the evidence that gregarines extrude a gelatinous substance is wholly conclusive. The animals are sticky, and will often remain adhering to the cover-glass in spite of rapid currents in the mounting fluid. I have also seen the substance arising from the surface of a progressing gregarine, and constituting a trail behind it. I made this observation but once, the gregarine being *Echinomera hispida*. With *Stenophora juli* I have never been able to see it. My observation differs from those of Schewiakoff in that the trail does not consist of fibres, but of a series of splashes (Plate II, fig. 8). The substance arose from the surface of the gregarine as short rods, which almost instanty expanded into irregular drops. These drops then became detached from the surface of the gregarine to constitute the trail.

I do not think that this observation gives any reason for questioning Schewiakoff's statement that the gelatinous substance passes backward as fibres. But since an extrusion of the sort shown in fig. 8 could hardly push the animal forward, the observation appears to me significant in indicating that the trail is the effect of progression and not its cause. It is an intrinsic weakness of Schewiakoff's explanation that it gives no reason why the gelatinous substance should pass backward instead of either forward or radially. If, however, the cause for progression is to be sought for elsewhere, it is easy to see why it passes backward. Upon its emergence on the surface of the gregarine, it is merely left behind, in precisely the same way as the mucus secreted by a snail is left behind as the animal advances. The passing backward of the gelatinous substance is the effect of progression, and not its cause.

As Schewiakoff states, progressing gregarines gather up and drag behind them masses of loose particles. The size of these masses is shown in figs. 9, 10 and 11. It often happens, however, that a gregarine may travel for a considerable distance without gathering up any such appendage. Except for perhaps half a dozen carmine particles or minute fat-drops, the animal drags nothing along behind it. This suggests that the quantity of adhesive substance on the surface of gregarines is subject to variation.

Whether Schewiakoff believes that the ability to extrude a gelatinous substance has been developed in gregarines for the purpose of locomotion does not appear. The extrusion of slimy substances by endo-parasites is, however, a common phenomenon, and we should look to find this power in a gregarine, just as we find it in a cestode.

In some cases, however, the sticky substance on the surface of gregarines appears to be derived from the host-tissue. To study gregarines, the method is to break up the appropriate host-organ on a slide, add a drop of some fluid, and place a cover-glass over the mount. There is necessarily released a quantity of various organic fluids, and these fluids are nearly always mucilaginous. That they are responsible for certain of the phenomena displayed by gregarines is suggested by the following observations, which also bear upon the question of gregarine progression. Fig. 12 shows a gregarine distant a trifle more than its own length from a solid mass of host-tissue. Between the gregarine and the host-tissue are a number of small particles. If an animal so situated be watched, it will be seen to advance slowly and unsteadily for a very short distance, possibly the half of its length, but usually much less. It will then stop, remain motionless for the fraction of a second, and finally, with a sudden jerk, return to the position which it occupied originally. The particles follow the movement of the gregarine, those nearest to it moving the greatest distance. This suggests that there is behind the gregarine a mass of an invisible, elastic substance, in which both the gregarine and the small particles are entangled. As the animal advances, this elastic substance is stretched, and when the force which has caused the animal to advance is released, it is brought back into its original position by the sudden shortening of the elastic substance.

This phenomenon, which was seen time and again, first caused me to question the truth of Schewiakoff's explanation of gregarine progression. For, if the advance be due to the elongation of a stalk behind the animal, this stalk should prevent the slipping backward. As will be developed later, I believe gregarine progression is due to slight muscular movements, not apparent under ordinary observational conditions. In such cases as the one now under consideration, the advance is resisted by the elastic sticky substance, and when the power is released the gregarine is jerked passively backward. Since it is those gregarines which are lying near the host-tissue which behave in this manner, it is probable that the elastic substance is derived in part from the host-cells. Gregarines some distance from any host-tissue were never seen to act in this way.

4. My studies had advanced to this point with no more result than to conclude that Schewiakoff's explanation of gregarine progression was probably incorrect. The case shown by fig. 12 suggested that the problem was to be solved by watching the gregarine

itself, although, assuming Schewiakoff to be incorrect, there was no other conclusion possible. The existence of locomotor organs, such as small cilia or temporary protoplasmic processes, was next considered. There was not, however, the slightest evidence for such organs to be detected with living gregarines, and the most rigid staining methods gave wholly negative results. Varying the observational conditions was next tried. I had been making my studies after the methods which I suppose have been generally employed in work on living gregarines. The highest powers used were those obtained with a one-eighth-inch dry lens and a No. 4 eye-piece. I had also followed the instinctive tendency to focus on the periphery of the gregarines, which results in studying no more than an optical section of the animals.

Knowing that *Stenophora juli* has the longitudinal elevations of the cuticle well developed, it occurred to me that they might furnish a means of getting at additional data. Accordingly, I began to make observations on the upper surface of the gregarines, using a one-twelfth-inch oil-immersion lens. It developed at once that this could not be done with ordinary illumination, on account of the opacity of most gregarines. But with the use of a lamp, it was easy to get an illumination sufficiently intense to render the gregarines almost transparent. The light was permitted to pass from the mirror to the sub-stage condenser without the interposition of blue or ground glass, and the diaphragm was left well open. The difficulty of managing a wet mount when studied under an oil-immersion lens was obviated in some cases by gluing the cover-glass to the slide with vaseline or spermaceti. This is not always necessary, for frequently the surface tension of the fluid of the mount will hold the cover-glass perfectly rigid.

This method very quickly revealed the fact that gregarines show a movement which hitherto appears to have escaped observation. This I shall designate as the *transverse movement.* It may be seen to take place when gregarines are behaving in any of the ways already described. It manifests itself as a shifting of the cuticular striations in a direction at right angles to the long axis of the animal. The more superficial granules of the endoplasm also take part in it, which indicates that the myocyte, or muscular layer, is involved. There is often to be seen in contracting gregarines a flow of granules which calls to mind the flow of granules seen in an amœba.

A deep constriction in the deutomerite will cause such a flow. The phenomenon just mentioned, however, is to all appearances of a totally different nature. It shows itself as a shifting, *en masse,* of all the granules in sight. There is no flowing, and, so far as it is possible to see, the granules maintain somewhat the same relative positions.

The reasons for supposing the muscular layer is involved in this phenomenon are as follows: The muscular layer lies upon and is directly continuous with the endoplasm. The latter is beset with granules to its extreme limit. Away from the surface, there is nothing to prevent a flow of these granules, but on the surface (of the endoplasm) it is not unreasonable to suppose that the netlike muscular layer entangles a number of these granules. In consequence, when the muscular layer contracts, the superficial granules are carried along with it. That there are granules embedded in the muscular layer is indicated by what is seen in plasmolyzed gregarines. In such animals, when the muscular layer is torn loose from the endoplasm, it always carries with it a number of granules.

The transverse movement is indifferently to one side or the other, or else to and fro. It is displayed conspicuously when the gregarine is behaving in the manner described on pp. 12 and 13, and illustrated in fig. 12. It also takes place when the animals turn, and frequently in such cases the cuticular markings and superficial granules are seen to sweep rapidly to one side, suggesting that the gregarine is rotating on its long axis. That such a rotation actually takes place can be confirmed by watching gregarines which have the nucleus out of the middle line, or some other mark which renders it possible to distinguish one side from the other.

In other cases there is nothing to demonstrate a rotation. The transverse movement is slight and slow, being first to one side and then to the other. This is seen when the animal is displaying the slow typical glide. Should the animal then turn, the transverse movement becomes more extensive and more rapid, while if progression be in any ways interfered with, a still greater increase in the speed and extent of the transverse movement takes place.

All of this occurs without the extensive muscular contractions which gregarines so frequently display. But it is possible to establish a correlation between the transverse movement and what is clearly a display of muscular activity. When a gregarine displays the common movement of a lateral displacement of the protomerite, or a bending just behind the septum, it can be seen with moderate powers that a wave of disturbance passes down the upper surface well to the rear end of the animal. Under high powers, with their limited focal depth, this wave is not readily seen unless it is the upper surface of the animal that is being watched. It is a very common phenomenon, and it establishes the fact that those muscular impulses which are most evident in the anterior part of the body make their influence felt nearly as far as the posterior extremity. Under moderate powers, it appears only as a wave passing down the upper surface, but if higher powers be used, it can be seen that this wave is the same as the transverse movement described above. That is, bending of the anterior part of the body causes a transverse movement of the cuticular striations and superficial granules. Moreover, the character of the bending bears a direct relation to the character of the transverse movement. When the bending is rapid and extensive, so also is the transverse movement, and it is under such circumstances that evident rotation may take place.

These phenomena are well seen in those animals which are entangled in some sticky elastic substance, as described on pp. 12 and 13, and shown in fig. 12. Such animals show frequently a more or less continuous bending of the anterior part of the body, and simultaneously the transverse movement.

In the case of animals which are gliding freely, the transverse movement is always much less extensive. With these it usually requires an oil-immersion lens to make satisfactory observations, with the result that it is altogether impossible, on account of the large size of *Stenophora*, to keep enough of the animal under observation at any one time to see if both the bending and the transverse movement take place together. Since, however, it is easy to see that an extensive bending is accompanied by an extensive transverse movement, it is supposable, by analogy, that the slight transverse movement is accompanied by slight bending.

I was able to obtain a certain amount of evidence that this is so. Observations were made on the protomerite of gliding gregarines, with the result of detecting frequent lateral displacements of this part of the animal. These movements were mostly so slight in extent that it required steady watching to detect them, and they would never be noticed with low or medium powers. They occur at frequent intervals. As stated above, *Stenophora* is so large that it is impossible to keep both the protomerite and the upper surface of the deutomerite in focus at the same time. But gregarines which showed these slight displacements of the protomerite were displaying the typical gliding movement, and such gregarines usually show the transverse movement. Moreover, by transferring the attention from the upper surface of the deutomerite to the protomerite, it was possible to see that both of these two sorts of movement take place at only very slightly separated periods of time.

It is evident that lateral movements of the protomerite which are at all evident must take place in a horizontal plane. A movement in a vertical plane would need to be far more extensive in order to be detected. Vertical displacements, however, can often be seen. That is, gliding gregarines move the protomerite indifferently in any direction. This appears to me a fact of considerable significance. It indicates that bendings of the protomerite may take place even when it is not possible to see them. Fig. 13 is a diagram of the anterior part of a gregarine. The solid line represents the longitudinal axis. The dotted line represents the axis of the protomerite when displaced in a horizontal plane. This displacement is so slight that it is clear, were it to be effected in a vertical plane, the highest powers and the most rigid attention would wholly fail to detect it.

It therefore seems reasonable to suppose that the transverse movement is directly correlated with either displacements of the protomerite or bendings of the body in the region of the septum. When both are extensive the connection is readily established, but when the transverse movement is slight, this can only be done by somewhat indirect means, as I have just pointed out. Yet it would be improbable that the transverse movement should at one time be correlated with bendings of the anterior part of the body, and not at other times, when the difference in the two cases is merely one of degree.

If, as I hope, my conclusions are warranted by the observational data, the cause for gregarine progression is extremely simple, and while the exact mechanics of the process are probably beyond observation, it may be suggested that it is effected in a manner somewhat as follows: The muscular impulse, starting backward from the region of the septum, necessarily causes the contact of the gregarine with the cover-glass to be different in this region from what it is in the more posterior parts. Further, since the transverse movement takes place at the same time as the backward movement, that part of the gregarine's surface where the contact relations are temporarily different moves not only backward, but from side to side as well. It is not difficult to see how movements of this sort may produce locomotion, when it be recollected that gregarines are sticky. If a particular part of the surface be in close contact with the cover-glass or slide, a muscular movement which carries this particular part backward would not be followed by a mere slipping of this part, but by a movement of the gregarine in the opposite direction. It is easy to see, when observing the upper surface of a progressing gregarine, that the contact relations of different parts are different. The upper surface loses its normal curved contour, and shows considerable irregularities. The observational conditions are too difficult to permit the changes of contour to be followed, and in consequence wholly direct evidence that progression is brought about in the manner outlined above is not to be had. It seems to me, however, that the explanation of gregarine progression here given is, on *à priori* grounds, more probable than that given by Schewiakoff, for it is based on the fact that gregarines possess a well-developed muscular system, and it is in line with the general principles of animal locomotion.

On the other hand, a passive locomotion by means of the extrusion of gelatinous threads is without parallel in the animal kingdom. Moreover, when the form of certain of the polycystid gregarines is taken into account, this mode of progression is almost inconceivable. Thus, *Porospora gigantea*, which inhabits the intestine of the lobster, is shaped like a serpent, and is about forty times as long as it is broad. Several genera, *Dactylophorus*, *Schneideria* and *Stichospora*, for examples, have the form of greatly elongated cones, with the posterior end terminating in a point. Specimens of *Echinomera hispida* frequently show an outline which recalls that of a tadpole. It is difficult to believe that the projection of gelatinous fibres from the extreme posterior ends of animals of this shape could push them forward.

It may not be amiss to call attention to the conditions in other Sporozoa. An adult coccidian possesses no muscular system, and lacks the power to move. On the other hand, intra-cellular gregarines, when squeezed out of the cells, show muscular contortions, and occasionally the typical progression of the free-living sporont. The Hæmosporidia and Myxosporidia, both of which are motile, possess muscle fibres similar to those of polycystid gregarines, whereas the Amœbosporidia (Schizo-gregarines) show no muscle, and are not known to possess the power to move. In general, throughout the Sporozoa, the possession of muscle fibres and the power of moving from place to place go hand in hand, while the forms which are not known to move lack muscular elements. It would, therefore, seem somewhat extraordinary if the polycystid gregarines, in which the muscular system is well organized, should have developed such a unique mode of progression as that described by Schewiakoff.

BIBLIOGRAPHY.

CALKINS, G. N., 1901. Columbia University Biological Series, No. 6, The Protozoa. New York, The Macmillan Co., 1901.

DELAGE ET HÉROUARD, 1896. Traité de Zoologie Concrète, Tome I, La Cellule et les Protozoaires. Paris, Schleicher Frères, 1896.

DOFLEIN, F., 1896. Die Protozoen als Parasiten und Krankheitserreger. Jena, G. Fischer, 1896.

FRENZEL, J., 1891. Ueber einige argentinische Gregarinen. Ein Beitrag zur Organisation und Physiologie der Gregarinen überhaupt. Jena Zeitschr., Bd. 27, pp. 233–336, Taf. 8.

LABBÉ, A., 1899. Das Tierreich; 5 Lief., Sporozoa. Berlin, R. Friedländer und Sohn, 1899.

LANG, A., 1901. Lehrbuch der vergl. Anatomie der wirbellosen Thiere. 2 Aufl., 2 Lief., Protozoa. Jena, G. Fischer, 1901.

LANKESTER, E. RAY, 1872. Remarks on the Structure of the Gregarinæ, and on the Development of G. (Monocystis) sipunculi Köll. Quart. Jour. Micr. Sci., N. S., Vol. 12, pp. 342–351, Pl. 20.

SCHAUDINN, FR., 1900. Untersuchungen über den Generationswechsel bei Coccidien. Zool. Jahrb., Bd. 13, Abth. f. Anat., pp. 197–292, Taf. 13–16.

SCHEWIAKOFF, V., 1894. Ueber die Ursache der fortschreitenden Bewegung der Gregarinen. Zeitschr. f. wiss. Zool., Bd. 58, pp. 340–354, Taf. 20 u. 21.

SIEDLECKI, M., 1900. Ueber die geschlechtliche Vermehrung der Monocystis ascidiæ R. Lank. Bull. intern. de l'Acad. des Sci. de Cracovie. Compt. Rendus des Séances de l'Ann. 1890, pp. 515–537, 1 pl. (Plate appeared in the number for May, 1901.)

EXPLANATION OF PLATES I AND II.

PLATE I.—Fig. 1.—The successive positions occupied by a gregarine (*Stenophora juli*) progressing in a zigzag. The line to the right shows the nature of the path followed.

Fig. 2.—The successive positions taken by a progressing gregarine (*Stenophora juli*) when turning without alterations in the shape of the body.

Fig. 3.—The successive positions taken by a gregarine (*Stenophora juli*) after running head-on into an obstruction.

Fig. 4.—The same phenomenon as that shown in fig. 3. Here the change from *b* to *c* is accomplished in the same way as the change from *b* to *e* in fig. 3, and the change from *d* to *e* and from *e* to *f* in the same way as the change from the first to the last positions in fig. 2.

Fig. 5.—A progressing gregarine (*Stenophora juli*) throwing the anterior end out of the line of progression, which is shown by the ruled line. (This line is incorrectly drawn too far to the left.)

Fig. 6.—A progressing gregarine (*Stenophora juli*) throwing the posterior end out of the line of progression.

Fig. 7.—A progressing gregarine (*Echinomera hispida*) making a turn. Between *c* and *d* the narrow posterior end swung rapidly around until it lay in line with the rest of the animal.

Plate II.—Fig. 8.—The trail of gelatinous substance left behind by a progressing gregarine (*Echinomera hispida*).

Figs. 9, 10, 11.—The appendages of carmine, etc., which progressing gregarines gather up and drag behind them.

Fig. 12.—A gregarine (*Stenophora juli*) behind which are a number of small particles, lying near a mass of host-tissue. Both the gregarine and the small particles are entangled in an invisible, elastic substance (see pp. 12–13 of the text).

Fig. 13.—Anterior end of a gregarine (*Stenophora juli*). The solid line represents the longitudinal axis; the broken line the axis of the protomerite when displaced in the horizontal plane.

A NEW SPECIES OF THE ORTHOPTEROUS GENUS PSEUDOPHYLLUS FROM SUMATRA.

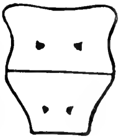
BY JAMES A. G. REHN.

The Academy of Natural Sciences of Philadelphia has been the recipient of a collection of zoological material from the island of Sumatra, presented by Mr. A. C. Harrison, Jr., and Dr. H. M. Hiller. The collection included an alcoholic specimen of a species of the genus *Pseudophyllus*, which on examination proves to be new, and which I take pleasure in dedicating to one of the donors.

Pseudophyllus harrisoni n. sp.

Type, female, Coll. Acad. Nat. Sci. Phila.

Allied to *P. neriifolius* Serville,[1] but differing in the obtuse anterior angles of the mesosternum, in the bluntly bituberculate prosternum, and the central position of the metasternal foveolæ. From *P. brullei* Pictet and Saussure it is distinguished by the centrally bent transverse veins, and by the anteriorly inserted radial vein.



Size large. Head with the vertex produced, acuminate, superiorly sulcate; eyes subovate, exserted; antennæ filiform. Pronotum with anterior margin subarcuate, posterior broadly rounded; lateral lobes with the lower margin obtusely triangular; transverse sulci two in number, the posterior very deeply incised. Tegmina elongate, moderately broad; radial vein inserted decidedly before the middle; transverse veins toward the apex centrally bent, giving them a subarcuate appearance. Wings exceeding the tegmina in length, apex acuminate. Prosternum bluntly bituberculate; mesosternum with the anterior border sinuate, the anterior angles obtuse and bearing a spine directed downward; metasternum with the anterior border truncate, as long as the same portion of the mesosternum, foveolæ placed in the central portion, rather close together. Anterior femora with a few very obscure spines on the lower margins; tibiæ with the upper

---

[1] See Brunner, *Monographie der Pseudophylliden*, p. 37, for a study of the synonymy of this species.

surface deplanate, foramina moderately inflated. Median femora bearing eight spines on the outer margin, six on the inner, the spines increasing to six on the outer margin as the distal portion is approached: tibiæ compressed, the inner margin of the upper surface with four spines. Posterior femora rather weak, genicular lobes produced and apically rounded, outer lower margin bearing twelve large dentiform spines, inner lower margin with ten or twelve spines; tibiæ compressed, quadrate, all margins spined, the outer upper margin with several very obscure spines, the inner upper margin with very distinct spines. Ovipositor very robust, lower margin arcuate, upper margin with the basal third straight, apical two-thirds slightly curved. Subgenital plate very small, triangular, apex moderately emarginate.

General color greenish; antennæ annulate with blackish; ovipositor with the apical portion black.

Length of body (excluding ovipositor),	88	mm.
Length of pronotum,	12.5	"
Length of tegmina,	93	"
Greatest width of tegmina,	22.5	"
Length of hind femora,	28.5	"
Length of ovipositor,	32	"

February 4.

Mr. Uselma C. Smith in the Chair.

Fourteen persons present.

February 11.

Mr. Lewis Woolman in the Chair.

Eight persons present.

Papers under the following titles were presented for publication:

"The Frons in Bembidium, with Descriptions of New Species," by F. E. Blaisdell, M.D.

"A New Bat of the Genus Glossophaga," by James A. G. Rehn.

February 18.

J. Cheston Morris, M.D., in the Chair.

Fourteen persons present.

February 25.

Edwin G. Conklin, Ph.D., Vice-President, in the Chair.

Papers under the following titles were presented for publication:

"Contributions to a Knowledge of the Hymenoptera of Brazil, No. 8. Eumenidæ, continued (Genus Odynerus)," by William J. Fox.

"Some Bermuda Oligochæta with a Description of a New Species," by J. Percy Moore.

"Structure and Development of the Thyroid Gland in Petromyzon," by Albert M. Reese.

"Karyokenesis and Cytokenesis in the Maturation, Fertilization and Cleavage of Crepidula and Other Gasteropods," by Edwin G. Conklin.

"Certain Aboriginal Remains of the Northwest Florida Coast, Part II," by Clarence B. Moore.

The following were elected members: J. P. Murlin, Ph.D., A. F. K. Krout, Ph.D., James A. Nelson and A. B. Gordon-Davis.

The following were ordered to be printed:

NEW LAND MOLLUSCA FROM JAPAN AND THE BONIN ISLANDS.

BY HENRY A. PILSBRY.

A monographic account of the non-marine mollusks of the Bonin Islands (Ogasawara-jima) is now in preparation, in which all of the species will be illustrated. As Mr. Nakada is still collecting in the islands for Mr. Hirase, and will probably spend a month or two more there, it has been thought desirable to publish brief notices of his discoveries, reserving the consideration of the extrinsic relations of the Ogasawaran fauna for the article to follow.

Besides the material sent by Mr. Hirase, I am indebted to Mr. S. Yoshiwara, of the College of Science, Imperial University, at Tokyo, for valuable specimens and data which will be fully utilized in the projected monograph. One of the most interesting of Mr. Yoshiwara's discoveries is the true locality of *Mandarina ruschenbergeriana* (Pils.), which he found on the islet Minami, off the southern end of Chichijima.

HELICINA Lam.

This genus is represented in the Bonin Islands by several species and varieties, all more or less related, and doubtless claiming a common ancestor, though several of them are conspicuously diverse. Those now known from Hahajima may be determined by the following key:

a.—Spire elevated, conic; lip simple, blunt, unexpanded. Whorls $4\frac{1}{2}$. Alt. 4, diam. 5.2 mm., . . . *H. capsula* n. sp.

*a*¹.—Spire convex or merely somewhat conoidal; base convex; lip more or less expanded or thickened.

  b.—Periphery conspicuously carinate; lip expanded and thickened.

    c.—Whorls 4; strongly striate spirally above. Alt. 3.2 or 3.3, diam. 5 mm., . *H. ogasawarana* n. sp.

    *c*¹.—Much depressed and very acutely carinate; pale yellowish-corneous; whorls $4\frac{1}{2}$. Alt. 2.7 to 3, diam. 5.8 to 6 mm., . . . *H. hirasei* n. sp.

  *b*¹.—Periphery more or less angular, or rounded though compressed.

c.—Surface delicately striate spirally. Alt. 3.5, diam. 5.3 to 5.8 mm., . . . *H. yoshiwarana* n. sp.

*c*¹.—Upper surface strongly striate spirally, *H. yoshiwarana* var. *arata* n. v.

*c*².—Smaller, delicately striate. Alt. 2.2, diam. 4.5 mm., *H. yoshiwarana* var. *microtheca* n. v.

Only one form is yet known from Chichijima, *H. ogasawarana* var. *discrepans*. It differs from the typical form in having the spiral striæ obsolete on the last whorl.

Alycæus biexcisus n. sp.

Shell similar in general form, size and sculpture to *A. reinhardti* Pils., but differing in the aperture. The lip is thickened and built forward. The parietal margin of the lip is continuous, raised in a blunt, somewhat triangular process. The columellar margin is excised in a broad curve, and there is a more or less pronounced notch at the junction of the basal and outer margins. The neck is only slightly constricted, and is striate. Whorls 3½. Diam. 3½ mm.

Suimura, Awa. Types No. 82,660 Coll. A. N. S. P., from No. 831*b* of Mr. Hirase's collection.

This is one of the most differentiated of the Japanese species of *Alycæus*.

Blanfordia japonica var. **simplex** nov.

The specimens of *Blanfordia* from Nippon which I have seen differ from *B. japonica* of Sado Island, as defined by A. Adams, in having the lip only a mere trifle expanded, hardly perceptibly so, and not doubled, as it is said to be in *B. japonica*. The shell consists of 5 whorls, the first one more or less worn, and it is covered with a yellowish-olivaceous cuticle. It is shorter and broader than *B. bensoni* of Yesso.

Length 6, diam. 4 mm.

Nishigo, Uzen. Types No. 78,836 Coll. A. N. S. P., from No. 406 of Mr. Hirase's collection. Similar specimens have been sent from Kajima, Satsuma, and one immature shell before me from Ibuki, Omi (No. 842 of Mr. Hirase's collection), may prove to be the same variety.

The species of *Blanfordia* now known are as follows:

B. bensoni (A. Adams).

Tomichia bensoni A. Ad., Ann. and Mag. Nat. Hist. (3), VIII, p 308 (October, 1861).

Blanfordia bensoni A. Ad., Ann. and Mag. Nat. Hist. (3), XII, p. 424, Pl. 7, fig. 11.
Blanfordia bensoni A. Ad., Möllendorff, Nachr'bl. d. D. Malak. Ges., 1897, p. 32 (description of specimens from Hakodate).
Pomatiopsis hirasei Pils., Nautilus, May, 1900, p. 12.

Southern Yesso, in the Province Ojima, at Matsumai (A. Ad.), Kayabe (Y. Hirase), and Hakodate (B. Schmacker).

B. japonica (A. Adams).

Tomichia japonica A. Ad., Ann. and Mag. (3), VIII, p. 308 (October, 1861).
Blanfordia japonica A. Ad., Ann. and Mag. (3), XII, p. 424, Pl. 7, fig. 12.

Sado Island (A. Ad.).

B. japonica var. **simplex** Pils. See above.

Blanfordia japonica Mlldff., Nachr'bl. d. D. Malak. Ges., 1900, p. 153.

Nishigo, Uzen, Nippon; Kajima, Satsuma, Kiushiu (Y. Hirase).

I have given the references in full because several authors, notably von Möllendorff and Kobelt, have expressed ignorance of the existence of descriptions of A. Adams' species; the former author, with characteristic temerity, stating that one of them had never been described.

Cyclophorus kikaiensis n. sp.

Shell depressed-turbinate, moderately solid but not thick, openly umbilicate; pale yellowish, encircled by many dark red-brown dotted or spotted lines and bands, those above usually more or less confluent, and usually marked with radiating zigzag light streaks; the earlier whorls purplish-brown; sculptured with minute, thread-like striæ, coarser and more separated on the early whorls. Whorls $4\frac{3}{4}$, very convex, the last rounded or sometimes indistinctly angular in front, convex below. Aperture circular, oblique, bluish inside, the peristome built forward beyond a very slight expansion, in fully mature individuals; in contact with the preceding whorl for a very short distance only.

Alt. $11\frac{1}{2}$, diam. 15 mm.

Alt. 12, diam. 16 mm.

Alt. $12\frac{1}{2}$, diam. 17 mm.

Kikai-ga-shima, Osumi. Types No. 81,940 Coll. A. N. S. P., from No. 547 of Mr. Hirase's collection.

I formerly thought this a small variety of *C. turgidus* Pfr., but further study of larger series shows it to be distinct. It is a smaller, less elevated shell, with decidedly larger umbilicus, the whorls being more loosely coiled. Specimens from the fossil-bed on the same island (Hirase's No. 684*b*) are a little larger, the largest measuring alt. 15, diam. 20 mm. They show the same open umbilicus and rather lax coil.

C. turgidus Pfr., from the same deposit, is decidedly larger than the typical form, diam. 27–28 mm.

Diplommatina kiiensis n. sp.

Shell cylindric, conic above, the tapering portion less than half the length of the shell; dull red; sculptured with strong but narrow thread-like rib-striæ, slightly coarser on the cone than on the last two whorls. Whorls 6½, convex, the last narrower, strongly ascending in front. Aperture circular, the lip narrowly expanded, reinforced by a narrow rib or crest close behind it; continuous across the parietal wall. Columellar denticle strong. Palatal fold very long. Length 3.3, diam. nearly 2 mm.

Nachi, Kii. Types No. 82,656, Coll. A. N. S. P., from No. 837*a* of Mr. Hirase's collection; also No. 837*b*, from the same locality.

Some specimens are superficially eroded, and whitish ash-colored. The palatal fold is unusually long. It is a smaller species than *D. tenuiplica*, larger than *nipponensis* or *cassa*.

Diplommatina kobelti var. **ampla** nov.

Shell with the spire long and regularly tapering to an obtuse apex. Whorls 8 to 8½, convex, the last narrower and ascending as usual; pale reddish or corneous; evenly sculptured with delicate thread-like rib-striæ, subobsolete on the last half of the last whorl. Aperture subcircular, with straightened, sinuous columellar margin. Columellar tooth strong. Palatal fold curved, covered by the expanded parietal callus.

Length 4, diam. 2 mm.

Gotō, Uzen. Types No. 82,664, Coll. A. N. S. P., from No. 812 of Mr. Hirase's collection. It is larger than *D. kobelti*, with more whorls.

Diplommatina pudica n. sp.

Shell cylindric below, tapering in a long, slender spire above, the apex small, somewhat obtuse; dull red, the spire and apex blushing deep rose. Sculpture of thread-like riblets, conspicuous and very widely spaced on the spire, rapidly becoming finer at the beginning of the penultimate whorl, which is very finely and closely striate; last whorl contracted, similarly sculptured but with the striæ partially effaced, ascending as usual. Aperture somewhat oblique, subcircular, the peristome expanded and reflexed, but not doubled and with no rib behind it. The columellar tooth is rather small, and deeply placed. No palatal fold is visible through the shell. Length 3, diam. 1.5 mm.

Nachi, Kii. Types No. 82,652, Coll. A. N. S. P., from No. 836*a* of Mr. Hirase's collection.

A very distinct species, like *D. kobelti* in the long spire, but in *D pudica* the cone is more slender above. The disparity in sculpture between the whorls of the cone and the last two is unusually marked. The color of fresh, unworn shells is deeper than in the other species of Nippon known to me.

Mandarina exoptata var. **obtusa** nov.

More depressed than the typical form, and merely angular at the periphery; whorls 4⅓.

Alt. 13, diam. 22½ mm.

Hahajima, No. 845 of Mr. Hirase's collection.

Mandarina mandarina var **hahajimana** nov.

Shell small, thinner than typical *mandarina*, pale yellowish; uniform or with a pale reddish band above, another below the periphery. Whorls 4½, the last slightly angular in front, soon becoming rounded at the periphery. Surface very densely engraved with clear-cut, minutely crimped spiral striæ, obsolete immediately around the axis.

Alt. 13½, diam. 18½ mm.

Sekimon-zan, Hahajima (Mr. S. Yoshiwara); Hahajima (Mr. Y. Hirase).

Genus **HIRASEA** Pilsbry.

This group has been modified to fill many places in the Ogasawaran snail fauna. Six species have already been found on Hahajima alone, and one on Chichijima. Those known from the former island may be determined by the following key:

I.—Spire more or less convex or low-conic; periphery angular or carinate.
  a.—Basal lip produced forward beyond the outer and upper margins; periphery angular above; whorls $5\frac{3}{4}$, closely coiled; upper surface dull, striate, base glossy. .
    b.—Spire but slightly convex. Alt. 2.1, diam. 4.3 mm., *H. sinuosa.*
    b^1.—Spire low-conic; base very convex. Alt. 2, diam. 3.1 mm., ... *H. eutheca.*
  a^1.—Aperture normally oblique, the outer and upper margins projecting forward of the basal.
    b.—Base translucent, thin, polished; whorls $5\frac{1}{2}$; periphery merely angular. Alt. 2, diam. 4.6 mm., *H. hypolia.*
    b^1.—Base opaque, finely ribbed, like the upper surface; periphery acutely carinate.
      c.—Biconvex; whorls $4\frac{1}{2}$ to $4\frac{3}{4}$. Alt. 2.2, diam. 4 mm., ... *H. nesiotica.*
      c^1.—Much depressed, the keel very acute; whorls 4. Alt. 1.6, diam. 4 mm., . . *H. acutissima.*

II.—Spire concave, the earlier whorls sunken; periphery rounded.
  a.—Disk-shaped; rich brown, and densely, minutely rib-striate above and at the periphery, becoming polished and somewhat translucent beneath, whitish near the axis. Whorls 5, the last rounded at the periphery; aperture lunate, the lip simple and acute in the specimens seen, which are probably not adult. Alt. 1.7, diam. 4 mm., *H. biconcava.*

Another genus or subgenus, apparently allied to *Hirasea*, is represented by one species sent from Hahajima, and by *Helix operculina* of Gould, collected on Peel Island [Chichijima] by the North Pacific Exploring Expedition, but not yet obtained by Mr. Hirase. This group may be defined as follows:

FAMETESTA subgen. nov.

Shell disk-shaped, excessively depressed and acutely carinate, concave below the keel, imperforate, thin, minutely striate. Aperture oblique, extremely narrow, the basal lip thickened within. Type *H. mirabilis.*

Two species are now known. Both are pale brown with 5 whorls. They differ thus:

a.—Diameter three times the altitude, 2.5 x 7.5 mm. Chichijima, *H. operculina* Gld.

a^1.—Diameter five times the altitude, 1.5 x 7 mm. Hahajima,
H. mirabilis n. sp.

The last species is so flat it looks as though trodden upon.

Kaliella ogasawarana n. sp.

Shell large for the genus, subperforate, conic, pale yellowish-corneous, subtransparent, glossy, smooth except for slight growth-lines. Spire almost straightly conic, the apex obtuse. Whorls 7½, somewhat convex, the last strongly angular at the periphery, moderately convex below. Aperture slightly curved, in crescent form, truncate at the ends; lip thin and acute, the columella concave, with narrowly reflexed margin. Alt. 5, diam. 5 mm. Hahajima, Ogasawara (Y. Hirase, No. 846).

Nesopupa dedecora n. sp.

Exceedingly small, obesely oval, dark red-brown, faintly striate. Whorls 4¾, convex, the last swelling in a very conspicuous crest some distance behind the aperture, and grooved at the position of the upper palatal fold. Aperture squarish, well rounded below, the lip expanded, brown. Parietal lamella long and strong; angular lamella well developed, not united with the parietal. Columellar lamella deeply placed, small. Basal fold small, close to the columella. Lower palatal fold very small and deeply situated. Upper palatal large and prominent All the teeth are whitish.

Length about 1.6, diam. 1 mm.

Hahajima, Ogasawara (No. 855 of Mr. Hirase's collection).

Eulota senckenbergiana var. **awaensis** nov.

Very large, dark brown with wide, ill-defined darker brown, and lighter dusky yellowish streaks, a narrow blackish supra-peripheral band bordered with yellow on both sides, and the interior of the umbilicus blackish. It wants the bright yellow variegation of typical *senckenbergiana*. Surface conspicuously malleate.

Alt. 30, diam. 55 mm.

Alt. 33, diam. 53½ mm.

Suimura, Awa. Types No. 82,608 Coll. A. N. S. P., from No. 828 of Mr. Hirase's collection.

The species has not hitherto been reported from Shikoku Island.

Eulota vulgivaga var. **lanx** nov.

Shell more depressed than *vulgivaga*, the base less convex. Last whorl deflexed in front. Aperture more oblique. Fringe at the periphery and sometimes along the suture well developed.

Alt. 9, diam. 22 mm.

Suimura, Awa, Shikoku Island (Mr. Hirase, No. 825).

A large form of *vulgivaga* occurs at Mt. Ibuki, Omi, having almost 7 whorls, a dome-like spire, and comparatively smooth cuticle; but smaller specimens seem to occur with the large ones, so that with the material now in hand I do not see that a distinct local race is indicated.

CONTRIBUTIONS TO THE LIFE-HISTORY OF PLANTS, NO. XVI.

BY THOMAS MEEHAN.[1]

The Bartram Oak, in Connection with Variation and Hybridism.

My recent discovery that the mature wood of trees may so change their original lines as to alter the whole form of the skeleton, and that these changes in form are characteristic of the species, may enable us to settle some disputed questions. In the case, somewhat famous, of the Bartram oak, *Quercus heterophylla* Mx., we may now say with absolute certainty that it is but a form of the pin oak, *Quercus palustris.* The angular divergence of the mature branches is the same in both; while other resemblances to the latter species are well known. Much of the confusion in regard to this matter has arisen from the tree, still in the Bartram gardens, that for many years past has been pointed out to botanists as a seedling from the original tree long since destroyed. Specimens from this tree are widely diffused through herbariums. It is but a somewhat lobed-leaved form of the willow oak, *Quercus Phellos,* a condition not infrequent among trees of this species, and of which form there are numerous specimens in the herbarium of the Academy of Natural Sciences of Philadelphia. If any one had thought to compare these specimens with the plate in Michaux's "Sylva," the error would have been noted. Dr. Engelmann was familiar with Michaux's plant only through these misleading Bartram specimens, and hence described his *Quercus palustris-imbricaria,* which proves to be identical with Michaux's *Q. heterophylla.* Dr. Engelmann was led to write positively in regard to the hybridity in a great degree from his belief in the sterility of hybrids—the St. Louis tree producing only a single acorn, so far as any one knew, during

---

[1] The manuscript of this article was found among the late Mr. Meehan's papers after his death and sent to the Academy for publication by his son, Mr. S. Mendelson Meehan. It possesses a special interest as being the last contribution from one who for nearly forty years enriched the *Proceedings* with the results of his acute and devoted study of nature. Mr. Meehan's first paper in the *Proceedings* of the Academy was published in 1862.—EDITOR.

its existence. From this acorn grew the tree now on my grounds. It is remarkably fertile, wholly destroying the "sterile" idea, even though it were a hybrid, and with the leaves and skeleton characters of *Q. palustris*, as already noted. Seedlings from Delaware trees, the acorns sent by Mr. Commons, a well-known local botanist, all retain the character of occasional entire leaves, but in other respects coincide with *Q. palustris*. While the absence of deep lobing struck Michaux, it is remarkable that he did not note the opposite in other cases.

It is not unusual to note individual trees of *Quercus palustris* with the leaves so deeply incised that there is left little of leaf-blade but the strong veins and midribs. Indeed, this variation in the lobing of leaves may be noted in all species of oak. There is no need to call in hybridism to account for this varying condition. We find in many plants a tendency to have lobed leaves in an early stage and wholly entire at a later. The evergreen ivy, *Hedera Helix*, is a familiar example. We now know that these changes result from varying degrees of growth-energy, and not from any external agency in which hybridism may be included. In the light of modern knowledge, explanations of the past seem remarkable. Referring to *Quercus heterophylla* Michaux says: "Every botanist who has visited different regions of the earth must have remarked certain species of vegetables which are so little multiplied that they seem likely at no distant period to disappear from the earth. To this class belongs the Bartram oak." When we remember that this was said of a young tree, described as "30 feet high and 8 inches in diameter," growing in the midst of numerous pin oak trees of great age, that formed almost the chief oak character of that region, and from which this young tree must have had its origin, one can only surmise that for once Michaux had lost his usual high judicial ability.

The main point of this note is to illustrate by the Bartram oak the value, in settling important questions in long dispute, of the discovery that old wood may change its direction so as to give a specific character to the main branches or skeleton of the tree, and incidentally to show that we gain a great point in biology when we note how striking variations may occur by varying degrees of vital energy, and without calling in the aid of survival, hybridism or of any external agency.

OBSERVATIONS ON THE FLOWERING OF LOBELIA CARDINALIS AND LOBELIA SYPHILITICA.

In my garden during the past year, 1900, I had some fifty plants each of *Lobelia syphilitica* and *Lobelia cardinalis* in rows side by side. They were so near each other that some of the flower stems of the latter fell over and seemed to be blooming among the plants of the former. It surprised me one day to note that while numerous winged insects visited the blue-flowered species, none cared for the scarlet ones. This excited an interest that led to a continuous observation through the whole flowering period. At no time did I see an insect visitor on the cardinal flower, while every day the blue-flowered species had abundant attention. On one occasion I found a humming-bird, *Trochilus colubris,* at work on the cardinal flower, and the zest with which numerous flowers were examined by the bird attested to the presence of nectar, a fact which my own test subsequently verified. The bird is not numerous on my ground, and with an abundance of flowers of various kinds over many acres of ground, it may be inferred that it was not a frequent visitor to the cardinal flower. I observed it only on this occasion. It wholly neglected the blue-flowered species, that seemed so attractive to the insects. Toward the end of the season the foreman in charge, Mr. Hemming, captured specimens of all that were visitors to *Lobelia syphilitica* during one day. These were identified by Mr. William J. Fox as follows: *Xylocopa virginica, Bombus pennsylvanicus, Bombus fervidus, Bombus americanorum* var. *pallidus, Apis mellifera,* and a sand wasp, *Scolia dubia.* It is worthy of note that the honey-bee did not visit the flowers till late in the season. About fifty yards away from these plants was a large bed of *Sedum spectabile,* which at the earlier stage of these observations were crowded by this well-known honey gatherer. It may be inferred that as long as they lasted they collected all needed from these flowers. Honey-bees at any rate are not numerous in this vicinity.

At the end of the season no difference could be observed in the fertility of the two species. Every capsule seemed abundantly seed-bearing. The presence or absence of insect visitors had no effect. Dissecting the flowers from time to time, and in various stages before and after anthesis, some original and interesting phenomena were observed. At the period when the anthers have reached their full development a rest is taken, apparently till the next day. Then the style elongates until it seems to be held fast by the united anther cap. After a short rest it is again in motion, the anther-cells burst, and the pollen is ejected so forcibly through the crown as to sometimes cover the scarlet petals with powder. In the case of the blue-flowered species, bees occasionally get a portion of the pollen shower.

Aside from the interesting fact in regard to the forcible ejection of the pollen, and the free fertility under self-fertilization—for, notwithstanding the freedom of insect visitors, *Lobelia syphilitica* is absolutely self-fertilized—note may be taken of differing observations. Of *Lobelia fulgens,* which is essentially identical with *Lobelia cardinalis,* Mr. Darwin says, in his "Cross and Self-fertilization in the Vegetable Kingdom": "This plant is never visited in my garden by bees, and is quite sterile; but in a nursery garden at a few miles' distance I saw humble-bees visiting the flowers, and they produced some capsules." Mr. Darwin once stated that one might as well use organic dust as to endeavor to get seeds of *Linum perenne* by the aid of its own pollen. I found *Linum perenne* of our Rocky Mountains abundantly fertile with own-pollen, and said so in one of my papers. Mr. Darwin took this to be an attempt to discredit his observation, and naturally felt aggrieved. My thought is rather that plants and insects behave differently under different conditions, and that failure or facture in perfecting seeds should often be referred to phases of nutrition aside from the action of insects.

The facts here recorded afford a valuable lesson on this matter. *Lobelia syphilitica,* with its shorter and more open corolla, could be more easily rifled of its nectar, and as the flowers were in great abundance, and fresh flowers opened daily, the insects worked in the easiest lines. In the case of the *Sedum* it will also be noted that the bees continued their easier work on this, before seeking the more difficult *Lobelia.* The failure of Mr. Darwin's *Lobelia* to produce, while mine were fertile, is obviously due to nutritive conditions. He was mistaken in referring the failure to the absence of insects, but no one would for a moment discredit his observation.

A NEW BAT OF THE GENUS GLOSSOPHAGA.

BY JAMES A. G. REHN.

Along with several other bats recently submitted to me for examination by Dr. J. Percy Moore, of the University of Pennsylvania, were three specimens of the genus *Glossophaga*. On comparison with a series of specimens from northern South America, loaned from the collection of the United States National Museum through the kindness of Mr. Gerrit S. Miller, Jr., of that institution, it was found that they represent a northern form of *G. soricina* Pallas,[1] and do not appear to closely resemble any of the other species of the genus. From *longirostris* and *elongata* Miller it is well separated; from the former it is immediately differentiated by the broader posterior portion of the bony palate, from the latter by the much shorter skull. On examination of the names usually placed as synonyms of *G. soricina* I find that none are available for this form.

Glossophaga soricina antillarum n. subsp.

Type.—No. 6,619 Collection Acad. Nat. Sci. Phila. Port Antonio, Jamaica, December 30, 1890. Female. Collected and presented by Dr. J. Percy Moore.

Distribution.—Jamaica and Bahamas. The collection of the Academy contains a skull from the latter locality.

General characters.—Larger than typical *G. soricina*, the skull much more elongate, the rostrum narrower, and second upper molar larger.

Size.—Large, the forearm considerably greater than in true *soricina*. The ear and foot show an increase in size, while the hind tibia is practically the same length.

---

[1] As Pallas gave no locality for his *Vespertilio soricinus* (Misc. Zool., p. 48), the typical form must be restricted by other means. In his figure (tab. V) the species is represented with a comparatively short rostrum, and as this is characteristic of the form from northern South America (and possibly others from that continent), I have restricted the name *soricina* to the form occurring in that region.

Color.—As far as can be judged from the alcholic Jamaican specimens, the form appears to have a more reddish appearance, the fur being walnut-brown, while the available alcoholic specimens and one skin of *G. soricina* are between a clove-brown and sepia. This appears to apply also to the membranes.

Skull.—Large, comparatively slender, the rostrum narrower than in *G. soricina.* Posterior bony extension of the palate rather broad.

Teeth.—Essentially as in *G. soricina*, but the second upper molar has the internal lobe longer, thus making the tooth heavier and more quadrate.

Remarks.—This northern form of *G. soricina* is very distinctly differentiated from typical *soricina* as restricted. The greater general size and more elongate skull, with the slender rostrum, immediately separate it. With *G. longirostris* and *elongata*, as shown above, no comparison is necessary.

Specimens examined. — Three alcoholic specimens from Port Antonio, Jamaica (type and cotypes). Skull from Bahamas.

Comparative measurements.

	G. s. antillarum.		*G. soricina.*	
	Type 6,619 A. N. S. Port Antonio, Jamaica.	5,098 A. N. S. Bahamas.	86,901 U. S. N. M. Berbice, British Guiana.	103,960 U. S. N. M. Trinidad.
Length of forearm	38		35.2	34.7
Length of hind tibia	13.5		14	13.2
Length of foot	9.5		9	9
Length of ear	13.5		12.5	13
Extent of interfemoral membrane	13.5		15	14
Length of skull	22.5	23	20	21
Length of rostrum from interorbital constriction	11	11.2	10	9.5
Width of brain case	9.2	9.2	8.5	8.5
Width of rostrum at canines	4	4	4	4

A NEW GENUS AND THREE NEW SPECIES OF CHILOPODS.

BY RALPH V. CHAMBERLIN.

Heretofore no Scolopendridæ of the sub-family Cryptopinæ have been reported from the Pacific States, and in consequence the author's present announcement of the finding of two new species belonging to this group in California will be of interest to myriapodists. Of these two species one belongs to the genus *Theatops*, making the third known from the United States, while the other represents a new genus, in some respects intermediate between *Cryptops* and *Theatops*. But two mature specimens of the latter species being in the collection, no detailed examination of the mouth parts has been possible, and accordingly a complete description of the genus is not now presented. Its general relationships will be understood from the diagnosis assigned in the analysis.

The new *Lithobius* here described belongs to that group in which the coxal pores are arranged in several series (*Bothropolys*). Its nearest relative, as seen from the key to the American species, is *Lithobius xanti* (Wood), which is found in California and Oregon, itself coming from the Wahsatch Mountains, Utah.

Analysis of the Genera of Cryptopinæ.

a_1.—Last dorsal plate not enlarged; anal legs but little crassate.

  b_1.—Ocelli present, single, . . . EREMOPS Bollman. 1.

  b_2.—Ocelli absent or indistinct.

    c_1.—First and second tarsal joints of anal legs toothed below; claw of anal legs unarmed; last pleuræ free, without processes; anal and genital segment very short, without a dorsal scutum, CRYPTOPS Leach. 2.

    c_2.—First and second tarsal joints of anal legs unarmed below; claw of anal legs armed with two spines; last pleuræ not exposed laterally, with strong processes posteriorly; anal and genital segment not shortened, dorsal scutum present, ANETHOPS gen. nov. 3.

a_2.—Last dorsal plate twice as long as the preceding; anal legs strongly crassate, ... THEATOPS Newport. 4.

Anethops occidentalis gen. et spec. nov.

Brown or fulvous brown, the feet paler; head punctate with moderately small punctæ, suboval, the posterior margin rounded; basal plate exposed; dorsal scuta lightly punctate, impressed with two deep marginal sulci, and upon the middle portion with six sulci, the two outermost and the two innermost indistinct, the intermediate ones deep; ventral scuta densely minutely punctate, each plate, excepting the three anterior and the three posterior, with a cruciform impression, the longitudinal sulcus wide and much deeper. Antennæ rather long, swollen at base, attenuated distally; articles 17, mostly rather short; densely clothed with short stiff bristles which become very short on the distal joints. Prosternal margin without teeth or spines, glabrous; coxal tooth small, black, acute. Legs sparsely aculeate distally; the first tarsal joint, excepting in the last pair, armed beneath with one spine and above with two, the second tarsal joint armed beneath with a spine, claws of all legs armed at base with two spines, tibiæ not armed. Anal legs scarcely swollen, not shortened, the third and the fourth joints not armed with teeth or spines. Last ventral plate wide, covering the pleuræ laterally, scarcely converging caudad, the posterior border widely sinuate; last pleuræ narrow, with conspicuous processes posteriorly, each ending in a stout, acute black point.

Length 33.5 mm., width 3 mm.; length of antennæ not quite 7 mm.

Habitat.—San Gabriel Canyon, Los Angeles county, Cal.

The type specimens were collected May 25, 1901, by Mr. Charles E. Hutchinson.

Etymology.—Genus: Greek ἄ, privative, ἦθος, character, and ὤψ, eye.

Key to American Species of Theatops.

a_1.—Femora of anal legs unarmed; none of the tibial or tarsal joints armed above; all tarsal joints armed beneath except the last two; processes of last pleuræ unarmed with spines, *posticus* (Say). 1.

a_2.—Femora of anal legs armed with one or two spines at the superior interior angle; tibiæ, except the last three, armed above; tarsal joints, except in last two pairs, armed above and beneath (first tarsal joint of first legs not armed beneath); processes of last pleuræ unarmed with spines, *spinicaudus* (Wood). 2.

a_3.—Femora and tibiæ of anal legs armed with a single spine at the inferior angle; tibiæ, except of anal legs, unarmed; first tarsal joint, except in last pairs, armed above and below with one spine, second joint armed beneath; processes of last pleuræ with a stout spine, . . *californiensis*, sp. nov. 3.

1. Theatops posticus (Say).

Cryptops postica Say (1821).
Theatops postica Newport (1844).
Opisthemega postica Wood (1862).
Opisthemega crassipes Meinert (1886).
Theatops crassipes Bollman (1888).

Habitat.—Eastern United States, south of Virginia, Indiana and Illinois.

2. Theatops spinicaudus (Wood).

Opisthemega spinicauda Wood (1862).
Theatops spinicaudus Bollman (1888).

Habitat.—Acapulco, Mex., and southwestern United States, extending northeast through Tennessee to Pennsylvania.

3. Theatops californiensis spec. nov.

Brown, feet and antennæ yellowish; head sparsely punctate, suboval, posteriorly truncate; dorsal scuta sublightly, sparsely punctate, deeply bisulcate, first plate triangularly impressed anteriorly; ventral plates sparsely lightly punctate. Articles of the antennæ 17, terminal articles densely shortly hirsute, median and basal joints sparsely shortly hirsute. Prosternal teeth 3–3, large, short; coxal tooth large, stout, obtuse. None of the tibiæ armed either beneath or above; first joint of tarsus, except in ultimate and penult pairs, armed below and above with one spine, the second tarsal joint armed beneath. Anal legs much crassate, contiguous, moderately short, claw long, strong, superior internal margin carinate; femur armed on the inferior interior margin with a single, rather stout tooth; tibia armed similarly to femur. Last ventral plate long, wide, the sides scarcely sinuate, strongly converging posteriorly, the posterior angles rounded, posterior border gently sinuate; last pleuræ wide, subsmooth, posteriorly widely sinuate, processes armed with a stout spine or tooth.

Length 41–46 mm.; width 4 mm.; length of anal legs 7–8 mm.

Habitat.—Near Quincy, Cal.

Found at a mining claim, altitude 3,500 feet, by Mr. Edward Garner.

Key to American Species of Lithobius, having the Coxal Pores in several series (Bothropolys).

a_1.—Posterior angles of none of the dorsal plates produced.
  b_1.—Prosternal teeth 9–9; spines of first legs 2, 3, 1, of anal 1, 3, 2, 1; length 25–29 mm. *bipunctatus* (Wood). 1.
  b_2.—Prosternal teeth 6–6; spines of first legs 2, 3, 2, of anal 1, 4, 3, 1–1, 4, 3, 2; length 18 mm., *monticola* Stuxberg. 2.
a_2.—Posterior angles of the 9th, 11th and 13th dorsal plates produced.
  b_1.—Spines of first legs 2, 2, 1–2, 3, 1, of penult 1, 3, 3, 2; middle lobe of claw of genital forceps much longest, pointed; inner lobe much reduced; basal spines 3–3; antennæ long, ... *xanti* (Wood). 3.
  b_2.—Spines of the first legs 2, 3, 2, of the penult 1, 3, 3, 1; middle lobe of claw of genital forceps not much longest, short and blunt, inner lobe subequal to outer, not reduced; basal spines 2–2, antennæ short, *permundus* sp. nov. 4.
a_2. —Posterior angles of 6th, 7th, 9th, 11th and 13th dorsal plates produced; prosternal teeth 7–7 to 9–9; spines of first legs 2, 3, 1–2, 3, 2, of anal 1, 3, 2, 1–1, 3, 3, 2, *multidentatus* Newport. 5.

1. Lithobius bipunctatus (Wood).

Bothropolys bipunctatus Wood (1863).
Lithobius bipunctatus Stuxberg (1877).

Habitat.—"West of Rocky Mountains" (Wood); Salt Lake, Utah, and Uintah counties, Utah (author).

2. Lithobius monticola Stuxberg.

Lithobius monticola Stuxberg (1875).

Habitat.—Sierra Nevada Mountains (*seq.* Stuxberg).

3. Lithobius xanti (Wood).

Bothropolys xanti Wood (1863).
Lithobius rugosus Meinert.
Lithobius xanti Stuxberg (1877).

Habitat.—California and Oregon (Wood, Bollman, author).

4. Lithobius permundus spec. nov.

Lithobius xanti Chamberlin, Proc. U. S. N. Museum, Vol. XXIV, p. 24 (1901).

Body robust, polished; head but little wider than long, sparsely punctate, especially anteriorly, sparsely pilose; dorsal scuta nearly glabrous except at margins, weakly furrowed, the furrows in part more or less converging anteriorly or parallel, not raised into rugæ; ferruginous, the head and the last dorsal and ventral plates usually darker, coloration of head deeper immediately caudad to the frontal suture. Antennæ rather short, pilose; articles 20–23, large, decreasing in size from first to last. Ocelli on each side in an oblong to narrowly oval patch, 16–25 in number, arranged in 3–5 longitudinal series. Prosternal teeth 7–7 to 9–9, black, uniform. Spines of first legs 2, 3, 2, of penult 1, 3, 3, 1 with 2 claws, of anal 1, 3, 2, 1 with the claw single; coxæ of the last two pairs of legs armed beneath and also laterally with a stout spine. Coxal pores usually of several sizes, numerous (often 25 and over), arranged in 2–4 series. Claw of genital forceps of female tripartite, the middle lobe a little longest, the lateral subequal, all short and blunt; basal spines 2–2, moderately stout, the outer pair longer and stouter than the inner.

Length 19–27 mm.; width 2–3 mm; length of anal legs 8–11 mm.; length of antennæ 8–11.5 mm.

Juvenis.—Specimens 13–15 mm. long measure 1.5 mm. in width; length of anal legs 4.5 mm.; length of antennæ 5 mm. Color brown. Ocelli 10–15 in 2–3 series. Prosternal teeth 5–5 to 7–7. Spines of the first and penult pairs of legs normal, those of the anal pair normal or 1, 3, 2, 0. Coxal pores 6–12 in 2–3 series.

Habitat.—Along the middle and lower courses of canyon streams throughout the greater extent of the Wahsatch Mountains, Utah.

Etymology.—Latin *permundus*, very elegant.

5. **Lithobius multidentatus** Newport.

Lithobius multidentatus Newport (1845); *id.* Gervais (1847).
Bothropolys nobilis Wood (1863).
Bothropolys multidentatus Wood (1865).
Lithobius multidentatus Stuxberg (1877).

Habitat.—Eastern United States, south from Missouri, Illinois Michigan and Pennsylvania (*seq.* Wood, Bollman *et al.*).

CONTRIBUTIONS TO A KNOWLEDGE OF THE HYMENOPTERA OF BRAZIL, NO. 8.—EUMENIDÆ, continued (GENUS ODYNERUS).

BY WILLIAM J. FOX.

As in most of the preceding papers of this series the work is based upon material collected by Mr. Herbert H. Smith, and which has now become the property of the Carnegie Museum, Pittsburgh, Pa. The types of all the new species described in these papers[1] will therefore be under the care of that Museum.

Odynerus (Stenancistrocerus) apicipennis n. sp.

♀.—Black, clothed with a grayish pile, especially on abdomen; anterior orbits below emargination, dot on tegulæ posteriorly, interrupted line on postscutellum anteriorly, line at apex and at sides of first dorsal segment, and sometimes an obscure line at apex of second, yellow; fore tibiæ internally yellow, the tips of all femora with a yellowish or reddish spot; antennæ reddish beneath toward apex; wings black basally, especially in costal region, clear apically; head with a fovea behind ocelli, and on each side of fovea a small patch of stiff hairs; front deeply punctured; clypeus broader than long, subpyriform, shallowly punctured, emarginate so as to present two acute, separated, teeth; scape fully as long as following four joints united; space between hind ocelli, if anything, slightly less than that between them and eyes; pronotum margined, obtuse laterally; dorsulum with strong, rather close punctures, the scutellum less closely punctured, flat, subquadrate; postscutellum subtriangular, entire; middle segment with strong, separated punctures, not so coarse as on dorsulum and becoming sparse apically and on sides, broadly depressed down middle, not ridged, presenting two convex surfaces; carina of first segment not very strong, the longitudinal furrow of upper surface rather feeble, the surface behind carina strongly punctured, anterior to it sparsely so; dorsals 2–5 strongly punctured, the punctures becoming closer and coarser from apex of segment 2, the last dorsal with shallow punctures;

---

[1] Except those described in Paper No. 6, which are in the Museu Paulista of São Paulo, Brazil.

ventral segments with separated punctures; nervures black, stigma ferruginous. Length 11 mm.

♂.—Sculpture coarser, especially at apex of second dorsal segment; in addition to the yellow markings of female the male has two yellow spots on clypeus apically, and there is a greater amount of red and yellow on legs; clypeal teeth larger, the emargination triangular; space between hind ocelli, if anything, slightly greater than that between them and eyes; antennæ hooked at end, the last joint acuminate, slightly curved, barely as long as joint 11; postscutellum crenulated; second, or second and third segments obscurely margined with yellow at apex, and the apex of middle segment marked with that color; in one example there are three lineated macula on pronotum, which may indicate that this part is sometimes margined with yellow posteriorly. Length 9–10 mm.

Chapada (March, December); Corumbá (April). Two ♀, three ♂ specimens.

Odynerus (Stenancistrocerus) convolutus n. sp.

♀.—Black, with a thin grayish pile; scape, flagellum beneath, mandibles, clypeus, eye-emarginations and the orbits below them, spot between antennæ, larger one at summit of cheeks, pronotum, tegulæ, mesopleuræ above, and a large spot on the postero-lateral angles of middle segment, rufous; hind margin of pronotum, base and apex of tegulæ, a dot beneath the latter, dot near each antero-lateral angle of scutellum, postscutellum entirely, and the apex of first and second abdominal segments rather broadly pale yellow; forelegs reddish-brown from just beyond base of femora; other legs black, with a spot near apex of medial femora, and a stripe on the four hind tibiæ, pale yellow; wings dark subhyaline, fuscous along costal margin and in marginal cell; nervures and stigma black. Head with deep, separated punctures, especially above; a rounded fovea behind ocelli; hind ocelli bordered internally by a smooth tubercle, the space between them perhaps a little less than that separating them from the eyes; clypeus convex, with shallow punctures, pyriform, triangularly emarginate at apex; pronotum with deep, separated punctures, scarcely margined, but dentate laterally; dorsulum and scutellum with larger punctures, those on mesopleuræ smaller; postscutellum entire, somewhat angular posteriorly; middle segment deeply punctured, smooth at base of sides, broadly depressed medially, the depression extending from base to apex, not margined, no horizontal surface medially, the postero-lateral region convex; first dorsal segment deeply punctured on its horizontal surface, which is rather long, the carina, when viewed from the front, highly arched; second dorsal less strongly and closely punctured, shallowly so beneath, the apical margin slightly reflexed, the ventral surface is slightly swollen transversely, but not much, near base; the third and fourth segments are punctured on apical half only, and much more finely; apical segment smooth. Length 8–9 mm.

♂.—Differs chiefly in the pale yellow clypeus, mandibles, spot between antennæ and eye-emargination; the reddish base of flagellum and much more swollen base of second ventral segment; hind tibiæ suddenly enlarged within at apex; first hind tarsal joint having a twisted and sinuous shape; antennæ hooked, the terminal joint curved, about as long as the eleventh joint, which in turn is about one-fifth longer than the tenth; clypeus narrower; four hind legs partly brownish. Length 8–9 mm.

Corumbá (April). Two ♀, seven ♂ specimens. Apparently related to *O. Fariasi* and *O. incommodus.*

Odynerus (**Stenancistrocerus**) **suffusus** n. sp.

♂.—Black; clypeus, spot on mandibles, scape in front, line between antennæ, and eye-emargination pale yellow; spot on cheeks above, hind margin of pronotum, dot behind tegulæ, and apical margin of segments 1–6, bright yellow; that on segments 2–6 quite broad, in fact segments 3–6 appear entirely yellow above; apical segment brownish; pronotum anteriorly, spot beneath wing, postscutellum and on middle segment postero-laterally, rufous and yellow; tegulæ brown; sides of abdominal segments 1 and 2 more or less suffused with rufous; legs reddish, anterior coxæ and most of hind femora black, the remaining coxæ yellow anteriorly, as well as a stripe on the fore and medial femora and a spot on hind pair at apex; flagellum reddish beneath; head with strong deep punctures; front presenting two convex surfaces; each hind ocelli margined internally by a tubercle; no fovea behind them; clypeus lozenge-shaped, longer than broad, roundly emarginate; antennæ hooked, the terminal joint flattened and strongly curved, barely as long as the eleventh joint, which in turn is fully one-third longer than the tenth joint; thorax deeply punctured, most closely so on pronotum, sparsely so on mesopleuræ; pronotum subdentate; post-scutellum slightly crenulated; middle segment broadly depressed or subconcave, not margined, with but a slight trace of a horizontal surface medially, postero-lateral region convex, especially above; hind tibiæ and tarsi as in ♂ of *convolutus;* abdomen much as in *convolutus,* but the second segment more reflexed at apex, the ventral swelling less strong and the punctuation stronger; wings as in that species. Length 8–9 mm.

Corumbá and Pedra Branca (April). Eight specimens.

Odynerus (Stenancistrocerus) areatus n. sp.

♂.—Black; clypeus at base and two parallel lines apically, scape beneath, spot at base of antennæ, in eye-emargination, and at top of cheeks, line on mandibles and on pronotum posteriorly, sometimes a spot on mesopleuræ above, and a line at apical margin of all segments, including last, yellow; flagellum beneath fulvous; tegulæ variable, black or yellow testaceous; legs black-brown, knees and tarsi lighter, anterior tibiæ yellowish in front; head very deeply punctured, especially the front; hind ocelli not margined internally by a tubercle, the space between them about equal to that which separates them from the eyes; clypeus with shallow punctures, subpyriform, almost as broad as long, sharply and triangularly emarginate, the teeth acute and each bearing a tolerably distinct carina extending back toward middle of clypeus; antennæ hooked, the last joint curved, rather slender, about as long as joint 11, which in turn is about one-fifth longer than 10; thorax deeply punctured; pronotum dentate laterally; scutellum impressed; post-scutellum entire, triangular; middle segment broadly concave, no horizontal surface medially, the postero-lateral angles prominent, above and on sides rugosely punctured, in the concavity deeply punctured; hind tibiæ and tarsi not modified; first segment strongly punctured, and behind the carina, laterally, there is a large, smooth, depressed area; second segment not so strongly or as closely punctured above, not reflexed, the ventral surface with shallow punctures, prominent in a transverse way, near base; remaining segments strongly punctured apically, finely so toward base; wings dark subhyaline, more fuscous along anterior margin; nervures and stigma dark brown. Length 9 mm.

Chapada (March, December). Two specimens.

Odynerus abdominalis n. sp.

♀.—Black; a narrow, medially interrupted line at base of clypeus, spot at base of antennæ and another at summit of cheeks, line on scape, anterior and posterior margins of pronotum narrowly, dot behind tegulæ, line on postscutellum, line on middle segment postero-laterally (sometimes absent), and apex of all abdominal segments, yellow; legs dark brown, anterior tibiæ yellow in front; head deeply punctured; a distinct medial fovea behind ocelli; clypeus longitudinally rugoso-punctate, a little longer than broad, subpyriform, subtruncate, a lateral carina terminates in a minute tooth; flagellum short; thorax deeply punctured, mesopleuræ less strongly; scutellum not impressed; postscutellum entire; middle segment broadly concave, coarsely punctured above, finely rugose in the concavity, postero-lateral angles prominent, a very slight horizontal surface medially; first segment behind the fine sharp carina broader than long, with tolerably strong punctures becoming sparse anteriorly; second segment strongly punctured apically, the punctures becoming sparser and feebler toward base, between middle and apex there is a distinct transverse depression and the apical margin is distinctly produced medially into a tooth; ventral surface depressed medially, transversely swollen near base, the punctures similar to those of the dorsal moiety laterally; wing subfuscous, paler apically, darkest along anterior margin; nervures black, stigma dark brown. Length 9–10 mm.

Chapada (March, December). Three specimens.

Odynerus (Stenancistrocerus) dentiformis n. sp.

♀.—Black, with silky pile, especially on the abdomen; arcuate line on base of clypeus, spot at base of antennæ, in the eye-emargination, base of mandibles, and at summit of cheeks, scape anteriorly, anterior and posterior margins of pronotum, postscutellum except apex, spot beneath tegulæ and a small one behind them, two semicircular spots on posterior surface of middle segment the two so placed as to almost form a circle, a spot before apex of middle and anterior femora, a line on all tibiæ, apical margin of abdominal segments 1–5, rather broadly, and last dorsal segment entirely, bright yellow; tegulæ reddish-brown, margined with yellow; flagellum not pale beneath; legs dark brown; head with deep, separated punctures; a smooth fovea behind ocelli, the hind pair of the latter each bordered internally by a tubercle; clypeus subpyriform, coarsely punctured, toward apex becoming striato-punctate, the apex with two well-separated teeth, subemarginate; pronotum sharply margined, subdentate, and like the dorsulum, though more closely, with deep separated punctures; postscutellum entire; middle segment broadly depressed or concave, strongly punctured, rugoso-punctate in concavity, which is not margined, no horizontal surface medially; first dorsal segment behind carina broader than long, with strong punctures, the carina sharpest laterally; second dorsal segment, viewed from the side, rather angulate toward base, where it is scarcely punctured, the punctures beginning behind base and increase in size toward apex, where they are quite coarse, at a point between middle and apex the segment is transversely depressed, the apical margin is dentiform medially, ventrally this segment is depressed medially, prominent basally, the punctures rather shallow; remaining segments except last strongly punctured apically, less coarsely toward base; wings subhyaline, yellow in costal cell, and with apical margin and most of marginal cell fuscous, stigma yellow-brown; nervures darker. Length about 9 mm.

♂.—Colored much like the ♀, with the flagellum more or less brown, fulvous beneath; clypeus yellow, but usually more or less dark medially, shorter than in ♀ and not striated; antennæ with terminal joint short and thick, broadly and obliquely truncate, the length of this joint about equals that of the penultimate, the two together barely as long as the eleventh joint; punctuation coarser than in ♀; hind tibiæ or tarsi not unusually modified. Length 8–9 mm.

Corumbá (April); Chapada (December). Seven ♀, nine ♂ specimens.

Odynerus (Ancistrocerus) fulvimaculus n. sp.

♀.—Black; head (except ∩-shaped spot including ocelli) and pronotum orange; antennæ orange, the flagellum above darker medially; clypeus, mandibles except inner margin and tips, tegulæ except brown middle, large spot on mesopleuræ above scutellum, postscutellum, postero-lateral angles of middle segment, and a fascia at apex of segments 1–5, yellow, that on segments 1 and 2 much the broadest; legs: the anteriors entirely, the medials except upper surface of coxæ, trochanters and base of femora, and of the hind pair a spot on coxæ at apex, a line on the femora beneath and the tibiæ except internally, yellow; hind tarsi brownish. Head less strongly and more closely punctured than in *rufimaculus*, the punctures rounder; occiput not so much depressed; vertical brush present, but no tubercles near ocelli; eye-emargination narrower and less triangular; clypeus similar in shape, but shallowly punctured, the apical emargination larger and more triangular; thorax practically as described in *rufimaculus*, perhaps less coarsely sculptured and the concavity of middle segment less distinctly margined laterally; abdomen very similar, as are also the wings. Length 7½ mm.

Chapada (April). Two specimens. Bears a strong resemblance to *rufimaculus*, but is at once separated by the orange, not red, color of head and pronotum. It is closely related to that species, but the absence of ocellar tubercles, more deeply emarginate and less strongly sculptured clypeus, as well as coloration, readily separate it.

Odynerus (Ancistrocerus) rufimaculus n. sp.

♀.—Black, head (except between ocelli) and pronotum rufous; antennæ rufous, the flagellum dark above medially; clypeus except medially, mandibles except tips, posterior margin and antero-lateral angles of pronotum, tegulæ except the brown middle, spot on mesopleuræ above, scutellum, postscutellum, postero-lateral angles of middle segment, apical margin of first dorsal, and apical margins of second, yellow; legs black, or black-brown, the anterior tibiæ in greater part and a stripe on the other tibiæ, yellow. Head strongly punctured; occiput transversely depressed; ocelli sunken, the hind pair margined internally by a smooth tubercle, and behind them a bunch of erect pale brownish hairs; clypeus cordate, longitudinally rugoso-punctate, but not coarsely so, the apex with two small approximate teeth, or, in other words, finely emarginate; eye-emargination quite triangular; thorax deeply punctured, especially the dorsulum; pronotum sharply margined, acutely angular or subdentate laterally; postscutellum distinctly crenulated, truncate, with a distinct vertical surface coalescing with the concave surface of middle segment, which surface is smooth, carinate down middle and bordered outwardly by a rough, tolerably distinct margin formed by its junction with the sides; the latter are strongly punctured except basally; abdomen robust; carina of first segment sharp, that portion of segment lying behind it much broader than long, the punctures distinct but not coarse, and sparser basally; second dorsal more distinctly and closely punctured, more coarsely apically, not reflexed, the ventral surface with larger, sparser punctures; other segments, as far as visible, distinctly punctured except the last; wings subhyaline, clouded apically, in the marginal cell, and less strongly in the costal; nervures and stigma black or dark brown. Length 7½ mm.

♂.—Colored like ♀, with the yellow of clypeus more extended; occiput less depressed, and no vertical brush; clypeus shorter with emargination deeper; eye-emargination not triangular; antennæ hooked, the last joint rather small, its length combined with that of the preceding one not equaling the eleventh joint; pronotum dentate; legs not unusually modified. Length 7 mm.

Corumbá and Pedra Branca in April. One ♀, three males.

Odynerus (Stenancistrocerus) atripes n. sp.

♀.—Black, with sericeous pile; sides of clypeus, spot between antennæ, in the eye-emargination, scape beneath, line behind eyes, posterior margin of pronotum, greater part of scutellum and postscutellum, dot beneath wings, a semicircular spot on each side of middle segment posteriorly, line at apex and sides of segment 1, and apical margin of segment 2, dull yellow; flagellum fulvous beneath; legs black, the fore tibiæ testaceous in front. Head with deep, rather close but not confluent, punctures; a rounded fovea behind ocelli; the latter not margined by tubercles; clypeus convex, low pyriform, broader than long, with shallow separated punctures, its fore margin with two rather widely separated teeth; thorax with strong, close punctures, those on mesopleuræ finer and sparser, and those of antero-lateral porton of middle segment large and sparse, giving that portion of the segment a spongy appearance; scutellum impressed; postscutellum subtriangular; middle segment at base with a short medial surface, but it is very slight and depressed below the postscutellum; concavity almost smooth, bounded by a tolerably strong carina; first segment with shallow punctures, with the carina sharp and sinuous, the dorsal surface twice as broad as long, and with a faint, though distinct, longitudinal furrow medially; second segment with similar sparser punctures, not reflexed, ventral surface with stronger punctures, transversely prominent near base; dorsals 3–5, closely and strongly punctured; wings subhyaline, a fuscous cloud in marginal cell, nervures and stigma dark brown. Length 10–11 mm.

♂.—Colored like ♀, but with clypeus entirely, mandibles except tips, and the fore margin of pronotum more or less, yellow; clypeus hexagonal the apical teeth closer and sharper; no fovea behind ocelli; flagellum elongate, together with the two preceding joints longer than head and thorax, subclavate, hooked at tip, the last two joints united barely longer than joint 11; longitudinal furrow of segment fainter or absent; general punctuation coarser than in ♀. Length 8–10 mm.

Chapada (January, May, October); Corumbá (April). Eleven ♀, twenty-seven ♂ specimens. In the longitudinally sulcate first segment this insect approaches *Symmorphus*, but the hooked antennæ of the male excludes it from that section of the genus.

Odynerus (Ancistrocerus?) conjunctus n. sp.

♀.—Black, with sericeous pile, that on sides of face somewhat silvery; clypeus except medial spot, mandibles near base, scape beneath, dot at base of antennæ, short line in eye-emargination, line on cheeks near vertex, pronotum anteriorly in middle and its hind margin, scutellum, postscutellum, tegulæ at base and apex, spot directly under them, a somewhat semicircular mark on each side of posterior face of middle segment, and a fascia at apex of segments 1–5, yellow; the fascia of segment 1 broadest and extends on the sides as far as the carina; flagellum beneath fulvous; sometimes the pronotum has on each side two obliquely parallel lines of rufous, one bordering the posterior margin; legs dark, the four anterior femora beneath toward apex, and all the tibiæ beneath more or less yellow, tarsi dark testaceous. Head with deep separated punctures, a rather transverse fovea behind ocelli; the latter not margined by tubercles; clypeus subconvex, depressed apically, somewhat triangular, broader than long, with rather distinct, separated punctures, the fore margin with two rather sharp and widely separated, diverging teeth; thorax with strong, separated punctures, those on scutellum and sides of pronotum less close; those on mesopleuræ smallest; middle segment above rugoso-punctate, on sides with sparse shallow punctures; scutellum entire; postscutellum with a slight emargination anteriorly in middle; middle segment with scarcely a medial upper surface, the posterior face broadly depressed, margined by a ridge, which reaches its greatest development apically; first abdominal segment closely punctured, the carina sharp and when viewed from the front shows a sharp angle above, dorsal surface not impressed, at apex twice as broad as long, but its sides narrow quite rapidly toward the carina; second dorsal more distinctly punctured, but not strongly, subconvex beneath; wings subhyaline, a fuscous cloud in marginal cell, nervures and stigma dark brown. Length 9 mm.

♂.—Colored like ♀, but with clypeus entirely, and mandibles except tip, yellow, as are also most of fore tibiæ and all tarsi; the yellow spot at base of antennæ is elongate, extending down between them; sculptured like the ♀, except that the punctures of the abdomen are stronger; flagellum beneath and tips fulvous, elongate, subclavate together with the two preceding joints, shorter than the head and thorax, the first joint a little, though distinctly, longer than second, hooked at tip, the last two joints minute, the two together considerably shorter than the preceding joint, the apical joint the longer of the two; clypeus small, hexagonal, the apical margin roundly emarginate. Length 7–9 mm.

Chapada (April, September, October, December); Corumbá (April). Three females, numerous males.

This species combines the characteristics of *Ancistrocerus* (upper face of first segment transverse) with those of *Hypancistrocerus* (cavity of middle segment bounded by a sharp ridge).

Odynerus (Hypancistrocerus) advena Sauss.

Corumbá (February, April, May); Chapada (April). Out of the large series present, but one specimen is marked as having come from Chapada. The differences of climate at these two districts and the greater elevation of Chapada[2] may have influenced the distribution of this species, as indicated by the present collection.

Odynerus (Hypancistrocerus) reflexus n. sp.

♀.—Black; with sericeous, grayish pile, especially on abdominal segments 1 and 2; clypeus basally, spot between insertion of antennæ, in each eye-emargination, scape beneath, line on each side of pronotum anteriorly, spot on cheeks near top, on tegulæ at base and apex, with a small one behind them, one on mesopleuræ, line on postscutellum, postero-lateral angles of middle segment, four anterior femora beneath apically, a line on all tibiæ, and apical margin of abdominal segments 1–5, yellow, that on second segment broadest; posterior margin of pronotum, and flagellum beneath,

---

[2] See these *Proceedings*, 1896, pp. 293, 294.

reddish-testaceous; four hind tarsi black. Head with deep, separated, punctures; front strongly convex; clypeus convex basally, flattened apically, elongate pyriform, with large, sparse punctures, and apically with a carina on each side terminating in a small tooth on apical margin, which is triangularly emarginate; a smooth fovea or area behind ocelli, the latter not margined by tubercles; thorax with deep, separated punctures especially on dorsulum and scutellum, the latter impressed apically; pronotum sharply cristate, obtusely dentate laterally; punctures of mesopleuræ not so coarse, and more scattered; middle segment with a distinct medial surface above, which is rugose, sides punctured like the mesopleuræ, concavity bounded by a ridge, broad, with large shallow punctures, the postero-lateral angles prominent, obtusely dentiform; abdomen with large separated punctures, not so coarse however as those of thorax; first segment smooth anteriorly, the carina rather sharp, angular medially when viewed from front, the segment behind it broader than long; second dorsal with its apical margin reflexed; wings subhyaline, darker in marginal cell. Length 9 mm.

♂.—Clypeus entirely yellow, somewhat hexagonal, with two sharp rather approximate teeth apically; hind ocelli margined with a tubercle internally; antennæ longer than head and thorax, flagellum fulvous beneath, the eleventh joint concave beneath apically and broad, twelfth joint small, much more so than the eleventh, the following joint narrow basally, widened at apex, and rather flat, terminal joint small, obtuse at tip, not half the length of preceding one; scutellum impressed its entire length; hind tibiæ slender, but widened suddenly at apex; second ventral segment transversely depressed at base. Length 7–9 mm.

Chapada (December, January, May); Corumbá (April).

The ♂ antennæ in this species are in reality 14-jointed, which is also the case in *O. advena*. This character seems to be the best for defining the division *Hypancistrocerus*, the horizontally produced superior face of middle segment being of less value, inasmuch as it is found in all degrees of development in various species. Some species with 13-jointed ♂ antennæ possess it.

Odynerus coxalis n. sp.

♀.—Black; thorax and abdomen with sericeous grayish pile; two spots on clypeus basally, one between insertion of antennæ, in each eye-emargination, on mandibles near base, line on scape beneath, a medially interrupted line on pronotum anteriorly, line on fore margin of postscutellum, spot on four anterior femora at apex, line on all tibiæ, and at apex of segments 1–5 rather broadly, yellow; flagellum beneath, hind margin of pronotum narrowly, and tegulæ (except a yellow basal spot), reddish-testaceous; tarsi dark. Head deeply but rather closely punctured, the hind ocelli margined by a tubercle internally and behind them a depressed smooth area; front not strongly convex, not impressed; clypeus elongate pyriform,. with large, sparse, shallow punctures, with a carina on each side toward apex, which projects in the form of teeth, one at each side of the fore margin; thorax punctured very similarly to front, but on the mesopleuræ the punctures are much sparser and not so deep; fore margin of pronotum sharply crested except medially; scutellum impressed down middle; middle segment with a distinct dorsal surface medially, rugoso-punctate above, on sides with large, sparse, punctures, the concave area with large, shallow punctures, bordered by a rough but not strongly indicated ridge, at the sides subangular; carina of first abdominal segment well-developed, sharply angular above, the dorsal surface of the segment not more than half as long as it is broad on apical margin, its punctures strong and separated but not as coarse as on front; the second segment with the punctures shallower, sparse at base, the apical margin slightly reflexed, ventral surface with stronger punctures, at base transversely depressed, the medial surface rather flat; wings subhyaline, clouded in costal and marginal cells, nervures black. Length 9 mm.

♂.—Colored like ♀, but with clypeus entirely yellow, the yellow of eye-emargination forming a line bordering the orbit, that on pronotum and legs more extended; punctuation coarser; clypeus shorter, though rather similarly shaped as in the female, with shallow punctures throughout; flagellum with joints 1–8 pale fulvous but the apices with a narrow black line, rather robust and clavate as far as the eighth joint, terminal joint long, equaling the two preceding ones united in length, somewhat curved; the total length of the antennæ is barely as long as head and thorax; legs not unusual except that the hind coxæ are strongly dentate above near base; second segment scarcely reflexed. Length 8 mm.

Chapada (September); Corumbá (February). Two ♀ and one ♂ specimens.

Odynerus Herbertii n. sp.

♀.—Black; rather densely sericeous with pile; dot at base of antennæ, and in eye-emargination, on mandibles at base, line on scape beneath, spot at summit of cheeks, spot or short line at lateral angles of pronotum, posterior margin of pronotum obscurely, line on postscutellum, line bordering the concavity of middle segment, extreme tips of femora, line on tibiæ, and apical margin of all abdominal segments including the last, lemon-yellow; the abdominal fasciæ broad, especially on second dorsal segment. Head with deep, separated punctures, the front convex, slightly impressed medially; hind ocelli pitted; a smooth depressed area behind them; clypeus pyriform, ferruginous at tip, with sparse shallow punctures running into coarse striæ apically, the apex triangularly emarginate, or with two acute teeth from each of which a short carina runs toward the middle of clypeus; thorax with the punctures larger and more separated, especially on mesopleuræ; pronotum with a slight crista toward sides, which is continued into a rather acute tooth on the antero-lateral angles, the medial length of the pronotum comparatively long; scutellum not impressed; middle segment rugoso-punctate above, with shallow sparse punctures on sides, a fairly developed medial upper surface, which however is emarginate, the concave surface strongly punctured, angulate laterally, the bordering ridge not well developed; first abdominal segment with the punctures strong, but much finer and closer than on any part of thorax, the carina margined by foveæ behind, and behind these foveæ is a transverse smooth area which is widest laterally, and is separated medially by some coarse punctures; the medial length of that portion of this segment behind the carina almost equals half its width; second segment impunctate basally, with shallow punctures, finer than on preceding segment, and which become stronger until on apical margin they are quite coarse; the latter not reflexed, but medially is angularly produced; remaining segments punctured on apical portion only, except second ventral, which has separated shallow punctures throughout; wings yellow basally and in the costal cell, the neuration brownish, more yellow toward base; apical portion of wing subhyaline, the margin narrowly, and a cloud in marginal cell, fuscous. Length 9 mm.

♂.—Coloration similar to that of female, except in the following points: clypeus entirely pale yellow; tegulæ brown with a yellow basal spot; the abdominal fasciæ heavier. The clypeus is longer, more lozenge-shaped, not carinated, and the punctures very shallow, in fact quite indistinct; front not impressed; hind ocelli margined internally by a tubercle; flagellum dull rufous beneath, the tenth joint minute, the eleventh elongate, acute, the combined length of the two not more than equaling that of the ninth joint; the length of the antennæ is not quite as long as the head and thorax united; medial length of pronotum not as great as in female; sculpture throughout somewhat coarser; the angulation of second dorsal more pronounced, almost dentiform. Length 8–9 mm.

Chapada (September, December, January); Corumbá (April). One female, eleven male specimens.

Odynerus cordatus n. sp.

♀.—Black; sides of clypeus, spot at base of antennæ, in each eye-emargination, at base of mandibles, scape beneath, short line on cheeks near summit, rather broad line on pronotum anteriorly and on scutellum posteriorly, spot on mesopleuræ, tips of four anterior femora broadly, most of fore tibiæ and a line on medial ones, the hind pair obscurely lined, and apical margin of segments 1–5 narrowly, yellow; flagellum beneath and tegulæ fulvous brown, the latter spotted basally with yellow. Head with large separated punctures; front slightly impressed; no smooth area behind ocelli; clypeus cordate, strongly punctured, not carinate, triangularly emarginate at apex; flagellum clavate, rather short; punctures of thorax scarcely as deep and a little more separated than on front, those on mesopleuræ much more separated; fore margin of pronotum cristate its entire length, subdentate at sides; medial length of pronotum not well developed; upper surface of middle segment very well developed medially, not emarginate, coarsely rugose, in length almost equaling the scutellum; concavity of middle segment apparently not sculptured, the surrounding ridge rather even, and not so broken as in many species of the genus; first abdominal segment closely though distinctly punctured on dorsal surface, which in length is not equal to half its breadth, the carina distinct though comparatively slender, and behind it there is a series of foveæ; second segment even more closely punctured, but more sparingly toward apical margin, which is not reflexed; ventral segments with large, sparser punctures, the second at base with a series of very large foveæ; wings subhyaline, with a fuscous cloud in marginal cell extending on to the apical margin, nervures and stigma dark brown. Length 7½ mm.

One specimen, without precise locality label. The black of clypeus, in shape, resembles an inverted decanter.

Odynerus dorsonotatus n. sp.

♀.—Black; with sericeous gray pile especially on abdomen; scape beneath, dot at base of antennæ, in eye-emargination, short line on cheeks near summit, posterior margin of pronotum and anteriorly in the middle (sometimes the lateral angles), large spot on dorsulum at apex, smaller ones beneath and behind tegulæ, postscutellum except apex, the margins of the concavity of middle segment, a stripe on all tibiæ, and apical margin of segments 1–5 (that on 1 and 2 broadest), yellow; in one specimen the entire concavity of middle segment is yellow; tegulæ dark brown or black. Head with deep, separated punctures, especially on front, which is convex and very slightly impressed; ocelli rather deeply pitted, the hind pair margined internally by a tubercle, and behind them is a smooth, depressed area; clypeus pyriform, wholly black, apparently impunctate at base and sides, coarsely striato-punctate apically, bearing a rather long carina on each side which terminates apically in a large acute tooth, making the clypeus strongly bidentate, the teeth well separated; flagellum clavate; punctures of the thorax not so close as on front, though probably as strong, those on mesopleuræ sparsest; pronotum not crested, but sharply dentate laterally, its medial length insignificant; scutellum distinctly furrowed down middle; upper surface of middle segment distinctly developed medially, not emarginate, rugoso-punctate; concavity broad with shallow punctures, the bordering ridge not well marked, sides of middle segment with large, sparse punctures; carina of first dorsal segment distinct, though not very sharp, and is somewhat irregular, margined posteriorly by foveæ, and then followed by a large, smooth, triangular area on each side, the remainder of segment with deep, separated punctures, its medial length greater than half its apical width; second dorsal almost impunctate basally, most strongly and closely punctured apically, the posterior margin not reflexed; second ventral segment with larger, shallow, sparser punctures; wings dark subhyaline, with a fuscous cloud in the marginal cell, nervures and stigma dark. Length 8 mm.

Chapada (December). Four specimens. The immaculate clypeus and mandibles and the spot on dorsulum are apparently constant in this species and are good superficial characteristics. The other spots, however, vary to some extent, and in one specimen there are traces of yellow on scutellum.

Odynerus longicornis n. sp.

♂.—Black; clypeus (except a median spot and the sides and apical margin narrowly), dot at insertion of antennæ, in the eye-emargination, near summit of cheeks, line on mandibles basally and on scape beneath, hind margin of pronotum, postscutellum except apex, elongate spot on median femora beneath at apex, dot on tegulæ at base, and a small one behind them, and a line at apex of abdominal segments 1–6, yellow; the lines on first two segments broadest; joints 2–10 of antennæ fulvous beneath; tegulæ, tibiæ and tarsi brownish. Head with deep punctures, well separated especially on the front, the latter rather flat, scarcely impressed; hind ocelli margined internally by a tubercle, scarcely pitted; clypeus pyriform, with shallow, sparse punctures, with a sharp carina on each side terminating in a sharp tooth apically (the apex has a deep triangular emargination); antennæ long and slender, longer than head and thorax; terminal joint curved, in length about equaling the preceding two united, the penultimate one small; pronotum not crested, but with a distinct blunt tooth laterally, its punctures as well as those of dorsulum deep and separated, and its median length not well developed; scutellum with fewer and shallower punctures, not impressed, the mesopleuræ even more so; middle segment not well developed above medially, rather emarginate, rugoso-punctate above, the punctures becoming shallower and sparser on sides near metapleuræ; concavity irregularly margined by a ridge, rugoso-punctate, but not so coarsely as the upper surface; carina of first segment bordered posteriorly by a series of foveæ, and then, on each side of the segment, by a smooth area; remainder of dorsal surface with deep separated punctures, its median length from the carina to apex about half as long as broad apically; second dorsal segment with the punctures separated, but much shallower except at sides, smooth at base however, where it is depressed, so that when viewed from the side the segment seems obtusely angulated between base and middle, apical margin not reflexed; punctures of remaining segments, except on second ventral, confined to apical portion; wings subhyaline, darker along costa and in marginal cell, nervures and stigma brownish. Length 9 mm.

Corumbá (April). One specimen.

Odynerus striatus n. sp.

♀.—Black; a curved medially interrupted line on clypeus at base, spot on mandibles near base, at insertion of antennæ, dot in eye-emargination, scape beneath, spot on cheeks near summit, on lateral angles of pronotum, posterior margin of the latter obscurely, dot behind tegulæ, line on postscutellum, the borders of the concavity of middle segment, and a line at apical margin of segments 1–5, yellow; flagellum entirely dark, the pedicel testaceous beneath; tegulæ brownish; legs dark, somewhat brownish, the tarsi and fore tibiæ lighter. Head deeply punctured; front strongly convex, the cheeks more so than in allied species; hind ocelli pitted, the head behind them with a small rounded depression or pit; clypeus pyriform, striated longitudinally, most coarsely apically, where, on each side, is a carina which terminates in a blunt though well-developed tooth at apex (the apex of clypeus between the teeth is depressed or excavated); flagellum clavate; thorax with the punctures larger than on the head, sparsest on mesopleuræ; pronotum with a well-developed crista toward sides which are dentate; scutellum not impressed; middle segment with a fairly well-developed medial surface above, where it is coarsely rugoso-punctate, the sides with coarse punctures becoming shallower and sparser toward metapleuræ, concavity with shallow punctures, bordered with a rather sharp ridge; carina of first abdominal segment bordered posteriorly by a series of foveæ, which are in turn followed by a transverse smooth area on each side, the remainder of the segment with fairly strong punctures much less strong than on any part of thorax, however; the length of the first segment from the carina back is greater than half its width at apex; segment 2 above similarly punctured, but more coarsely at apex, which is slightly produced in the middle, giving it an angular appearance, ventrally the segment is more sparsely punctured; wings subhyaline, quite dark along costal margin, and in marginal cell; nervures and stigma black. Length 9 mm.

♂.—Colored much like the ♀, but differing as follows: clypeus entirely, and a median spot on pronotum, yellow; fore tibiæ testaceous brown; flagellum beneath brownish. Clypeus shorter, more rounded, convex, triangularly emarginate; hind ocelli margined by a tubercle internally; flagellum elongate, subclavate, the apical joint about as long as the preceding two united, the penultimate minute; length of first dorsal segment from carina to apex not greater than half its width; apical margin of second dorsal slightly reflexed. Length 7–8 mm.

Chapada (September, December, January, March). Three ♀, four ♂ specimens. The striated clypeus, brown unspotted tegulæ and dark legs are apparently constant characteristics of this species.

Odynerus inusitatus n. sp.

♂.—Black; line between insertion of antennæ, line in eye-emargination bordering the orbit, scape beneath, clypeus (except a black medial spot), mandibles except apex and outer margin, short line on cheeks near summit, spot at lateral angles and at each side of middle of pronotum (none of these spots touching the fore margin), spot under tegulæ and a smaller one behind them, and on them at base, postscutellum except apex, spot on postero-lateral angles of middle segment, a line at apex of segments 1–6, four anterior femora more or less at apex, and all the tibiæ more or less, yellow. Head with deep, more evenly separated punctures; front subconvex, slightly impressed; hind ocelli margined by tubercles internally, a deep furrow extending from between the tubercles back toward the occiput; clypeus rather pyriform, convex, with unusually deep, separated punctures, apex with two well-separated, acute teeth, each of which is preceded by a fairly distinct carina; antennæ shorter than head and thorax united, the pedicel and flagellum fulvous beneath, terminal joint a little longer than the two preceding united; thorax with punctures larger and more separated than on head, those on mesopleuræ quite sparse; pronotum cristate its entire width, the lateral angles strongly dentate; scutellum and postscutellum deeply impressed down middle; middle segment with a well-developed medial surface above where it is rugoso-punctate, sides with strong punctures becoming obsolete basally, concavity with bordering ridge not well developed; carina of first segment not sharp, though strong, bordered posteriorly by a series of small foveæ, but the segment has no smooth areas as in allied species, and is marked dorsally by strong, separated punctures, its length from the carina to apex is barely equal to half its width at apex; second segment almost smooth at base, the punctures becoming stronger toward apex where they are quite deep, the apical margin not reflexed, but is depressed; third dorsal more closely punctured; first joint of medial tarsi somewhat sinuous; wings subhyaline, darker along costa and in marginal cell. Length 8 mm.

Chapada (December). Two specimens. The yellow spots on, behind, and beneath the tegulæ are wanting in one example. The carinated, deeply punctured clypeus, sulcus between ocelli, deeply impressed scutellum, together with the mesially dark clypeus and peculiar spotting of pronotum, easily distinguish this species.

Odynerus rufosuffusus n. sp.

♀.—Black; mandibles, pronotum, mesopleuræ above, and tegulæ, rufous; antennæ reddish-testaceous, darker above; clypeus, longitudinal line on front, spot at base of antennæ, a large one almost filling the eye-emarginations, line on cheeks above, fore margin of pronotum obscurely, line on scutellum, dot on tegulæ at base, and line at apex of segments 1–5, yellow (these latter lines sometimes obscure or wanting on segments 3–5); fore legs entirely, the others from the base (or beyond) of femora, reddish-testaceous. Head with the vertex elevated so that when viewed from the side it appears subangulate above; punctures of the front large, well-separated, though not very deep, those on the occiput much closer and coarser, especially medially; two large tubercles are situated between the hind ocelli; in the eye-emarginations the surface seems smooth and except for a series of foveæ bordering the orbit of the eye there; clypeus broader than long, convex, apparently smooth, with an unusually deep and narrow emargination at apex; flagellum clavate; thorax with the punctures much coarser than on head, especially on dorsulum; pronotum cristate, sharply dentate laterally; scutellum deeply impressed; postscutellum large, fully half as long as scutellum, rugoso-punctate; middle segment with a well-developed dorsal surface mesially, where it is also emarginate, rugoso-punctate as far as sides where the punctures are large and shallow, almost forming a reticulation, concavity margined by a rim; first abdominal segment with fairly strong punctures, the usual carina sharp, bordered posteriorly by foveæ, and in about the middle of the segment there is another more obtuse carina or ridge, somewhat sinuous, and not entirely reaching the sides; second segment with finer punctures which become stronger toward the apical margin, which is not reflexed; wings fusco-hyaline, darkest anteriorly. Length 6 mm.

Var. a.—Head, except the usual yellow marks, and a black spot including ocelli, rufous; only segments 1 and 2 yellow at apex.

Var. b.—Rufous color absent on the parts indicated in the description except the tegulæ; clypeus except base, and antennæ above, black; border of concavity of middle segment, and mandibles more or less, yellow.

Corumbá (April). Three specimens.

Odynerus relativus n. sp.

♀.—A closely allied species to *O. rufosuffusus;* in coloration it differs by the absence of rufous from the pronotum, etc., and the yellow marks are more extended; clypeus yellow basally, otherwise light rufous or black; frontal line united with spot at base of antennæ; a broad yellow line traversing the pronotum; mandibles in greater part, a variable spot under tegulæ, margin of concavity of middle segment, and segments 1–5 distinctly at apex, yellow; hind margin of pronotum yellow-testaceous; punctuation coarser perhaps than in *rufosuffusus* and on the thorax the punctures are larger, shallower and more separated; clypeus with a rather broad triangular emargination; orbit of the eye in the emargination not margined by foveæ; pronotum acutely dentate, the crista curving backward much more than in *rufosuffusus;* a single large tubercle between hind ocelli. Length 7 mm.

Corumbá (April). One example.

Odynerus præcox Sauss.

Eight females, and a large series of males. Chapada (April, September to November); Corumbá and Pedra Branca in April; Santarem. The banding of the dorsal segments beyond the second may be present or absent, and the flagellum beneath varies from entirely black to rufous. *Odynerus zonatus* Sauss. is probably a variety of *præcox.*

Odynerus nasidens Latr.

One specimen (♀). Chapada (September).

Odynerus brevithorax Sauss.

A female specimen from Chapada (April).

Odynerus (Odynerus) corumbæ n. sp.

♀.—Black; rather densely sericeous with pale brownish pile, the pubescence of front pale; scape and pedicellum beneath, and teeth of clypeus, reddish; narrow line, broadly interrupted medially, on fore and hind margins of pronotum, spot on mandibles basally, on tegulæ anteriorly, narrower line on postscutellum, a narrow line on each side of the vertical face of middle segment, small spot at tips of femora, line on fore tibiæ anteriorly, a broad fascia (brighter in color) on apical margins of segments 2–5, and the apical segment entirely, yellow. Head strongly punctured, most closely on front; clypeus about as long as broad, cordate, striato-punctate, medially with two widely separated tubercles, at apex bidentate, or triangularly emarginate; pronotum with strong, deep, punctures, sharply margined anteriorly, the lateral angles obtuse, not dentate; punctures of dorsulum and scutellum less strong, the latter subquadrate, large, convex; postscutellum entire; middle segment, with the dorso-lateral surfaces with very large, though rather shallow, punctures, the posterior depressed surface transversely striate, bordered above on each side by a sharp ridge which terminates in a small tooth on the lateral angles; the apical portions of the segments strongly punctured except the second ventral, which is punctured throughout; wings fusco-hyaline, brown in costal cell, nervures brownish. Length 13 mm.

Corumbá (April). One specimen.

Odynerus (Odynerus) chapadæ n. sp.

♀.—Black; with sericeous pale brownish pile, especially on abdomen, the pubescence of front black; mandibles reddish apically; spot on inner orbit near clypeus, on mandibles basally, the posterior margin of pronotum, line on postscutellum, and one on apical margin of segments 1–6, yellow; that on segment 1 narrowest; tegulæ black at base, with a brown medial spot, and margined externally with yellow; the tips of femora obscurely yellow. Head strongly punctured, more closely on front; clypeus about as long as broad, striato-punctate (except basally, where there are separated punctures), with two rather strong, widely separated, polished tubercles, the apex with two rather widely separated teeth, there being but a feeble emargination between them; thorax above with large separated punctures, those on dorsulum anteriorly closest; pronotum sharply margined anteriorly, not dentate; scutellum with a longitudinal medial raised line; postscutellum with a serrated crista; middle segment with the dorsal surfaces rugoso-punctate, sides with large shallow punctures, the concave surface more finely striate than in *corumbæ*, bordered above by a ridge terminating at the postero-lateral angles which are obtuse; abdomen rather distinctly punctured throughout, especially beneath, except the last dorsal which has microscopic punctures; wings yellowish-ferruginous basally as far as stigma, the veins of the same area similarly colored, those beyond including stigma brownish, marginal cell more or less fuscous. Length 13 mm.

Chapada (February, October). Two specimens.

Odynerus (Odynerus) sericeus n. sp.

♀.—Black; with dense sericeous pile, especially on abdomen; apex of clypeus, spot on inner orbits near clypeus, on mandibles basally, fore and hind margin of pronotum, line on postscutellum, irregular lines on middle segment bordering the concavity above at either side, tips of femora obscurely, line on fore tibiæ internally, and spot on tegulæ at base, yellow; abdomen entirely black; tarsi testaceous. Head strongly punctured, but less so than in *chapadæ*, the punctures of front rather close; clypeus about as broad as long, closely punctured, with two elongate, polished tubercles medially, strongly bidentate apically, roundly emarginate between teeth; the thorax is quite similar to *chapadæ*, but on the whole the punctuation is not so coarse, and the postscutellar crista is feebler; striæ of concavity of middle segment stronger; abdomen distinctly punctured throughout; wings subhyaline stained with fuscous along costa, nervures black. Length 12 mm.

Chapada (March). One specimen.

Odynerus (Stenodynerus) serratus n. sp.

♂.—Black; with sericeous yellow-brown pile; triangular spot on mandibles basally, two dots at base of antennæ, scape beneath, line on medial tibiæ, and a broad fascia at apex of segments 2–6, the seventh entirely, yellow; tegulæ with a testaceous spot. Form elongate; head strongly punctured, the punctures smaller and fewer on occiput; clypeus a little longer than broad, with large, shallow punctures, broadly emarginate, or, in other words, with two large widely separated teeth; thorax coarsely punctured; scutellum slightly impressed down middle; dorsal surface of middle segment longer than postscutellum, rugoso-punctate, armed posteriorly with a large, serrated crest, which is broken medially; posterior surface of middle segment smooth, polished, strongly concave; sides with large punctures, the postero-lateral angles furnished with a process; abdomen fusiform, the first segment transversely carinated or furrowed, but bearing a slight longitudinal furrow above, with strong, rather even punctures which are much less coarse than those of thorax; second dorsal segment with a medial prominence, the punctures quite coarse apically; remaining dorsals closely and coarsely punctured, especially apically; ventrals with large sparse punctures; wings flavo-hyaline, darker on apical half, nervures testaceous. Length 11 mm.

Corumbá (April). One specimen. The first segment bears above close to apical margin a tooth-like projection, which may be a malformation. Other specimens are needed to verify this.

Odynerus (Stenodynerus) griseus n. sp.

♀.—Black; abdomen and sides of middle segment thinly pale sericeous; short line on inner orbits near clypeus, line on mandibles basally, sometimes two spots on postscutellum, a line bordering posterior surface of middle segment, yellow; legs testaceous brown, fore tarsi lighter apically; tegulæ with a testaceous spot medially. Form elongate, head strongly punctured, those on front largest, becoming smaller toward occiput; clypeus with large shallow punctures, a little longer than broad, broadly emarginate at apex; thorax strongly punctured, those on dorsulum and scutellum well separated, those on mesopleuræ not confluent; dorsal surface of middle segment rugose, in length medially about equal to the postscutellum, with a medially emarginate crista, posterior surface concave, polished, apically with a few transverse striæ, postero-lateral angles strongly dentate; abdomen beyond first segment closely, though distinctly, punctured, the first with stronger, separated punctures, which become sparser anteriorly; second dorsal apically, and remaining segments strongly punctured; second dorsal medially with an elongate, polished tubercle; wings fuscous on basal two-thirds, remainder subhyaline, nervures black; stigma brown. Length 12 mm.

♂.—Form and coloration similar to female, the punctuation perhaps a little coarser; clypeus more angularly emarginate, the lateral angles therefore more acute; flagellum elongate, hooked at tip, the last joint slightly curved; seen from above the first joint of flagellum is scarcely one-third longer than the second. Length 12–13 mm.

Chapada (March); Corumbá (April). Two female and two male specimens.

Odynerus (Stenodynerus) subapicalis n. sp.

♀.—Brownish-black; scarcely pilose, the abdomen with short sparse pale hairs; sides of clypeus, dot between antennæ, scape beneath, spot on mandibles basally, and a line on fore tibiæ, yellow; mandibles medially, posterior margin of pronotum, tegulæ, tips of femora, and apical margin of segments 2–6, testaceous; wings black, especially in costal cell, apical third (except the narrow fuscous apex) whitish. Form elongate; punctuation coarser than in *O. griseus;* clypeus pyriform, distinctly longer than broad, angularly emarginate at apex; middle segment much as in *griseus,* the crista serrated, the striæ of apical portion of concavity oblique on each side, the postero-lateral angles obtusely dentate; abdomen practically as in *griseus.* Length 13–15 mm.

♂.—Colored as in the female, except that the clypeus is almost entirely yellow, the sculpture coarser; flagellum elongate, longer than in *griseus,* hooked at tip, apical joint curved, first joint (from above) fully one-third longer than second; clypeus smaller than in ♀, not much longer than broad. Length 14 mm.

Mararú and Chapada (April); Rio de Janeiro (November); Sântarem. Six female, one male specimens.

Synoptic Table of New Species described in this paper.

1\. First abdominal segment carinated transversely, . . . 2
First abdominal segment not carinated, ... 22
2\. First dorsal segment with a distinct longitudinal furrow; body deep black, with or without rather indistinct yellow markings; wings fuscous, apical half pale, . *apicipennis* ♀ ♂.
First dorsal segment not furrowed longitudinally, or faintly so, ... 3
3\. Middle segment without a ridge encircling the depression or concavity, not or scarcely produced at base behind postscutellum (without horizontal surface), ... 4
Middle segment with a more or less developed ridge encircling the concavity, ... 8
4\. Apical margin of second dorsal segment entire, ... 5
Apical margin of second dorsal segment sharply angulate or dentate medially, ... 7
5\. Only two abdominal fascia; pronotum rufous, *convolutus* ♀ ♂.
All the segments fasciate; pronotum not rufous, ... 6
6\. First segment behind carina longer than broad, no transverse smooth area behind carinæ, ... *suffusus* ♂.

First segment behind carina broader than long, a broad transverse smooth area behind carina; clypeus sharply emarginate, *areatus* ♂.

7. Abdomen with deep punctures; tegulæ reddish; a yellow spot under wing, the latter yellowish along costa, *dentiformis* ♀ ♂.

Abdomen with fine, much shallower punctures; tegulæ black; no spot under wing, the latter dark, . . . *abdominalis* ♀.

8. Middle segment without a horizontal surface, ... 9

Middle segment with a more or less developed horizontal surface, ... 10

9. Head and pronotum orange; all abdominal segments fasciate, *fulvimaculus* ♀.

Head and pronotum red; only two abdominal fascia, *rufimaculus* ♀ ♂.

10. Vertex not elevated, as usual, ... 11

Vertex strongly elevated, strongly tuberculate near the ocelli; first abdominal segment with an additional carina, . . 21

11. Horizontal surface of middle segment very short, almost wanting medially; form graceful, *Polybia*-like, ... 12

Horizontal surface well developed, ... 13

12. Segments 1 and 2 fasciate; second ventral segment transversely prominent before base, ... *atripes* ♀ ♂.

All the segments fasciate; second ventral segment not prominent basally, rather evenly convex, . . *conjunctus* ♀ ♂.

13. Second segment distinctly reflexed at apex, . *reflexus* ♀ ♂.

Second segment not or but slightly reflexed, ... 14

14. Wings yellowish, paler apically; segments broadly fasciate, *Herbertii* ♀ ♂.

Wings subhyaline, ... 15

15. First abdominal segment without a transverse, depressed area behind the carina on each side, ... 16

First abdominal segment with a transverse, depressed area behind the carina on each side, ... 17

16. Clypeus pyriform, bicarinate in ♀, these carinæ ending in two sharp teeth (not carinate in ♂, shorter and bidentate); abdomen shining, with strong separated punctures; scutellum not yellow, male coxæ dentate above basally, *coxalis* ♀ ♂.

Clypeus cordate, not carinate, with a not deep triangular emargination; abdomen subopaque, finely and closely punctured; scutellum with yellow line, ... *cordatus* ♀.

17. Females, ... 18

Males, ... 19

18. Clypeus convex, punctured, with a strong carina on each side ending apically in a tooth; dorsulum with a yellow spot before scutellum. . . . . *dorsonotatus* ♀.

Clypeus flat, longitudinally striated; dorsulum not spotted, *striatus* ♀.

19. Antennæ longer than head and thorax united, slender, *longicornis* ♂.

Antennæ shorter than head and thorax, the flagellum more or less clavate, ... 20

20. Clypeus black medially, deeply punctured, with a carina on each side, ending in a sharp tooth, . . . *inusitatus* ♂.

Clypeus entirely yellow, not carinate, the apical teeth blunt, *striatus* ♂.

21. Pronotum and legs in part (sometimes the head) reddish, *rufosuffusus* ♀.

Pronotum, legs and head black, maculated with paler, *relativus* ♀.

22. Form broad and short, the thorax subquadrate; middle segment without a horizontal surface medially, ... 23

Form elongate; thorax elongate (dorsulum longer than broad); middle segment with a well-developed horizontal surface bearing a serrated crista, ... 25

23. Abdomen with yellow fascia, ... 24

Abdomen immaculate, with dense sericeous gray pile (wings blackish along costa; pronotum with the fore and hind margin, and postscutellum broadly, pale yellow), *sericeus* ♀.

24. First segment of abdomen margined with yellow; wings yellow-ferruginous along costa, the costal and subcostal nervures of the same color; medial clypeal tubercles smooth and shining, ... *chapadæ* ♀.

First segment of abdomen not fasciate; wings fuscous along costa, brownish in costal cell, the costal and subcostal nervures dark; medial clypeal tubercles feeble, not shining, *corumbæ* ♀.

25. Abdominal segments 2 and following broadly fasciate with bright yellow; wings yellow-ferruginous, dusky apically; pilosity of head and thorax pertaining to golden, *serratus* ♂.

Abdomen entirely dark, ... 26

26. Wings black, apical third pale, followed by a fuscous apical margin; clypeus pyriform, much longer than broad in the ♀; thorax immaculate, ... *subapicalis* ♀ ♂.

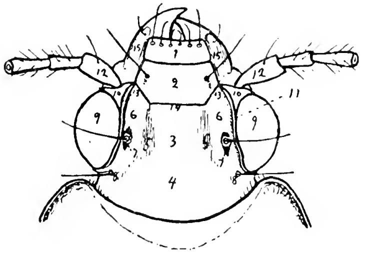
Wings dark fuscous mingled with paler on basal half, the remainder subhyaline; clypeus rather hexagonal, not much longer than broad; postscutellum and middle segment, or the latter only, more or less yellow; abdomen with griseus pile, ... *griseus* ♀ ♂.

THE FRONS IN BEMBIDIUM, WITH DESCRIPTIONS OF NEW SPECIES.

BY F. E. BLAISDELL, M.D.

There is often connected with the recognition and placing of species in the systematic scheme difficulties which become perplexing and annoying, not so much from the nature of the characters as from the instability or tendency to variation in such characters among species naturally closely allied.

I was forcibly impressed by these facts while working over the species of *Bembidium* contained in the collections of Mr. Charles Fuchs, Dr. E. C. Van Dyke, and my own. It is the perplexities that arose while dealing with the frontal characters that have brought about this attempt at their elucidation. I wish to express my thanks to the above-mentioned gentlemen for the use of material and also for many suggestions.



Head of *Bembidium suspectum*.—1. Labrum; 2. Epistoma; 3. Frons; 4. Vertex; 5. Frontal sulcus (internal of Hayward); 6. Frontal costa or ridge; 7. Anterior supraorbital setigerous puncture within fovea; 8. Posterior supraorbital setigerous puncture, fovea not developed; 9. Eye; 10. Plate in front of eye; 11. Ocular bead, ocular sulcus just within; 12. Basal joint of antenna; 13. Anterior lateral process of frons; 14. Frontal suture; 15. Mandibular scrobe, bearing a seta arising from a puncture. (Magnified 28.5 diameters.)

That part of the cephalic exoskeleton constituting the interocular region is called the *frons*. It is bounded above by the vertex, from which it is separated by an imaginary line; below by the epistoma, with which it is connate, the line of union being marked by the frontal suture; laterally by the eyes, in front of which is a strong chitinized plate supporting the antennæ. The union of this plate with the side of the frons in front of the eye forms the frontal ridge.

In form the frons is subquadrate, with its anterior lateral angles produced and embracing the obliquely truncated basal angles of the epistoma.

Laterally, where the frons meets the eye, the margin becomes raised into a fine convex ridge or ocular bead, which is continuous anteriorly with the frontal ridge, posteriorly it winds around the eye to become evanescent.

Immediately within this bead is a fine sulcus or stria parallel to it, usually well marked and varying in the degree of its width and depth, and conveniently termed the ocular stria. The ocular beads and striæ are common to all Bembidia.

In all species of *Bembidium* there are developed other frontal ridges and sulci; these reach their minimum of development in some species of the *variegatum* group, where the ocular striæ are bounded internally by rather broad convex longitudinal ridges, which in turn are limited internally by broad shallow grooves—the internal sulci of Hayward—which pass more or less gradually into the plane or convex central area of the frons.

This condition is defined by Mr. Hayward in his paper treating of the species of *Bembidium*, Group XII (*variegatum*), as " Frontal grooves single, parallel or rarely very feebly convergent." In some individuals these grooves and ridges are quite obsolete.

In the different groups of species these grooves and ridges may be parallel to or converge toward the median line.

Generally the supraorbital setigerous punctures are placed in small pit-like depressions or foveæ upon the convexity of the ridges. In some groups it is by the extension and coalescence in a longitudinal direction of the foveæ bearing the punctures that this single broad, convex ridge becomes divided into two lateral moieties, forming as a result two ridges separated by a sulcus—the *external sulcus* of Hayward—the setigerous punctures now being found in the bottom of this groove.

This condition reaches its maximum development in *B. sulcatum*.

As long as the ridges and grooves are parallel to the median line of the insect, they *do not* extend on to the epistoma (Pl. III, figs. 2, 5 and 8, representative of Groups I to XIII, XV and XVIII to XXI of Mr. Hayward's paper); with convergency the extension on to the epistoma does take place (figs. 1, 3, 4, 6, 7 and 9, representative of Groups XIV, XVI and XVII of the above-mentioned paper). Observe that this only occurs in those species with double frontal grooves.

The following is an explanation of the figures given in the plate, which are camera lucida tracings, the details being filled in as accurately as possible. I believe them to be true representations of the specimens from which they were made, the accuracy centering upon the ridges and grooves, and are representative of Mr. Hayward's groups, as follows:

Figure 8, Group XII, *B. vile,* drawn from a specimen collected at San Diego, Cal. From its general facies it is usually placed in collections with individuals of Groups XIV or XVII. An examination of the frons and other group characters will readily distinguish it.

"*Frontal grooves single, parallel.*" The single ridge of either side terminating anteriorly at apex of the frontal process of the corresponding side, not passing on to the epistoma, posteriorly becoming attenuated and disappearing near the posterior border of the eye and bearing upon its convexity the supraorbital setigerous punctures; ocular bead well developed; ocular sulcus narrow and normal; internal grooves normal.

Fig. 2, Group XIII, *B. bifasciatum,* drawn from a large specimen collected at Poway, San Diego county, Cal.

"*Frontal grooves single, parallel.*" Frons broad, feebly convex, disposition of grooves and ridges as in Group XII. Anterior supraorbital punctures in large shallow foveæ. Ocular bead and sulcus well developed and normal.

Fig. 5, Group XV, *B. affine,* drawn from a specimen collected in Virginia.

"*Frontal grooves slightly oblique, the outer interrupted.*" The obliquity being so slight and the ridges not extending on to the epistoma, I believe it to be next in the evolutionary series.

The anterior foveæ have extended backward and forward, separating the two lateral moieties of the single ridges, forming the first rudiments of the interrupted external groove of Hayward. The disposition of the sculpturing is nearly as in Group XII—*i. e., no extension on to the epistoma;* ocular bead and sulcus fine but otherwise normal.

Figs. 3 and 6, Group XIV, *B. 4-maculatum* and *B. dubitans.* The former drawn from a specimen collected in Massachusetts; the latter from a specimen collected near Portland, Ore.

"*Frontal grooves double, oblique, the outer interrupted.*" With the obliquity an extension has taken place on to the epistoma. The external groove is really not developed, on account of the non-extension of the foveæ. The setigerous punctures of the epistoma are within the anterior extremities of the developing external grooves, while the other punctures are within foveæ, as in figs. 2 and 8, the extension of the foveæ being not developed. Ocular bead and sulcus normal.

Figs. 4 and 9, Group XVII, *B. anguliferum* and *B. assimile.* The former drawn from a specimen in the Van Dyke collection, and collected in Lake county, Cal.; the latter species from a specimen taken in Ohio.

"*Frontal grooves very deep, strongly convergent, double, the inner groove long, the outer shorter and often feebly marked.*" Ridges strongly developed and very convex. Here is a stronger tendency for the foveæ to coalesce; it can be seen that the foveæ on epistoma are elongate, the splitting of the ridges being more evident. The internal groove is strongly developed and entire; ocular beads not developed at margins of the eyes, but present on outer borders of frontal processes; ocular sulcus feeble but normal.

Figs. 7 and 1, Group XVI, *B. concinnum* n. sp. and *B. sulcatum.* The former collected by Dr. Van Dyke in Eldorado county, Cal.; the latter species was taken in the Caraboo District, B. C., and is in the Fuchs collection.

"*Frontal grooves double, scarcely (to moderately) converging, the outer entire*" (or nearly so).

I have placed *concinnum* in the present group on account of the frontal grooves moderately converging, and also from the greater tendency toward the development of the external groove, by the appearance of intermediate foveæ between those of the punctures of the epistoma and those of the anterior supraorbital punctures. The internal groove is well developed; ocular bead and sulcus normal.

In *sulcatum* the full development is reached—the internal and external grooves are entire; the internal ridges are entire, the external being bifurcate to receive the posterior supraorbital punctures. Ocular bead entire; the ocular sulcus broad and normal in extent.

Bembidium obscuripenne n sp.

Elongate, very moderately convex; color black and shining, with an obscure brownish humeral spot extending backward to near middle third; a similar spot at junction of middle and posterior thirds.

Head slightly wider than thorax at apex; eyes large; antennæ about one-half as long as body.

Prothorax about one-third wider than long, slightly wider at base than at apex; the latter slightly emarginate in circular arc; median line entire, moderately fine; transverse impressions distinct, the posterior deeper; basal impressions rugulose, broad, deep and bi-striate; sides arcuate in anterior three-fourths, feebly sinuate in posterior one-fourth, with margins narrowly reflexed, marginal sulcus moderately broad; basal angles rectangular, carinate, carinæ nearly parallel to median line.

Elytra oblong-ovate, about one-half wider than thorax, one-half longer than wide, striate, striæ moderately impressed, entire or feebly impressed at apex, strongly punctate to one-fourth distance from apex; third stria with first dorsal puncture a slight distance posterior to basal one-fourth, second a slight distance anterior to basal fourth, intervals flat. Legs and abdomen dark piceous to black. Length 5–5.5 mm.

Tarsi.—First two joints of anterior tarsi of male dilated; first subquadrate with inner anterior angle prolonged as usual, second moderately dilated.

Diagnostic characters.—Closely related to *longulum*. Basal angles of thorax rectangular, striæ subentire, more convex form and presence of brownish elytral spots, with many other characters if Mr. Hayward's measurements of *longulum* are correct.

Two specimens collected in Oregon. Fuchs' collection.

Bembidium humboldtensis n. sp.

Form elongate, somewhat robust, convex; color coal black; surface very smooth and shining.

Head as wide as thorax at apex; antennæ less than one-half the length of the body.

Prothorax convex, about one-fourth wider than long, length equal to base, as wide or slightly wider at base than apex, surface smooth; apex truncate; base evenly and feebly arcuate; median line distinct, slightly abbreviated before and behind; transverse impressions feeble; basal impressions moderately deep and rather sharply defined, unistriate; sides narrowly reflexed, arcuate in front, oblique and straight behind; hind angles obtuse, not rounded, and without trace of carina; smooth and convex between basal impressions and margins.

Elytra oblong-oval, one-half wider than thorax, slightly more than one-half longer than wide, striate; striæ abbreviated, except the first and sometimes the second, seventh represented at tip by a short groove, strongly and rather coarsely punctate to posterior third, then impunctate; third striæ with first dorsal puncture one-third from base, the second about one-third from apex; intervals nearly flat. Beneath and femora black, tibiæ and tarsi slightly piceous. Length 4 mm.

Diagnostic characters.—Resembles *recticolle* in general form and should follow it in our lists.

Readily recognized by the form of the basal impressions, absence of carinæ, shorter antennæ, and the elytral striæ being obsolete and impunctate in basal third.

Described from a series of twelve specimens collected in Humboldt county, Cal., by Dr. Van Dyke.

Bembidium vandykei n. sp.

Form rather broad, elongate, scarcely depressed; color nigro-piceous, more or less tinged with bluish, especially the head and pronotum; surface smooth and shining.

Head slightly wider than thorax at apex; antennæ reaching to first dorsal punctures of elytra.

Prothorax about one-third wider than long, length equal to width of base, base equal to apex; base very feebly arcuate; apex slightly emarginate; median line impressed, abbreviated in front, extending nearly to base; transverse impressions distinct, anterior angulate and feeble; basal impressions moderately broad, deep and bistriate; sides arcuate in anterior three-fourths, sinuate behind, nearly parallel for a short distance in front of hind angles, which are rectangular and feebly carinate.

Elytra about one-half wider than thorax and about one-half longer than wide, oblong-ovate, finely striate; striæ entire, impunctate, fifth strongly grooved at tip; third stria with first dorsal puncture one-eighth of the length of elytra in front of middle, the second one-fourth from apex; intervals flat.

First two joints of anterior tarsi dilated; the first oblong with inner angle feebly produced, the second feebly dilated with inner angle large and produced. Legs piceous. Length 5–6.3 mm.

Diagnostic characters.—Its resemblance to *planatum;* prothorax wider in comparison to its length; impunctate striæ; smaller size; more slender form and slightly more convex elytra. Should follow *planatum* in the list. Named from a series of specimens collected in Mendocino county, Cal., by Dr. Edwin C. Van Dyke.

Bembidium falsum n. sp.

Form oblong-ovate, elongate, depressed; color nigro-piceous, faintly tinged with bluish; surface smooth and more or less extremely finely reticulate.

Head about as wide as thorax at middle; antennæ reaching to anterior dorsal punctures.

Prothorax one-fifth to one-fourth of its width wider than long; slightly narrower at base than apex; base about equal to the length, and very feebly arcuate; apex slightly emarginate; median line impressed at middle and subentire; transverse impressions distinct, the anterior feeble; basal impressions moderately broad, deep, bistriate; sides arcuate in anterior three-fourths, sinuate behind, parallel for a short distance in front of basal angles, which are rectangular and feebly carinate.

Elytra about one-half wider than thorax, and about two-thirds longer than wide, oblong, sides nearly parallel; strongly striate; striæ entire, impunctate, fifth strongly grooved at tip; third stria with first dorsal puncture just slightly in front of the middle, the second one-fourth from apex; intervals convex. Legs piceous; anterior tarsi with first two joints dilated; the first oblong with inner angle produced, the second transverse, feebly dilated with inner angle large and produced. Length 5.5–6 mm.

Diagnostic characters.—Resembles *planiusculum*, from which it may be recognized by its larger head, elongate and parallel form, and deeper elytral striæ. It can precede the latter species in our lists.

Described from a series of specimens taken in Mendocino county, Cal., by Dr. Van Dyke.

Bembidium suspectum n. sp.

Form moderately broad, rather convex; color nigro-æneous; elytra piceo-æneous with paler spots arranged as follows: a small basal spot occupying intervals four and five, a small oval spot in third interval just in advance of first dorsal puncture, similar spots in intervals four, five and six, increasing in length from within outward, another large spot extending from sixth stria to margin, occupying about the second one-fourth. A large spot commencing at fourth stria opposite posterior dorsal puncture and extending to the margin, and an apical pale spot; these pale areas may vary as to size and degree of coalescence.

Head and thorax alutaceous; elytra sculptured with exceedingly minute transverse rugulæ.

Head very slightly wider than thorax at apex; antennæ one-half as long as body.

Prothorax subquadrate, one-half wider than long; base slightly wider than apex and feebly arcuate at middle; apex slightly emarginate; median line distinct, abbreviated in front, obsoletely so behind; transverse impressions well marked; basal impressions broad and deep, bistriate; sides evenly arcuate in anterior three-fourths, subsinuate in basal fourth; hind angles rectangular, strongly carinate with carinæ parallel to the median line.

Elytra oblong-oval, one-half wider than thorax, and scarcely one-third longer than wide; deeply striate; striæ entire, distinctly punctate to posterior dorsal puncture, then more feebly, becoming impunctate near apex, seventh slightly grooved at tip; intervals flat, the third with first dorsal puncture one-third from base, the second one-fourth from apex. Beneath tinged with greenish, shining; legs nigro-piceous, tinged with green. Length 6.2 mm.

Diagnostic characters.—Near *approximatum;* recognized by its larger size and broader form; elytra oblong-oval; basal angles of thorax rectangular. Should precede the above species in our lists.

Type collected at Oregon City, Ore., on the shore of the Willamette river. Several specimens.

Bembidium fuchsii n. sp.

Form elongate, moderately convex. Color black. Antennæ, tibiæ and tarsi piceous; surface bright and shining, slightly æneous, very finely and faintly reticulate.

Head wider than thorax at apex; eyes large; antennæ nearly one-half the length of the body.

Prothorax subquadrate, about one-half wider than long; base slightly narrower than apex, both truncate; sides arcuate in anterior three-fourths, faintly sinuate behind; marginal bead fine, narrowly reflexed; disk very moderately convex, somewhat transversely rugose in basal half; median line fine, abbreviated before and behind; anterior transverse impressions feeble, the posterior more marked; basal impressions broad, moderately shallow, bistriate; hind angles subobtuse, carinate, carinæ parallel to the margin.

Elytra scarcely one-half wider than thorax, about one-half longer than wide, oblong-oval; deeply striate; striæ entire, more finely impressed toward tip, fifth grooved at tip, strongly punctate to near apex, then obsoletely so; intervals just perceptibly convex, the third with the first dorsal puncture just posterior to basal fourth, the second about one-third from apex. Anterior tarsi of male with first two joints dilated, first strongly so, quadrate, inner anterior angle feebly prolonged, strongly convex dorsally; second moderately dilated, inner anterior angle moderately produced. Length 3.2 mm.

Diagnostic characters.—Closely related to ***timidum***, from which it can be recognized by its coal-black color, deeply striate elytra, and strongly punctate striæ.

Described from three specimens in the Fuchs, Van Dyke and my own collections.

Type collected at Blue Lakes, Alpine county, Cal.; co-types in Eldorado and Placer counties, Cal.

Bembidium concinnum n. sp.

Form moderately robust. Color piceous; surface shining, finely reticulate, with a very faint bluish reflection.

Head wider than thorax at apex; antennæ nearly one-half as long as body. Prothorax subquadrate, rather more than one-third wider than long; base equal to apex, the latter truncate in circular arc; median line fine but distinct, obsoletely abbreviated in front and behind; transverse impressions distinct; sides arcuate in anterior two-thirds, nearly straight or feebly sinuate and converging in posterior third; margin narrowly reflexed; marginal and basal setæ long; basal impressions deep and sharply defined, bistriate; hind angles obtuse, not rounded, carinate; carinæ but slightly divergent from margin.

Elytra oblong-oval; one-half wider than thorax, about one-half longer than wide, and widest near middle; striate, striæ feebly impressed, distinctly punctate to posterior fourth, then obsoletely so to apex, first and second entire, fifth slightly grooved at tip; intervals flat to feebly convex, the third with first dorsal puncture a little more than one-third from base, the second three-eighths from apex. Beneath blackish. Legs rufo-piceous. Length 3.5 mm.

Anterior tarsi of male with first two joints dilated, the first strongly so, slightly oblong; second but feebly dilated, inner anterior angle not noticeably produced; other joints stouter than usual. Female tarsi with joints stouter than usual.

Diagnostic characters.—The scarcely converging frontal grooves, the outer nearly entire, and extension on to the epistoma, with dorsal punctures two, situated on the third interval, place this species in Group XVI of Mr. Hayward's classification. Sufficient has been stated in this paper to render this species easily separable from *sulcatum*, the only other member of the group.

Described from several specimens collected in Eldorado county, Cal., by my friend, Dr. Edwin C. Van Dyke.

All comparative measurements have been made from camera lucida outlines.

In attempting to give the diagnostic characters, I have confined my remarks merely to the species most closely related to those under consideration, as reference to Mr. Hayward's synopsis of group characters will aid in approximately placing any form here described.

EXPLANATION OF PLATE III.

Fig. 1.—*Bembidium sulcatum*, Group XVI (Hayward).
Fig. 2.—*Bembidium bifasciatum*, Group XIII (Hayward).
Fig. 3.—*Bembidium 4-maculatum*, Group XIV (Hayward).
Fig. 4.—*Bembidium anguliferum*, Group XVII (Hayward).
Fig. 5.—*Bembidium affine*, Group XV (Hayward).
Fig. 6.—*Bembidium dubitans*, Group XIV (Hayward).
Fig. 7.—*Bembidium concinnum* n. sp., Group XVI (Hayward).
Fig. 8.—*Bembidium vile*, Group XII (Hayward).
Fig. 9.—*Bembidium assimile*, Group XVII (Hayward).
Magnified 28.5 diameters.

SOME BERMUDA OLIGOCHÆTA, WITH A DESCRIPTION OF A NEW SPECIES.

BY J. PERCY MOORE.

During two visits to the Bermuda Islands in the summers of 1898 and 1901, Prof. A. E. Verrill, while devoting most of his attention to marine zoology, was able to gather a collection of Oligochæta which adds materially to our knowledge of the fauna of these islands. The character of the collection and the circumstances under which it was gathered indicate the probable occurrence of additional forms. Of the six species hitherto recorded from the Bermudas in several of Beddard's papers, all but one, and that the very common and widely distributed *Perichæta bermudensis* Bedd. (*Pheretima hawayana* (Rosa) Mich.), are represented in Prof. Verrill's collection. In addition the material includes two species of *Pheretima* not previously known from the Bermudas, a new species of *Enchytræus* and an immature *Helodrilus* having a combination of characters not known in any hitherto described species, but which is not now characterized because of the lack of suitable material.

Enchytræus marinus sp. nov.

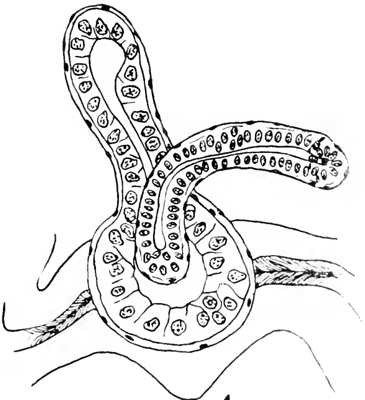
The alcoholic specimens measure exactly 10 mm. in length and about .7 mm. in greatest diameter. There are 73 somites in the type specimen and 71 in the other, which is crushed at about the middle into two pieces. The prostomium is broadly rounded. Toward the anterior end the length of the somites is about two-thirds their diameter, while the posterior ones become very short, about one-quarter their diameter. The terminal three or four of the latter taper abruptly to the anus.

With the exception of somites III and IV, in which there are three, the ventral setæ are two per bundle throughout the entire length of the body; but they are absent entirely from I and XII. From II to X, inclusive, the dorsal bundles contain 3, on all other somites 2 setæ. All setæ are nearly straight externally and strongly hooked within the body wall. They are stout, somewhat thickened at the middle, and taper to the ends. Those composing each bundle are of equal length and thickness. In the ventral bundles the setæ increase in size to somite IV, where they are about one and one-half times as long as on II, and distinctly larger than the dorsal setæ of the same somite. This relative size of dorsal and ventral setæ continues to at least somite X.

A small cephalic pore exists between the prostomium and peristomium, but other dorsal pores are wanting. The genital pores are, as usual in the family, the male on XII, the female $\frac{\mathrm{XII}}{\mathrm{XIII}}$, and the latter slightly the more mesiad. The clitellum is undeveloped. No pigment is apparent anywhere and the blood shows no trace of color in the alcoholic specimens. Prof. Verrill's label describes the living worms as "white."

Pepto-nephridia are certainly absent from the example sectioned, and none could be detected in the type specimen when cleared in glycerine. Conspicuous septal glands are developed on $\frac{\mathrm{V}}{\mathrm{VI}}$, $\frac{\mathrm{VI}}{\mathrm{VII}}$ and $\frac{\mathrm{VII}}{\mathrm{VIII}}$, and open in the usual way on the pharyngeal pad. As a result of great development of muscular tissue all of the dissepiments between the last septal gland and the testes somite—that is $\frac{\mathrm{VII}}{\mathrm{VIII}}$, $\frac{\mathrm{VIII}}{\mathrm{IX}}$, $\frac{\mathrm{IX}}{\mathrm{X}}$ and $\frac{\mathrm{X}}{\mathrm{XI}}$—are much thickened.

The spermathecæ (fig. 1) occupy somite VI, and open to the exterior in the furrow $\frac{\mathrm{V}}{\mathrm{VI}}$ on a level nearly midway between the dorsal and ventral setæ-bundles. The duct is a simple thick-walled tube having a length about equal to the flask-shaped ampulla, into the bulbous base of which it opens on the latero-dorsal aspect, from which a striking asymetry of the entire organ results. Unicellular glands, which are such a conspicuous feature of the spermathecal duct of *E. albidus*, are altogether absent from the examples here described. The ampulla is regularly flask-shaped, with



1

a nearly spherical base and a cylindrical neck slightly dilated at its free dorsal extremity. The two parts are of about equal length, the base being about three times, and the neck one and one-half times the diameter of the duct. The ampulla stands vertically by the side of the œsophagus, above which the neck rises. The bulbous base is in contact with the side of the œsophagus and the contiguous tissues of the two are continuous, but whether an actual communication between the cavities of the two organs exists could not be demonstrated beyond question. A few spermatozoa are present in the cavities of both ampulla and duct of the specimen sectioned. A lateral view of the right spermatheca is shown in fig. 1, which sufficiently exhibits the general cellular constitution of its walls, and its topographical relation to the œsophagus, which is shown in outline.

Although its distortion prevents an accurate measurement, the sperm funnel appears to be only two and one-half times as long as wide; highly glandular. The vas deferens is coiled and reaches to the posterior end of XV before returning to the male pore; it has a total estimated length of from six to eight times the funnel. Its two limbs have an equal diameter, which is about one-tenth to one-twelfth of the body at the same point.

The brain is anteriorly slightly concave, posteriorly nearly straight, with a slight median concavity and feebly prominent postero-lateral lobes.

Some of the characters used to distinguish *E. marinus* from the widely distributed *E. albidus* Henle, 1837 (= *Halodrillus littoralis* Verrill, 1874), are doubtless due to the immaturity of the specimens, but this cannot be true of the absence of the pepto-nephridia, the form of the spermatheca, and the peculiarities of the setæ. I have repeatedly studied *E. albidus* at Wood's Hole (where it abounds) and elsewhere, and have found no connecting variations.

Prof. Verrill writes that the species was common in the upper littoral zone, below the tide mark of ordinary tides, at Coney Island, but was not noticed elsewhere. The collection contains two specimens labeled "No. 940, High-water mark, Bermuda, 1898."

Pontodrilus arenæ Mich.

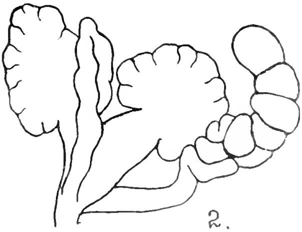
This species appears to be of common and very general occurrence at and below high-tide mark. In almost all cases the intestine is filled with coarse coral and shell sand, the grains of which are frequently upward of .5 mm. in diameter. The ornamentation on the setæ is extremely faint. No. 939, 1898; No. 965, Hungry Bay, April 13, 1901; No. 966, Elbow Bay, March, 1901.

Pheretima schmardæ (Horst) Mich.

Prof. Verrill remarks upon the great activity (so characteristic of the genus) of this and the next species. When captured they writhe like active lizards, as a result of which most of the specimens are broken in two. They occurred under stones only in the neighborhood of a house said to be 250 years old. The intestines were filled with a very fine reddish earth. *P. schmardæ* has not previously been reported from the Bermudas, and in the West Indian region is known only from the Barbadoes. No. 964, Walsingham, May 5, 1901; No. 962, 1901.

Pheretima rodericensis (Grube) Mich.

This widely distributed species, described by Beddard (under the name of *Perichæta dyeri*) from Jamaica, Trinidad, etc., is represented in the collection by a single example from the Bermudas, to which islands it is new. A peculiarity of the gizzard of this species appears to have escaped notice. The organ in question occupies somite X and a small part of XI. From near its posterior end on each side a stout tapering band or column of muscle arises and passes obliquely caudad to the body wall at the setæ line of somite XI. These form powerful retractors and dilators of the gizzard, and may be the remains of the septum $\frac{X}{XI}$, as Beddard has suggested in the case of a somewhat similar structure described by him in *P. taprobanæ*, and especially *P. bermudensis*. A delicate membrane runs from the muscles mesiad and dorsad to the dorsal blood vessel and appears to be continuous with the peritoneal sheaths of both of these organs.



2.

The diverticula of the spermatheca show considerable variation. The folded portion becomes successively longer from before backward and at the same time changes from a spirally coiled condition to a tortuous folding in one plane. An abnormality of the second spermatheca of the left side is shown in fig. 2, as viewed from behind. The ampulla is divided into two portions, each of which has the form, but little more than one-half of the diameter of the normal. Each has a short duct which unites with its fellow into a common one much enlarged at the point of union. One perfectly normal diverticulum springs as usual from the cephalic face of the ampullar duct, but it is diverted to a mesial instead of the usual lateral position. A second much smaller diverticulum arises from the caudal face of the common duct and for about one-third of its blind end is reflected on itself. No. 961, 1901.

Eudrilus euginæ (Kinberg) Mich.

Three large examples. No. 936, 1898.

Onychochæta windlei Bedd.

One small specimen. No. 962, 1901.

Eisenia fœtida (Sav.) Mich.

One specimen of this now cosmopolitan species. No. 938, 1898.

Helodrilus (**Allolobophora**) **chloroticus** (Sav.) Mich.

Common. No. 937, 1898; No. 962, 1901; No. 965, Hungry Bay, April 13, 1901, just below high tide. This last record of the label, if correct, is of interest as indicating the occurrence of this species on the littoral zone. Many of the posterior setæ of these specimens are missing, the bundles being reduced in such cases to single seta.

Helodrilus sp.

A very small *Helodrilus*, No. 963, 1901, could not be determined at all; a larger example, No. 961, 1901, while exhibiting characters of an undescribed species, is too immature for satisfactory description.

STRUCTURE AND DEVELOPMENT OF THE THYROID GLAND IN PETROMYZON.

BY ALBERT M. REESE.

INTRODUCTION.

The material with which the following work was done was of two, or possibly three, species. The first species was *Petromyzon planeri*, the small lamprey that, in the adult condition, reaches a length of about six inches only. This first lot of material was collected by Dr. R. G. Harrison at Naples. It included stages from the recently fertilized egg to the swimming larva, in which the yolk was no longer externally visible and in which the mouth was separated from the pharynx only by a thin partition of cells. This oldest stage was killed fourteen days after fertilization.

The second lot of material was obtained at Ithaca, N. Y., and probably includes larvæ of both *P. dorsatus*, Wilder (lake lamprey) and *P. branchialis* (brook lamprey), as both species are known to spawn in the same nest, and it is impossible to tell to which species the larvæ belong. Part of this lot of material was sent me through the courtesy of Prof. S. H. Gage, of Cornell; the rest I myself obtained from one of the "nests" in a stream at Ithaca, New York.

I wish to express here my gratitude to my friend, Dr. Ross G. Harrison, for placing at my disposal the material from which the younger stages of development were made out; to Prof. Simon H. Gage for the really considerable amount of trouble he took in aiding one who was, at the time, wholly unknown to him, to obtain the older stages for this work; and to Prof. Brooks for much valuable aid and many suggestions during the progress of the work.

I obtained the best results by killing in corrosive acetic (95 cc. saturated solution of $HgCl_2$ and 5 cc. glacial acetic acid), hardening in the usual alcohols and staining *in toto* with borax carmine, and on the slide with Lyon's Blue. The greatest technical difficulty experienced was in obtaining good preparations of the long gland cells. Embryos were fixed in a number of ways, but in no single case was a *good* preparation of the gland cells obtained. Maceration was tried also, but with no success. Some difficulty was experienced also in sectioning the earlier stages, on account of the mass of yolk, but with later stages there was no trouble of this kind. The figures referred to are on Plates IV–VII.

All the sections were drawn with a camera, though in most cases the details had to be filled in from a series of sections.

Development of the Thyroid Gland in Petromyzon.

(11th day.)—The thyroid begins, in *Petromyzon*, as a simple pit or groove, pushed out from the ventral wall of that part of the digestive cavity which may be called the pharynx, though at this time there are no gill openings connecting this cavity with the exterior.

This groove, or beginning thyroid, was first found, in *P. planeri*, in an embryo eleven days old—that is to say, eleven days after fertilization.

The external appearance of this embryo is seen in fig. 1*a*. At this stage there is no external indication of gill-slits, the mouth is deeply pitted in, though not yet broken through, and the yolk still forms a large, round mass at the posterior end of the embryo. As is seen by the figure, the embryo is distinctly retort-shaped, the yolk-mass forming the body of the retort, while the neck of the retort is represented by the head and neck regions of the embryo. The stomodæum is seen as a pit in the head region, and, at a slightly older stage, the first external indication of gill-clefts is seen as a series of shallow transverse grooves in the narrowest part of the neck of the flask.

The thyroid groove, at its anterior end, is broad and deep, so that, with its thick walls, it is half as large, in cross section, as the part of the pharynx from which it is derived. Its lateral walls, throughout its length, are very thick, and are composed of a single row of greatly elongated cells, each cell with a large nucleus near its centre. The ventral wall is usually much thinner and is composed of shorter, even cubical, cells.

As the groove is followed posteriorly, it is found to become gradually narrower and also somewhat more shallow until it finally disappears.

Fig. 1*c*, though representing a slightly older stage, may be taken to represent a transverse section through the middle of the gland very shortly after its first appearance as an evagination from the floor of the pharynx (*phar.*). The thick lateral walls and much thinner floor of the thyroid are shown in this section. Anterior to the point represented in this figure, the thyroid groove is somewhat wider, while posterior to this point it is slightly narrower and gradually becomes more and more shallow until it finally disappears.

The thyroid at this stage, then, is a groove, relatively larger, perhaps, than at any other time, and opening along its entire length into the pharynx.

(12th day).—On the twelfth day the thyroid begins to be shut off from the pharynx by the growth of two horizontal partitions, one roofing over the anterior end, the other roofing over the posterior end, of the thyroid groove.

These partitions or septa are shown, at a slightly later stage, in fig. 3, which is a sagittal section through the anterior end of a thirteen-day embryo, cutting the thyroid almost medially and passing slightly to the side of the medial line of the mouth invagination. The anterior septum (*a.h.l.*) is seen to be further advanced than the posterior one, which is just beginning (*p.h.l.*). In this figure the cells of the thyroid evagination are stippled to distinguish them from the remaining cells of the pharyngeal wall. That the section represented in fig. 3 did not cut the thyroid in an exact median plane is shown by the much elongated cells which form the floor of the groove. The section was probably somewhat oblique. The body wall of the embryo is shown in outline (*b.w.*), and the first indication of gill clefts is seen as two or three evaginations of the pharynx, dorsal and anterior to the thyroid (*v.c.*). A transverse section of the twelve-day embryo, through the anterior end of the thyroid (through the line *ab* in fig. 3), shows that it is now a closed cavity (fig. 1*b*) with thick walls, lying just beneath the pharynx and between two large blood vessels. Throughout the mesoblast that surrounds the thyroid are scattered numerous yolk granules, the mesoblast cells themselves being rounded and very different in shape from what they will be in later stages. The cells in the floor of the pharynx are not so sharply differentiated from those in the roof of the thyroid as is indicated in this figure. The cells of the body wall are very similar in size and shape to those lining this part of the pharynx. Fig. 1*c* is a section cut posterior to fig. 1*b* (through the line *a′b′* in fig. 3) and passes through the part of the thyroid which is still open to the pharynx. In fig. 1*b* only the cells of the thyroid are dotted, while in fig. 1*c* the cells of both thyroid and pharynx are dotted. The only change since the eleven-day stage is the beginning of the horizontal septa, the anterior end of the thyroid being converted into a closed tube by the backward growth of the anterior septum.

The septa seem to be formed by a rapid growth at the points where the most anterior and the most posterior epithelial cells of the thyroid merge into those of the pharynx, causing these two projections to be pushed out, the upper layer of each septum apparently being derived from the pharyngeal epithelium, the lower from what may be called the epithelium of the thyroid (fig. 3). The thyroid, though closed in anteriorly, is still entirely open above for a greater part of its length. As is seen in fig. 1*b*, the dorsal wall of the thyroid is closely pressed against the ventral wall of the pharynx, so that it is difficult to distinguish the two walls.

It will be interesting to compare the thyroid of *Petromyzon* at this stage with the thyroid at a corresponding stage in *Amblystoma* (figs. 8*a* and 8*b*). A section through the anterior end of the thyroid of *Petromyzon* (fig. 1*b*) shows it to be a closed cavity, while posteriorly it is still an open groove (fig. 1*c*). In *Amblystoma*, on the other hand, the open groove is anterior to the closed part of the gland, the closing in taking place, apparently, in a postero-anterior direction.

(13th and 14th days.)—At about this time the lateral walls of the thyroid, especially toward the anterior end, become greatly thickened by the increase in length of the columnar cells of which they are composed. At the same time an invagination of these thickened walls occurs as a longitudinal groove, pushing inward and upward from the outside of the gland (fig. 2*b*, *i.v.*). This invagination becomes still more marked in later stages, and extends further in a posterior direction.

At this stage the extreme anterior end of the thyroid is forked, so that a section through this region would show two distinct cavities with thickened lateral and ventral walls (fig. 2*a*). This is plainly seen in sections and in a wax reconstruction of the thyroid made from a series of sections of this stage. These two divisions of the anterior end of the gland are separated by a vertical partition of mesoblast. The two parts of the thyroid are more widely separated by the mesoblast than they will be at later stages, but at this stage the separation extends only a short distance from the anterior end of the gland. The thyroid is here not so closely pressed against the pharynx as was the case in previous sections, being separated from the wall of the pharynx by a collection of mesoblast cells. The cavity of each half of the gland is crescentic in cross section, and on the left side is seen the beginning of the lateral invagination.

The thyroid cavity is closed in, now, for about two-fifths of its entire length, both anteriorly and posteriorly, so that its opening into the pharynx is reduced to a slit extending only one-fifth the length of the gland.

Sections through the thyroid, anterior to this opening (fig. 2*b*) but posterior to the divided portion of the anterior end, show the cavity to be considerably complicated by the thickening and folding of the walls. The simple, circular cavity of the preceding stage (fig. 1*b*) is now reduced, by the growth and invagination of the walls, to a narrow vertical slit with lateral diverticula above and below, giving the cavity, in cross section, somewhat the shape of a distorted letter T. The dorsal wall of this cavity (fig. 2*b*, *d.l.*) is comparatively thin, being composed of a single layer of rather short columnar cells, and is what Dohrn calls the "Decklamelle." The ventral wall is also comparatively thin, and shows in the centre, at the extreme anterior end of the unpaired cavity, a slight upward projection (fig. 2*b*, *m.l.*), which would seem to be the first indication of the medial longitudinal partition that will later divide the gland into two lateral parts. According to Dohrn, this medial lamella is formed as far back as the opening of the gland, before the lateral invagination takes place, but in my material this is certainly not the case, as is shown in fig. 2*b*.

The lateral invaginations extend posteriorly to a point a little behind the anterior edge of the slit-like opening into the pharynx, fig. 2*c* being from a section that cut through the extreme posterior part of the invagination in the right side, but was too far posterior to cut that of the left side, either because the section was somewhat oblique or because the right invagination had proceeded further than the left.

It is well to get a clear idea of these lateral invaginations in the simple condition represented in fig. 2*b*, as the more complicated later stages will thus be more easily understood. Were the lateral walls straightened out, thus obliterating the lateral invaginations, the thyroid would be reduced to a more or less cylindrical body, as it was in fig. 1*b*, though with a much larger cavity. The long cells of the lateral walls are divided by the invagination into two groups, which become more and more distinct as development proceeds. In fig. 2*b* one of these groups, on each side, lies between the invagination and the perpendicular part of the cavity of the gland; the other group lies between the invagination and the dorsal, horizontal part of the cavity (compare fig. 5*e*). The cavity of the thyroid, between this point and the posterior edge of the opening into the pharynx, is simply a deep and narrow groove slightly expanded at the bottom, where a narrow space is left, on either side, between the thick lateral and thin ventral walls (fig. 2*d*). Along this groove-like part of the thyroid the cells of the pharynx and gland pass quite insensibly into one another, and are not sharply distinguishable, as might be supposed from the stippling in figs. 2*c* and 2*d*. The portion of the thyroid posterior to the opening is a simple tube-like structure, nearly circular in outline and with a vertical slit-like cavity (fig. 2*d*). The walls here are of nearly the same thickness on all sides, and lie in contact with the epithelium of the pharynx above and with that of the body wall below: in fact, throughout almost the entire length of the gland this is the case. On each side of the thyroid, throughout its entire length, lies a pseudobranchial artery (*art.*) ("Spritzlocharterie" of Dohrn). There is no indication, as yet, of the ciliated grooves, "Pseudobranchialrinne."

The stages of development which follow were obtained from Ithaca, and the larvæ, it will be remembered, were possibly of two species, neither of which was identical with the material from Naples, *P. planeri*.

The next change that is noticed in the thyroid gland is the development of the median vertical lamella (fig. 4*a*, *m.l.*), which is formed by the invagination of the thin dorsal and ventral walls, beginning at the anterior end and gradually extending posteriorly until, at this stage, the gland is separated into two distinct lateral parts, from the anterior end about half-way to the opening to the pharynx. Fig 4*a* is a section through the extreme posterior edge of the partition, showing the invagination of dorsal and ventral walls. The once simple tube is complicated now by four invaginations of its walls. The two that have been spoken of as the "lateral invaginations" (*i.v.*), pushing into the thick side walls in a dorso-median direction, are not very different from what we saw in fig. 2*b*. The other two push toward each other from the roof and floor of the gland (fig. 4*a*, *m.l.*) until they meet and fuse, thus separating the thyroid into two distinct lateral halves. At a later stage of development mesoblast cells press in between these halves to form a thin mesoblastic partition. At this stage the mesoblast is composed still of closely packed, rounded cells, and contains a few scattered yolk granules. It is at this time, also, that the first trace of the ciliated grooves (the "Pseudobranchialrinne") makes its appearance as a groove in the floor of the pharynx, extending anteriorly a short distance from the opening of the gland (fig. 4*b*, *v.c.g.*). At this stage no cilia could be seen, and the groove was much wider than it was at later stages of development. The cavity of the gland, in the region represented in fig. 4*b*, still retains, in cross section, its resemblance to the letter T. This section is anterior to the duct, but posterior to the median lamella represented in fig. 4*a*. The other changes noticed at this stage are the closing of the slit-like opening into the pharynx until only a small circular canal is left (no section through this opening is represented), the thinning of what we shall hereafter call, after Dohrn, the "cover" cells ("Decklamelle") (fig. 4*b*, *d.l.*), and the thickening and deeper invagination of the "gland" cells ("Drusenlamelle") (fig. 4*b*, *g.l.*). The part of the gland posterior to what we may call now the "duct" remains about as in the preceding stage (fig. 4*c*).

The larvæ of the next stage were about 9 mm. long, and showed all the outward characteristics of the normal *Ammocœtes*. An outline drawing, from life, of the side of the head is shown in fig. 5*a*. Being drawn under the microscope with a camera, the relative size and position of the thyroid are accurately shown. The gland is seen to extend from the first to the fifth gill-arch, and to be closely wedged in between the pharynx above and the body wall below. The upwardly curved ends did not show in the living animal, except as indicated by the upward bending of the longitudinal grooves; neither did the duct leading to the pharynx, so these features were omitted in this illustration. The longitudinal grooves are exaggerated somewhat in the drawing. The gland, in life, had a faintly yellow color, while the rest of the larvæ, except the blood, was nearly white, with numerous many-branched, black pigment spots resembling very complicated nerve cells. The living larva of this age is quite transparent, so that the pulsation of the heart and of the velum (*v.*) and the circulation of the blood through the branchial arches can be seen easily under a low power. The thyroid, being rather more opaque than the rest of the animal, shows very plainly by contrast. In the figure the outlines of the pharynx and the positions of the arches are shown by the broad dotted lines. The characteristic hood-like projection over the mouth is also shown. With the exception of the eye (*e*), no attempt has been made to represent any of the other organs of the larva.

A ventral view of the larva of this age shows the thyroid as a clearly defined elongated body, lying against the ventral wall of the pharynx.

By this time great advances have been made in the development of the thyroid and of the ciliated grooves. Fig. 5*b* is a transverse section a short distance anterior to the thyroid. It shows the spinal cord (*sp.c.*), notochord (*ch.*), body wall (*b.w.*), etc., in outline, while the cell structure of the pharynx (*phar.*) is shown. This section, on the right side, passes through the ciliated groove at the point (*l*) where its anteriorly directed ventral branch (*v.c.g.*, on the left) turns dorsalward to run posteriorly as the dorsal groove (*d.c.g.*, on the left). On the left of the section the two branches of the groove are distinct as a dorsal (*d.c.g.*) and ventral (*v.c.g.*) groove. These grooves are lined with cells which are much higher and more columnar than the cells of the rest of the pharyngeal wall, so that they are easily followed, by sections, throughout their course. Their cilia are short and indistinct.

The mesoblast (*mes.*) surrounding the thyroid and pharynx is now quite different from that of earlier stages, being composed of scattered angular cells instead of closely packed, more or less oval cells. The yolk has disappeared. The outline of the pharynx is represented in a somewhat diagrammatic manner, though it was traced as accurately as possible under a camera.

Fig. 5*c* shows the wide separation of the dorsal and ventral branches of the ciliated grooves, so that the two dorsal branches are now quite near together at the mid-dorsal line (*d.c.g.*), while the two ventral branches also are seen to approach each other as they pass posteriorly along the walls of the pharynx (*v.c.g.*). The dorsal grooves continue to approach each other gradually as they are followed posteriorly until they are separated only by a median ridge of ciliated columnar cells (fig. 5*d*). At a point a short distance anterior to the thyroid, the grooves disappear and the medial ridge continues posteriorly, though diminished in height, as the *ciliated* dorsal ridge (fig. 5*k*, *c.d.r.*). This ridge continues to the extreme posterior end of the pharynx and enters the œsophagus, of which it forms, for some distance, the ciliated dorsal wall.

The ventral grooves, as has been said, approach the mid-ventral line of the pharyngeal wall until they unite and lead into the duct of the gland (figs. 5*e*–*i*). Posterior to the opening into the thyroid they are continued on the floor of the pharynx as a single, shallow, median groove (figs. 5*j*–*k*), which finally disappears, posterior to the thyroid, as a groove, but continues to the œsophagus as a ridge of thickened epithelium. In an embryo cut sagitally, so that the pharynx may be laid open and exposed from above, the ciliated grooves may be seen easily with the naked eye, and still more plainly with a lens, but *no* indication of grooves or bands running from the dorsal ciliated ridge to the ventral groove is to be made out. A transverse section through one of the gill-arches showed the presence of very fine short cilia, but their arrangement could not be made out. This arrangement of ciliated grooves is quite different from that described by Willey in his interesting book, *Amphioxus and the Ancestry of the Vertebrates.* On p. 168 he says: "These grooves curve forward and upward in front of the gill-clefts (after the obliteration of the first gill-pouches), and then proceed backward on either side of the dorsal middle line of the pharynx as far as the commencement of the œsophagus. Here they appear to curve downward again, and, uniting together, extend forward as a median ventral groove to the posterior lip of the hypobranchial aperture."

The arrangement of the ciliated bands and grooves, then, is briefly as follows: on the floor of the pharynx, beginning at or near the opening of the œsophagus, is a ridge of epithelium on which no cilia could be made out. This ridge, after extending forward for a very short distance, becomes changed gradually into a shallow, median, ciliated groove that continues without change to the duct of the thyroid. Just anterior to the duct, the ventral ciliated groove splits into two grooves, which separate gradually on the floor of the pharynx, and near the extreme anterior end pass upward on each side to the roof of the pharyngeal cavity. The grooves then converge as they pass backward until, at a point anterior to the front end of the thyroid, they unite again and form the median, ciliated dorsal ridge which extends backward to the œsophagus, of which it forms, for a short distance, the dorsal wall.

In the gland itself the changes begun in previous stages have been carried now much further. The cover cells (figs. 5*e–m*, *d.l.*) (Decklamelle) have shortened until they form a sort of membrane, while the gland cells (figs. 5*f–m*, *g.l.*) have greatly elongated and their nuclei now lie near one end. The gland is completely divided by the median lamella (figs. 5*e–h*, *m.l.*) from the anterior end as far back as the duct. From the duct to the posterior end (figs. 5*i–k*, *m.l.*), the lamella is simply a partition rising from the floor of the gland but not reaching to the roof, its upper edge being swollen for a considerable distance posterior to the duct (figs. 5*i–k*, *m.l.*). The lateral invagination is very deep and important in determining the structure of the organ. Near the anterior end (fig. 5*e*, *i.v.*) it has not changed greatly from the condition in which it was at the last stage, but as we pass to sections further back we find that the invagination forms a considerable cavity in each lateral half of the gland (figs. 5*f–h*, *i.v.*), and posterior to the duct the gland, in cross section, is seen to be divided into three distinct parts, a central and two lateral divisions (figs. 5*i–k*). In the posterior part of the invagination mesoblast cells are often seen (fig. 5*i*, *mes.*).

The most extensive and complicated changes that have taken place are those of the gland cells (*g.l.*). The first among the changes to be mentioned is the separation of these cells into two groups, the ciliated cells and gland cells proper. The method of this separation is partly shown in fig. 5*e*. As seen in this section, the nuclei of the gland cells appear to have arranged themselves near the periphery of a somewhat oval mass of cells and to have been pushed in, at one point, by the lateral invagination (*i.v.*). On the medial side of this oval mass of cells, lying parallel to the median lamella (*m.l.*), is seen a double row of nuclei, the lateral row (*n.g.l.*) apparently having been separated from the medial row (*n.f.l.*). The nuclei in the medial row become the nuclei of short columnar cells (fig. 5*f*, *f.l.*), while the lateral nuclei remain in the gland cells proper (fig. 5*f*, *g.l*). A considerable space is formed between the ciliated cells and the gland cells, which becomes connected with the lateral invagination (figs. 5*f–h*, *i.v.*) by the separation in the centre (at the end of the line *n.g.l.*, fig. 5*e*) of the nuclei of the lateral row (*n.g.l.*), and the joining of these separated ends with the nuclei of the adjacent sides of the invaginated double row of nuclei; the cells above (dorsal to) the line *n.g l.* (fig. 5*e*) joining with those above the invagination (*i.v.*), and the cells below (ventral to) *n.g.l.* joining the cells on the lower side of the invagination. In other words, the space formed between the ciliated cells and the gland cells becomes connected with the exterior by the breaking through (between the short parallel lines at the end of the reference line *n.g.l.*, fig. 5*e*) of the lateral invagination. The nuclei that are connected by the short black lines, referred to above, will lie hereafter in adjacent gland cells.

The result of these changes is not only the formation of a distinct layer of columnar ciliated cells (fig. 5*f*, *f.l.*), but also the formation of four *groups* of gland cells in each half of the thyroid. Of these four groups of cells, two are large and have reached nearly their full differentiation at this stage (figs. 5*e–j*, *g.r.*); the other two (figs. 5*e–j*, *g.r'.*) are still very small and undeveloped, though even when fully developed they remain somewhat smaller than the first formed groups. The large groups of gland cells are somewhat fan-shaped, when seen in cross section, and are composed of greatly elongated conical cells, whose nuclei lie at their bases.

On account of the great difficulty in obtaining good preparations of these gland cells, as before mentioned, many series of sections had to be studied before any conclusion could be reached as to the minute structure of the cell *groups*. The pointed ends of the cells are directed toward the opening (*o.*) of the cell group, and, in the later stages at least, are usually obscured by the mass of secretion which fills any space there may be in the centre of the cell group. In practically every instance there was a small protuberance at the opening of the cell group (fig. 5*g* and fig. 6*l*, *p.s*), which appeared to be a small mass of secretion which had been forced out of the cell group by the contraction of the gland at fixation. There was no secretion found in any other part of the gland, which fact could be explained only by supposing that the secretion was carried away as fast as it was formed, by the cilia. As seen in fig. 6*l* (a camera drawing of a section of the next stage, magnified 925 diameters), the opening of the cell group is covered over by a membrane which is continuous with the membrane from which the cilia arise. As this membrane, in any given group, may be followed without a break through a long series of sections and the protuberance of secreted matter seen in each section, it is difficult to see how the secretion gets on the outer side of the membrane, unless it passes through a series of holes in the membrane that, when filled as they are with secretion, are too minute to be seen, even under a magnification of 1200 diameters.

In fig. 6*l* may be seen, just under the basement membrane, a number of triangular condensations of the cell substance on each side of the opening. These inverted cones were seen in a number of sections that happened to be stained in just the proper way, but no explanation of their presence suggested itself.

Roughly speaking, each half of the thyroid may be considered to be made up essentially of two large and two small cylinders of gland cells, each cylinder extending the whole length of the gland (fig. 5*c*, *gr.* and *gr'.*). The small cylinders (*gr'.*) are as yet so rudimentary that they can scarcely be recognized as such, but, as has been said, they will acquire later the same structure as is now possessed by the larger cylinders (*gr.*). Extending the entire length of each cylinder or cell group is a narrow band of minute holes, mentioned above (fig. 5*f*, *o.*, and fig. 6*l*, *m.*), through which the secretion of the gland cells escapes into the ciliated chambers and thence, through the duct, to the ciliated grooves of the pharynx.

The remaining structural details of the gland may be understood from a description of the duct, which is somewhat complicated. As has been described above, the two ventral branches of the ciliated grooves run along the floor of the pharynx, getting closer and closer together, until they unite and form a single deep groove (figs. 5*e–h*, *v.c.g.*). In fig. 5*f* the ventral ciliated grooves (*v.c.g.*)

have almost united, being separated only by a wedge-shaped portion of the pharyngeal floor. They are deep, and so narrow that there would seem to be but little room for ciliary action. The cells lining the grooves are here somewhat shorter than the other cells of the pharynx, whereas more anterior sections showed the reverse to be the case, as was mentioned above (fig. 5*b–d*).

The single ciliated chamber (considering one side, only, of the bilaterally symmetrical gland) forms about three-fourths of a circle (*m.c.h.*) and is bounded by the *cover* cells (*d.l.*) on the one hand, and by the *ciliated* cells (*f.l.*) on the other. The *cover* cells have become so much flattened that they form a mere membrane, and their nuclei are pressed far apart. The *ciliated* cells are of a typical ciliated columnar form, and are exposed, at their ciliated ends, to the cavity that has been described as the *ciliated chamber*, and, at their basal ends, to the space that is now a part of the lateral invagination (*i.v.*). Several large blood vessels are seen, surrounded by the angular mesoblast cells, and on each side of the thyroid, lying close to the body wall, is a large longitudinal muscle. Before reaching the point at which it opens into the thyroid, the groove spreads out at the bottom (fig. 5*g*, *p.*) and resembles, in cross section, an inverted letter T. The cross arms of the T turn upward as they pass further backward (fig. 5*h*, *p.*) until they are closely pressed against the vertical part of the T. The way in which this curious groove opens finally into the thyroid is interesting. A short distance back of the point represented in fig. 5*h*, the cells of the ciliated and cover layers are interrupted at about the point marked *b.r.* (fig. 5*h*), and at the same time the side pouch (*p.*) of the groove (*v.c.g.*) becomes separated from the groove itself along the line *x–y* (fig. 5*h*). By the union now of the medial end (1.) of the ciliated layer with the end (1′.) of the adjacent side of the groove, and at the same time by the union of ends 2 with 2′ and 3 with 3′, we have a condition represented in fig. 5*i*. The end (4) of the cover layer unites with its fellow of the opposite side of the gland to form the swollen upper edge of the partition (*m.l.*, fig. 5*i*) mentioned above. By a careful comparison of figs. 5*h* and 5*i*, the relationships just described will become clear.

In fig. 5*i* then we have represented a section passing directly through the duct of the gland, and we see that the secretion from the two groups of gland cells (*g.r.*) passes out of the gland in two ways: that from the ventro-median group passes into the central ciliated chamber (*m.c.h.*) and thence directly out through the duct (*v.c.g.*), while the secretion from the dorso-lateral group has to pass into the duct through the side pouch (*p.*). Anterior to the duct, the ciliated chambers (*m.c.h.* and *l.c.h.*) being one (fig. 5*f*, *m.c.h.*), the secretion from the different groups of cells may, of course, pass out either way. The duct is inclined, somewhat, in a postero-ventral direction and is lined with ciliated columnar cells. The point at the end of the line 1 (fig. 5*i*) indicates the place of union of the medial part (fig. 5*h*, 1.) of the ciliated layer with the adjacent side (1′.) of the deep ciliated groove (*v.c.g.*). Reference line 2 shows where the lateral part (2) of the cover layer joined the outer side (2′) of the ciliated pouch (*p.*). Reference line 3 indicates the point at which the lateral part (3) of the ciliated layer joined the medial side (3′) of the ciliated pouch (*p.*). *m.l.* is the median lamella formed by the union of the medial portions of the cover layers (*d.l.*) of the two parts of the gland; from this point it is an incomplete partition all the way to the posterior end of the gland.

Posterior to the duct (fig. 5*j*), the medial portion (1.) of the ciliated layer joins its fellow of the opposite side, above the median lamella (*m.l.*), while the outer part (3) of this layer remains continuous with the outer part of the cover layer. By this arrangement the lateral invagination (*i.v.*) apparently completely separates a lateral from the central part of the gland, as has been mentioned before, and the mesoblast cells are found between the two divisions (*mes.*). This is shown also in fig. 5*m*, which is a horizontal section of the entire gland. A section at this plane gives the impression that the lateral invagination (*i.v.*) almost completely separates the lateral from the central portion of the gland, but of course if the section were cut nearer to the dorsal surface of the gland, the lateral portion would be seen to be joined to the central portion anterior to the duct (to the left of *m.l.*), as has been seen in figs. 5*e*–*h*. Fig. 5*m* shows the extent to which the gland is completely divided by the partition (*m.l.*), and also the position of the gland in relation to the gill-arches (*v.a.*, 2–5). The cilia are omitted from this figure. In all the sections posterior to the duct, as seen in fig. 5*j*, there are three distinct ciliated chambers. The median ciliated chamber (*m.c.h.*), occupying the central division of the gland, is triangular in cross section, and is partially divided into two chambers by the median lamella (*m.l.*) which rises from the middle of its ventral wall. Into each half of the median ciliated chamber empty one of the large and one of the small groups or cylinders of gland cells. The smaller cell group, as has been said, at this stage is still in a rudimentary condition.

The lateral ciliated chamber (*l.c.h.*) is crescentic in cross section, the lesser curve of the crescent being formed by the ciliated cells, the greater curve by the cover cells. Into the lateral chamber empty a large and a small group of gland cells. Dorsal to the gland are the two large blood vessels (*art.*) and close above these the floor of the pharynx, with the ventral ciliated groove (*v.c.g.*), now much diminished in depth. Fig. 5*k* is of a section near the posterior end of the gland, passing through the upcurved portion. The reference line *m.c.h.* begins in the cavity of this upwardly bent part, which is cut through at the point where it is continuous with the central ciliated chamber of the gland. A section just anterior to this would show this upper space as a separate cavity. Dohrn says this marked bend at the posterior end, as well as the less marked one at the anterior end, is caused by the growth of the gland being more rapid than that of the space in which it is enclosed.

The lateral portions of the gland at the point represented in fig. 5*k* are very small. The central partition (*m.l.*) is still present, as seen in fig. 5*l*, and imperfectly at *m.l'.* in fig. 5*m*. The ventral groove (*v.c.g.*) and dorsal ridge (*c.d.r.*) are also very plainly seen in fig. 5*k*. The blood vessels are followed easily and are usually filled with large nucleated corpuscles. In the last two sections (figs. 5*k* and 5*l*) the thyroid has diminished in size, and the arrangement of the gland cells into the four groups can be recognized no longer. The lateral ciliated chamber is reduced to a nearly circular cavity, and the ventral ciliated groove is flattening out gradually, preparatory to changing to the low ridge mentioned in the description of the system of ciliated grooves. The ciliated dorsal ridge is very prominent and partially embraces the aorta in its folds. The cell structure of the body wall and of most of the pharyngeal wall is omitted in these as in most of the preceding figures.

In the following and last stage of development (figs. 6*a*–*k*), the gland has apparently reached its greatest complexity, as the only noticeable change from the preceding and much younger stage, except increase in size, is the remarkable coiling of the posterior end of the gland, caused, Dohrn says, as has been previously mentioned, by the longitudinal growth of the gland being more rapid than the space in which it is enclosed. The larva from which this stage was taken had reached a length of about 15 cm., and a circumference of about 2.5 cm. in the region of the thyroid.

Fig. 6*j* is a ventral view of the anterior end of a larva of this stage, the ventral integument (*b.w.*) of which has been dissected along the mid-ventral line and drawn to each side, so as to expose the thyroid gland (*thy.*). The figure shows the shape of the gland as seen from the ventral side, and also its relative size and position. The cartilaginous bars (*c.b.*) of the branchial basket are also shown, and it is seen that the large mid-ventral bar divides when it reaches the posterior end of the gland into two lateral bars, one of which lies close to each side of the thyroid throughout nearly the entire length of the gland. The longitudinal grooves (ventral and lateral invaginations) are quite indistinct because of the mass of white, fibrous-looking connective tissue which now surrounds the gland on all sides. At this stage, as is seen in fig. 6*j*, the gland extends from the middle of the first to the middle of the fourth gill-pouch (*g.p.*), and is about one-third the diameter of the entire pharynx. In a ventral view, the coil of the posterior end of the gland does not of course show, but at each end is seen a median groove which shows, even through the fibrous envelope; these grooves are caused by the separation of the two parts of the gland, at each extremity, whereas throughout most of their length the halves are in close contact with each other. The numerous transverse folds in the seven pairs of gill-pouches are seen in this figure, and also the fibrous character of the anterior wall of the pharynx. The actual oral opening is not shown.

Fig. 6*k* is a diagrammatic side view of the gland, to show the points through which the sections were cut, and also to show longitudinal space relations, such as size and position of duct, extent of coil, etc. Being carefully reconstructed and drawn by scale, it shows these relations with more or less accuracy. As is seen from this diagram, the duct lies a little nearer the posterior than the anterior end of the gland, though if the coiled posterior end of the gland were straightened out the duct would then be considerably nearer the anterior end. By comparing fig. 6e with this diagram, it will be noticed that the duct is now a longitudinal slit instead of a nearly circular duct, the lateral growth of the duct apparently not having kept pace with the longitudinal. Fig. 6*k* represents the actual relative *longitudinal* but not *vertical* dimensions of the duct. The actual increase in size of the gland may be appreciated by noting that, though all the sections were drawn with a camera, those represented in figs. 5*b–l* are enlarged 240 diameters, while those in figs. 6*a–i* are magnified only 90 times.

A section through the anterior end of the gland, passing through the point marked *a*, fig. 6*k*, is represented in fig. 6*a*. The chief difference, besides that of size, between this section and the corresponding one of the preceding stage (fig. 5*f*) is in the complete development of the cell-groups (*gr'.*), which in the preceding stage were quite small and undeveloped. We have now in each side of the gland, which is exactly bilaterally symmetrical, four *groups* of gland cells, the groups being arranged in pairs, one pair on each side lying near the middle line, the other being nearer the side (figs. 6*e* and *k*, *m.c.g.* and *l.c.g.*). This arrangement of the cell-groups into pairs is distinct from end to end of the gland, and for convenience they will be spoken of as the "median" and "lateral" *pairs* of cell-groups. As has been said, the groups *gr'.* never reach the size of the first developed groups *gr.*

The ciliated cells have changed somewhat since the preceding stage. They have become relatively, as well as actually, more elongated at certain parts of the ciliated layer, while at other places they are still short and nearly filled with their large oval nuclei. The nuclei of the longer cells are small and circular in outline, and at certain places seem to be more or less regularly arranged near one end or other of the cells, while at other places there is no apparent regularity in their arrangement. In fig. 6*a*, the short cells with large nuclei are seen on either side of the slit-like openings (*o.*) into the groups of gland cells. The ciliated grooves (*c.c.g.*), at the point where this section is cut, are still some distance apart on the floor of the pharynx, and are not noticeably changed from their condition in the preceding stage. They are separated by one large and two small folds in the floor of the pharynx, which seems, at this point, to be very irregular in outline, probably caused partly by shrinkage at fixation. They are very deep and narrow and seem filled completely by their cilia.

The connective tissue covering (*c.t.*) of the thyroid, spoken of in connection with the outward appearance of the thyroid, is seen, in section, to form a thick layer entirely around the gland and to form the central mass of median lamella (*m.l.*). It also forms a thick coating around each branch of the large artery which Dohrn calls the Pseudobranchial artery (Spritzlocharterie) (*art.*). The large and now nearly enclosed space (*i.v.*), formed by what was called the "lateral invagination," is more or less completely filled by a sort of reticulated tissue with scattered nuclei. This reticulated tissue also fills the space between the floor of the pharynx and the thyroid. Numerous small blood vessels are found imbedded in it, both in that which fills the lateral invagination and in that which lies between the gland and the pharynx. This tissue is represented only in figs. 6*a* and 6*b*, but the fibrous tissue is shown in all the figures of this stage.

Fig. 6*b* represents a section cut a short distance anterior to the duct, at the point *b.*, fig. 6*k*, and about corresponds to fig. 5*h* of the preceding stage. The ciliated grooves at this point have united to form a single deep groove, which is spread out at the bottom to form the side pockets (*p.*) described in the preceding stage. The lateral and median *pairs* of cell-groups have approached each other until their adjacent groups are nearly or quite in contact; at the same time the ciliated layer (*f.l.*) has increased somewhat in length, and at its dorso-median angle (at the end of the lines *f.l.*, fig. 6*b*) its cells have changed from the tall columnar with small, round nuclei to short cells, almost completely filled with their large oval nuclei and resembling the cells that lie close to the openings (*o.*) of the groups of the gland cells. It is this group of cells, lying in the dorso-median portion of the ciliated layer, that separates into two about equal parts, a little further posteriorly, to connect the gland with the deep ciliated groove, in the manner described in the preceding stage and shown in figs. 5*h*–*i* of that stage and in fig. 6*c* of the stage now under discussion. The ciliated layer is somewhat folded, as though it had increased in length very rapidly, or had been compressed by the shrinkage of the connective tissue (*c.t.*) surrounding the gland. There is considerable space at this point between the pharynx and the thyroid, which necessitates the very deep ciliated groove shown in this and the next figure. The arteries (*art.*) are very large and are bound closely to the gland by the connective tissue mentioned above. The *cover* layer (*d.l.*) in these sections is reduced to such a thin membrane that it is often difficult to distinguish it from the connective tissue to which it is closely applied throughout.

A section passing directly through the opening of the duct into the gland is represented in fig. 6*c*. The duct, a deep, narrow slit, is lined with short, ciliated columnar cells, similar to the shorter cells of the ciliated layer spoken of above. These short cells lead quite suddenly into the long cells of the ciliated layer (*f.l.*).

The lateral pair of cell-groups (*l.c.g.*) is now entirely distinct from the median pair (*m.c.g.*), and the pocket (*p.*) by which the lateral cell-groups are connected with the duct, as before explained, is continued to the extreme posterior end of the gland, the two lateral pairs of cell-groups taking no part in the posterior coil but continuing back of this for some distance (figs. 6*i* and *k*).

The median lamella (*m.l.*), which back to this point has completely divided the gland into two parts, is from this point merely a tall ridge (fig. 6*c*, *m.l.*) projecting upward into the median ciliated chamber (*m.c.h.*) and covered by the cover cells (*d.l.*) (Decklamelle) of the two median pairs of cell-groups. As in the preceding stage, the dorsal edge of this ridge is at times somewhat thickened.

The space between the anterior end of the coil and the duct is short, as is seen by fig. 6*k*, and a section through the gland in this region (fig. 6*d*) differs very little from a corresponding section on the preceding stage (fig. 5*j*), except in the particulars already pointed out for the anterior end of the gland. The median ciliated chamber (*m.c.h.*) is long and narrow in a dorso-ventral direction and its dorsal part is made up of the shorter form of ciliated cells. The lateral ciliated chamber (*l.c.h.*) is also much more extensive than in the preceding stage. The ciliated groove (*v.c.g.*) is seen above the gland in the floor of the pharynx. It is much less deep than it was, just anterior to the duct, and remains in about this condition to a point beyond the extreme posterior end of the gland. There is still a considerable space between the thyroid and the floor of the pharynx, which space is filled with the reticulated tissue mentioned above and shown in figs. 6*a* and 6*b*.

The following four sections (figs. 6*e–h*) all pass through the coiled posterior end of the gland, at the points indicated by the corresponding letters in fig. 6*k*. The apparent complexity of these four sections will be made plain by comparing them with the diagrammatic lateral view of the gland (fig. 6*k*). In all four sections, what we have called the lateral pairs of cell-groups (*l.c.g.*) remain the same and may be recognized by their long, curved, lateral ciliated chambers (*l.c.h.*).

In fig. 6*e* the median pairs of cell-groups are seen in a mid-ventral position (*m.c.g.*) as they are followed in an anterior-posterior direction, again in a mid-dorsal position (*m.c.g′.*) as they are followed in a posterior-anterior direction, and again in nearly the centre of the gland at *m.c.g″.* as they are followed toward the posterior end again. This is easily understood by noting the position of the line *e* in fig. 6*k*, which shows that the section is cut at the point where the posterior-anteriorly directed part of the median cell-groups (*m.c.g′.*) turns ventralward, to pass again toward the posterior (*m.c.g″.*). The central ciliated chamber (*m.c.h.*) is thus seen, in this section, to be continuous from the dorsal (*m.c.g′.*) to the middle (*m.c.g″.*) position of the median cell-groups. The general character of the various groups and layers of cells remains about the same in all four of these sections, so that it will be only necessary to speak of their position and arrangement in the sections.

The next section (fig. 6*f.*) cuts the median cell-groups in four places, as is shown in fig. 6*k*—at *m.c.g.* in the anterior-posteriorly directed portion, at *m.c.g′.* in the dorsal posterior-anterior portion, at *m.c.g″.* in the part that is directed again toward the posterior end, and at *m.c.g‴.* in the last whorl of the coil which is directed toward the anterior end of the gland. It will be noticed in this and in the other sections passing through the coiled part of the gland, that the median lamella (*m.l.*) extends into the coil only a short distance. It extends through the dorsally directed part of the coil shown in fig. 6*h*, and for a short distance in the posterior-anteriorly part lettered *m.c.g′.* Whether it was never found in this end of the gland, or whether it was flattened out by compression was not determined. The shape of the median ciliated chamber varies considerably in the different whorls of the coil, as is seen in fig. 6*f*, *m.c.h.* In its ventral position—that is, in the position lettered *m.c.g.*—the ciliated chamber has the same outline as in previous sections, and is divided by the median lamella (*m.l.*). In its dorsal position (*m.c.g'.*) it is a large chamber undivided by a median lamella. In the middle of the coil, especially in the position lettered *m.c.g'''*, the chamber is much diminished, apparently by the pressure of the surrounding whorls of the coil. By remembering that the groups *m.c.g'.* and *m.c.g'''.* are inverted, as a comparison with the line *f.* in fig. 6*k* will show, it will be seen that the gland is in reality no more complicated than it was further forward. Nothing further need be said of this section.

Fig. 6*g* represents a section cut through the point where the posteriorly directed whorl (*m.c.g''.*) turns dorsalward, to pass anteriorly as the innermost whorl (*m.c.g'''.*) of the coil.

Fig. 6*h* shows the most posterior of the four sections passing through the coil. It passes through the point where the median cell-groups (*m.c.g.*) make their first bend dorsalward to where they turn again to form the anteriorly directed whorl (*m.c.g'.*).

As has been previously said, the lateral cell-groups (*l.c.g.*) take no part in the posterior coil but extend for a considerable distance posterior to the coil, somewhat diminished in size, and gradually approach each other until they are in close contact.

Fig. 6*i* represents a section taken at a point about midway between the extreme posterior end of the gland and the posterior surface of the coil. It shows the two pairs of lateral cell groups (*l.c.g.*), each with its characteristically curved lateral ciliated chamber (*l.c.h.*). Just posterior to the coil the two large pseudobranchial arteries, which were seen on each side of the gland in all the preceding sections (figs. 6*a–h*, *art.*), unite to form the one large artery seen in fig. 6*i*, *art.*, lying between the gland below and the ciliated groove above. This artery is very large, being almost as great in cross section as the end of the thyroid below it. The wall of the pharynx is separated from the gland by a comparatively small space, so that it is evidently pushed upward by the large coiled end of the gland and sinks down again just behind this elevation. The groups of gland cells have diminished somewhat, in cross section, but they are not greatly diminished even at their extreme posterior end.

If, as Dohrn says, the coiling of the posterior end of the thyroid gland is caused by its longitudinal growth being more rapid than the growth of the space in which it lies, it is difficult to see why the lateral cell-groups have not taken part in the coil, instead of projecting as they do for a considerable distance posterior to the coil.

THE THYROID AND SALIVARY GLANDS IN THE ADULT LAMPREY.

The condition of the thyroid in the adult lamprey was studied in several large sea lampreys (*Petromyzon marinus*) taken at the herring fisheries of the Susquehanna river, and in a couple of brook lampreys (*P. branchialis*) from Ithaca, N. Y.

Wilhelm Müller says[1] that the thyroid in the "sexually mature" animal extends underneath the long tongue muscle from the second to the fourth gill-sac, and is built up of a number of closed follicles lined with intensely brown-yellow epithelium. He says it cannot be mistaken for the salivary gland, lying under the eye and opening by a duct into the mouth.

A study of serial sections of a couple of recently transformed brook lampreys confirmed Müller's description of the position and anatomy of the adult thyroid, but careful dissection of one or two adult sea lampreys, and even sections of part of the floor of the pharynx, failed to show any trace of the thyroid. As the brook lampreys were, as has been said, only just transformed, while the sea lampreys were killed at sexual maturity, it is possible that the thyroid, which is ductless and a mere rudiment in any case, had nearly or quite disappeared in the older animals. As is seen in fig. 10*a*, the thyroid, which in the younger larval stages was enormously large, proportionally, is a small group of follicles lined with columnar or cuboidal epithelium (fig. 10*b*). It is surrounded by connective tissue and lies between the tongue muscle above and the median ventral cartilaginous bar below, with a large blood vessel on either side. It extends, as Müller says, from the second to the fourth gill-pouch. The follicles are generally filled with a secretion (not shown in the figures), and, with their surrounding cells, form, in cross section, an oval mass. Usually from four to six follicles are cut in each transverse section.

Born was the first to describe correctly the salivary or basilar gland in the lamprey, Rathke having mistaken the basilar muscle, in which the gland lies imbedded, for the tissue of the gland, considering the true gland as merely the *cavity*.

---

[1] *Jenaische Zeitschrift*, Bd. VII.

The gland is paired, and each half lies, as has just been said, imbedded in the tissue of the corresponding half of the large, paired basilar muscle. This muscle lies in the floor of the mouth and pharynx and is one of the muscles used by the animal in adhering to rocks or fish. By contraction of this muscle the salivary gland is compressed and its secretion thus forced out.

In the large, adult sea lamprey the two parts of the basilar gland are easily discovered by dissection, lying in the medial sides of their corresponding halves of the basilar muscle. In the much smaller brook lamprey, the position and structure of the basilar gland may be made out by stained serial sections (figs. 9*a* and 9*b*). Each half of the gland is a thin-walled ovoidal sac, about 2 cm. long and 8 mm. in cross section, in the sea lamprey. The epithelial cells of the walls are of a short columnar form, and the walls are thrown into numerous irregularly arranged papillæ and short folds, which project into the cavity of the gland (figs. 9*a* and 9*b*).

From the medial side of the gland, a short distance back of its extreme anterior end, the duct leads forward, gradually approaching its fellow of the opposite side, but never meeting it, to open into the mouth cavity through a small papilla. Little or no secretion was seen in the gland. The posterior end of the gland is separated from the first gill-sac by a distance about equal to the space occupied by two gill-sacs.

Fig. 9*a* represents a transverse section through the ventral part of the body of an adult brook lamprey. The large basilar muscle (*b.m.*) is seen on each side, between the body wall (*b.w.*) below and the pharynx (*phar.*) above. Imbedded in this muscle is the basilar or salivary gland (*b.g.*) whose walls are thrown into irregular folds and papillæ, as has been mentioned.

Fig. 9*b* is anterior to 9*a* and is drawn under greater magnification. One side only of the gland is shown, the section passing through it just anterior to the opening of the duct (*d.*) into the gland. This figure shows that the folds in the wall of the gland are formed by invaginations of irregular form and at irregular intervals. The wall of the duct is of about the same thickness as that of the gland, but is not thrown into folds. The duct diminishes in size somewhat as it passes forward.

As no trace whatever of this basilar or salivary gland could be found in even the oldest larvæ at hand, which must have been very nearly ready to undergo transformation, though several well preserved and stained series were examined, it seemed possible that this gland might have been developed from the anterior part of the larval thyroid, or from the pair of deep ciliated grooves which run forward from the opening of the thyroid and which are not present, as such, in the adult condition.

The similarity in the secretion and function of the larval thyroid to the secretion and function of a salivary gland seems to support this view.

The author hopes, with the aid of proper material, to be able to prove definitely whether or not there is any relation between the larval thyroid and the salivary gland of the adult *Petromyzon*.

BIBLIOGRAPHY.

BABES, 1881. Researches on the Minute Structure of the Thyroid Gland, Phil. Trans. Roy. Soc., London, 1881, pp. 577–608.

BROOKS, 1893. Origin of the Chordata in "Genus Salpa," pp. 178–203. Mem. from the Biol. Lab. of Johns Hopkins Univ.

BUJOR, 1891. Contribution à l'étude de la metamorphose de l'Ammocœtes branchialis et P. planeri. Revue Biol. de Nord France; 3ème Ann., No. 8, 305–315; No. 9, 325–339; No. 10, 365–390; No. 11, 417–426; No. 12, 474–486; 4me Ann., No. 2, 41–46.

DOHRN, 1886. Thyroidea und Hypobranchialrinne, Spritzlochsack und Pseudobranchialrinne bei Fischen, Ammocœtes und Tunicaten. Mitt. zool. Sta. v. Neapel, Bd. VII, pp. 301–336.

1886. Thyroidea bei Petromyzon, Amphioxus und Tunicaten. Mitt. Zool. Sta. v. Neapel, Bd. VI, pp. 49–89.

FISCHELIS, 1885. Beiträge zur Kenntniss der Entwicklungsgeschichte der Glandula thyroida und Glandula thymus. Archiv. fur mik. Anat., Bd. XXV, 1885.

FÜRBRINGER, 1875. Untersuchungen z. Vergleichenden Anatomie d. Muskulatur d. Kopfskelets d. Cyclostomen. Jen. Zeitschr., Bd. IX, 93 pages.

GAGE, 1893. Life-History of Certain Species of Lamprey. Wilder Quarter-Century Book, 1893, pp. 420–479.

JULEIN, 1890. Vascular and nervous system, etc., and the metamorphic value of the thyroid body. Archiv. d. Biol., T. VII, pp. 759–902.

KOHN, 1895. Studien über die Schilddrüse. Archiv. f. mik. Anat., Bd. XLIV, 1895, pp. 366–422.

KUPFFER, 1888 and 1890. Development of the Lamprey (P. planeri). Archiv. f. mik. Anat., Bd. XXXV, pp. 469–558.

MAURER, 1885. Mittheilung u. d. Schilddrüse und Thymus d. Teleosts. Jen. Zeitschr., Bd. XIX.

DE MEURON, 1886. Recherches sur le development du Thymus et de la gland thyroid. Recueil zoologique Suisse, Premier Series, T. III.

MULLER, W., 1872. U. d. Hypobranchialrinne d. Tunucaten und deren Vorhandensein b. Amphioxus u. d. Cyclostomen. Jen. Zeitschr., Bd. VII.

SCOTT, 1887. Development of Petromyzon. Jour. Morph., Vol. I, pp. 253–310.

WILLEY, 1894. Amphioxus and the Ancestry of the Vertebrates. Macmillan Co

EXPLANATION OF LETTERING.

a.h.l., anterior horizontal lamella.
aort., aorta.
art., pseudobranchial artery.
b.g., basilar (salivary) gland.
b.m., basilar muscle.
br., point of separation of ciliated and of cover cells.
b.w., body wall.
c.b., cartilaginous bars.
c.d.r., ciliated dorsal ridge.
ch., notochord.
c.t., connective tissue envelope.
d., duct of basilar gland.
d.c.g., dorsal ciliated groove.
d.l., cover cells (Decklamelle).
e., eye.
f.l., ciliated cells.
g.l., gland cells (Drusenlamelle).
g.p, gill pouch.
gr., primary group of gland cells.
gr'., secondary group of gland cells.
i.v., lateral invagination.
l., loop of the ciliated groove.
l c.g., lateral cell-group.
l.c.h., lateral ciliated chambers.
m., membrane over *o.*
m.c.g., *m.c.g'.*, etc., median cell-groups.
m.c.h., median ciliated chamber.
mes., mesoblast.
m.l., median lamella.
m.l'., extreme posterior end of median lamella.
n fl., nuclei of ciliated cells.
n.gl., nuclei of gland cells.
o., slit-like opening of cell-groups.
œs., œsophagus.
p., side pouch of ventral ciliated groove.
phar., pharynx.
p.h.l., posterior horizontal lamella.
p.s., protuberance of secreted matter.
s., secretion.
sp.c., spinal cord.
sto., stomodæun.
thy., thyroid gland.
t.m., tongue muscle.
u.l., upper lip.
v., velum.
v.a.1, 2, etc., 1st, 2d, etc., visceral arches.
v.c, visceral clefts.
v.c.g., ventral ciliated groove.
x-y., line through which the separation of the side pouch from the ventral ciliated groove takes place.

EXPLANATION OF PLATES IV, V, VI, VII.

All sections drawn with a Zeiss Camera Lucida.

Fig. 1*a*.—Larva of *P. planeri*, 11 days after fertilization, to show the external appearance of the larva at the time of the first trace of the thyroid. (Mag. 65 diam.)

Fig. 1*b*.—Transverse section of 12-day larva of *P. planeri*, through the anterior end of the thyroid, just anterior to the opening into the pharynx. Shows the gland as a circular cavity lined with columnar cells, lying under the digestive cavity. (Mag. 325 diam.)

Fig. 1*c*.—Transverse section posterior to fig. 1*b*, through the anterior part of the opening of the thyroid into the pharynx. (Mag. 325 diam.)

Fig. 2*a*.—Transverse section through the extreme anterior end of the thyroid of a 14-day *P. planeri*. (Mag. 325 diam.)

Fig. 2*b*.—Transverse section posterior to fig. 2*a*, but anterior to the opening of the gland into the pharynx. Shows beginning of lateral invagination. (Mag. 325 diam.)

Fig. 2*c*.—Transverse section posterior to fig. 2*b*, through the anterior part of the opening of the gland into the pharynx. (Mag. 325 diam.)

Fig. 2*d*.—Transverse section posterior to, fig. 2*c*, through the posterior part of the opening of the gland into the pharynx. (Mag. 325 diam.)

Fig. 2*e*.—Transverse section through the gland, posterior to the opening into the pharynx. (Mag. 325 diam.)

Fig. 3.—Sagittal section through the head of a 13-day *P. planeri*, passing almost through the median plane of the thyroid and somewhat to one side of the centre of the stomodæum. Shows the beginning gland as an evagination of the floor of the pharynx. The anterior and posterior horizontal lamellæ, which finally separate the gland from the pharynx, are just beginning to be formed. (Mag. 325 diam.)

(Figs. 4–7 are taken from the material obtained at Ithaca, N. Y., and are therefore either of the lake or of the brook lamprey, or perhaps of both.)

Fig. 4*a*.—Transverse section through the anterior end of the thyroid, passing through the extreme posterior edge of the vertical lamella. Shows beginning of differentiation of cells into "gland" and "cover" cells. (Mag. 240 diam.)

Fig. 4*b*.—Transverse section posterior to fig. 4*a*, cutting the gland just anterior to the duct, and showing the first trace of the ciliated groove. (Mag. 240 diam.)

Fig. 4*c*.—Transverse section near the posterior end of the gland, posterior to the duct and to the lateral invaginations. (Mag. 240 diam.)

Fig. 5*a*.—Lateral view of the head of a 9 mm. larva, to show the relative size of the thyroid gland and its position in relation to the gill-arches, etc. (Drawn from the living animal under a magnification of 50 diam.)

Fig. 5*b*.—Transverse section through the head of a larva of *Petromyzon*, anterior to the thyroid, through the point where (on the right side) the ciliated groove turns from the dorsal toward the ventral side of the pharynx. The section cuts exactly through the end of the loop on the right side, but somewhat posterior to this point on the left side. (Mag. 240 diam.)

Fig. 5*c*.—Transverse section a short distance posterior to fig. 5*b* to show how the dorsal branches of the ciliated grooves approach each other, on the roof of the pharynx, as they pass toward the posterior; and the same for the ventral branches on the floor of the pharynx. (Mag. 240 diam.)

Fig. 5*d*.—Transverse section posterior to fig. 5*c* and just anterior to the gland. Shows the dorsal ciliated grooves separated only by a ridge of cells, which, a short distance further toward the posterior, becomes the ciliated dorsal ridge. The ventral grooves also are seen nearer together. (Mag. 240 diam.)

Fig. 5*e*.—Transverse section through the anterior end of the thyroid. Shows the still nearer approach of the two ventral grooves. The cover cells are flattened out into a thin membrane, while the gland cells are very long, are splitting off from their nucleated ends the cells to form the ciliated layer and begin to show an arrangement into the four cell-groups. The lateral invagination deeply indents each of the halves into which the gland is divided by the median lamella. (Mag. 240 diam.)

Fig. 5*f*.—Transverse section posterior to fig. 5*e*. The ciliated grooves are nearly joined, the ciliated layer of cells is now distinct, as are two of the four cell-groups. The lateral invagination is very deep. (Mag. 240 diam.)

Fig. 5*g*.—Transverse section posterior to fig. 5*f* but still anterior to the duct. The ciliated grooves have united to form a single deep groove which is here spread out at the bottom, giving it the shape, in cross section, of an inverted letter T. The structure of the gland is now about the same as in the preceding section. (Mag. 240 diam.)

Fig. 5*h*.—Transverse section posterior to fig. 5*g* and just anterior to the opening of the duct. The structure of the gland is the same as in fig. 5*g*, but the shape of the ciliated groove has changed somewhat. (Mag. 240 diam.)

Fig. 5*i*.—Transverse section through the opening of the duct into the ciliated groove. Shows that the median ciliated chamber opens directly into the deep ciliated groove, while the lateral ciliated chambers open into the ciliated groove through the side pouches noticed in the last two preceding figures. The lateral invaginations, from this point to the posterior end, divide the gland into three distinct parts, a median and two lateral parts. The median lamella is no longer a complete partition and shows a decided swelling on its dorsal edge. (Mag. 240 diam.)

Fig. 5*j*.—Transverse section a short distance posterior to the opening of the duct. The ciliated groove is still present but much diminished in depth. (Mag. 240 diam.)

Fig. 5*k*.—Transverse section posterior to fig. 5*j*, passing through the beginning posterior coil. Shows the now broad and shallow ciliated groove close to the top of the gland, and ciliated dorsal ridge on the roof of the pharynx. (Mag. 240 diam.)

Fig 5*l*.—Transverse section through the extreme posterior end of the gland. (Mag. 240 diam.)

Fig. 5*m*.—A horizontal section through the thyroid, showing the extent of the complete median lamella, the relative position of the visceral arches, etc. (Mag. 240 diam.)

Fig. 6*a*.—Transverse section through the anterior end of the thyroid of a 10 cm. larval *Petromyzon*. All four groups of cells are now fully developed, and the gland has increased greatly in size, as is shown by the fact that figs. 5*a–m* were magnified 240 diameters, while the larger figs. 6*a–i* were magnified only 90 times. This figure about corresponds to Fig. 5*e* of the preceding stage.

Fig. 6*b*.—Transverse section posterior to fig. 6*a* and just anterior to the opening of the duct. Corresponds to fig. 5*h* of the preceding stage. (Mag. 90 diam.)

Fig. 6*c*.—Transverse section through the duct of the gland. Corresponds to fig. 5*i* of the preceding stage. The lateral ciliated chambers are much more extensive than in the preceding stage. (Mag. 90 diam.)

Fig. 6*d*.—Transverse section just posterior to the duct. Corresponds to fig. 5*j* of the preceding stage. (Mag. 90 diam.)

Figs. 6*e–h*.—Transverse sections through the coiled posterior end of the gland, cut in the planes indicated in fig. 6*k*. (All mag. 90 diam.)

Fig. 6*i*.—Transverse section through the thyroid, posterior to the coiled posterior end of the gland, to show the manner in which the lateral pairs of cell-groups extend for some distance behind the coiled median cell-groups. The pseudobranchial arteries are seen in this section as a single large vessel. (Mag. 90 diam.)

Fig. 6*j*.—Ventral view of the head of a 15 cm. larva, with the ventral integument drawn to each side to expose the thyroid gland. The relation of the gland to the bars of the branchial basket is shown. (Mag. 3 diam.)

Fig. 6*k*.—Diagrammatic lateral view of the thyroid gland, reconstructed by measurement to show, more or less accurateley, the *longitudinal* relationships of the various parts of the gland. The dotted lines indicate the planes through which the sections (figs. 6*a–i*) pass.

Fig. 6*l*.—Section through the opening of one of the cell-groups, highly magnified to show details in structure. (Mag. 925 diam.)

Fig. 7.—Larva of a stage between those represented in figs. 5 and 6. About 2½ cm. in length.

Fig. 8*a*.—Transverse section through the pharynx and anterior end of the thyroid in *Amblystoma*, showing the latter as a deep, ciliated groove in the floor of the former. (Mag. 240 diam.)

Fig. 8*b*.—Transverse section posterior to fig. 8*a*, showing the thyroid as an enclosed tube lined with cilia. (Mag. 240 diam.)

Fig. 9*a*.—Transverse section through the ventral half of the head of an adult brook lamprey, to show the position and relative size of the paired salivary or basilar gland. (Mag. about 17 diam.)

Fig. 9*b*.—Transverse section through one side of the salivary or basilar gland and its duct, just anterior to the opening of the latter into the former. (Mag. 50 diam.)

Fig. 10*a*.—Transverse section through the ventral half of an adult brook lamprey, cutting through the fourth gill-sacs, to show the position and relative size of the thyroid gland. (Mag. 30 diam.)

Fig. 10*b*.—Transverse section through the thyroid at about the plane of the section represented in fig. 10*a*. (Mag. 420 diam.)

MARCH 4.

Mr. ARTHUR ERWIN BROWN, Vice-President, in the Chair.

Thirty persons present.

A paper entitled "Karyokinesis and Cytokinesis in the Maturation, Fertilization and Cleavage of Crepidula and other Gastropods," by Edwin G. Conklin, Ph.D., was ordered to be printed in the JOURNAL.

The death of Francis W. Lewis, M.D., a member, was announced.

The Neurofibrillary Theory and its Bearings upon Localization of Function in the Nervous System.—DR. CHARLES K. MILLS, after referring to the correlation of nerve energy with the other forms of physical energy, spoke of the reception and differentiation of stimuli by peripheral end organs, and the manner in which the neurofibrils or their elementary constituents transmit nervous impulses, holding that the elementary fibrils in which is stored neural energy not only conduct or transmit nervous impulses, but by means of the special manner in which they are arranged in the nerve centres as well as in the periphery, determine the intensity and character of the discharge. He regarded the fibrillary coils and bundles as representing a complicated induction apparatus. Localization of function is brought about by means of special arrangements of intracellular and intercellular neurofibrillary coils and plexuses in the particular regions called centres.

MARCH 11.

The President, SAMUEL G. DIXON, M.D., in the Chair.

Eleven persons present.

Papers under the following titles were presented for publication:

"The Germination of the Seeds of Carapa guianensis Aubl.," by John W. Harshberger, Ph.D.

"Revision of the Japanese Viviparidæ, with Notes on Melania and Bithynia," by Henry W. Pilsbry.

MARCH 18.

MR. LEWIS WOOLMAN in the Chair.

Eight persons present.

The death of Carlos Berg, a correspondent, was announced.

MARCH 25.

MR. CHARLES MORRIS in the Chair.

Nineteen persons present.

Papers under the following titles were presented for publication:

"A Collection of Mammals from Sumatra, with a Review of the Genera Tardigradus and Tragulus," by Witmer Stone and J. A. G. Rehn.

"Mammals Collected by Dr. W. L. Abbott in the Region of the Indragiri River," by Gerritt S. Miller, Jr.

Miss Madeline Dahlgren was elected a member.

REVISION OF JAPANESE VIVIPARIDÆ, WITH NOTES ON MELANIA AND BITHYNIA.

BY HENRY A. PILSBRY.

My work on these groups has been based largely upon material supplied by Mr. Y. Hirase, of Kyoto, Japan.

VIVIPARIDÆ.

The *Viviparidæ* of Japan, so far as their appearance in the field of literature is concerned, are involved in mind-destroying chaos. This has been due partly to the intrinsic difficulty of the subject, but chiefly to a failure on the part of authors to correctly identify the older Oriental species. Mr. T. Iwakawa,[1] of Tokyo, has published a lucid essay upon the subject, in which the natural divisions or species are for the first time correctly set forth. Owing, however, to the fact that he used the names for the species given by Kobelt[2] (as there is probably no library in Japan sufficient for the verification of the German author's statements), the nomenclature adopted by Iwakawa requires revision. This implies no criticism of the Japanese naturalist's admirable essay. The source whence his nomenclature was drawn was tainted; but the names aside, his grasp of the facts of nature was sound.

Pseudo-japanese species.

In my opinion, the following species do not occur in Japan:

Paludina oxytropis Benson, Journal of the Asiatic Society of Bengal, v, 1836, p. 745, type locality Sylhet. Figured in Conchologia Indica, Pl. 76, fig. 5, and Conch. Iconica, fig. 9.
+ *P. pyramidata* v. d. Busch in Philippi, Abbildungen, etc., I, p. 113, Pl. 1, figs. 3, 4 (1844). Type locality, Bengal.

Paludina ingallsiana Lea, Proc. Acad. Nat. Sci., 1856, p. 110. Figured in Observations on the Genus Unio, etc., XI, p. 74, Pl. 22, fig. 9. Type locality, Siam. Not *P. ingallsiana* Reeve!

I am satisfied that those who will compare authentic specimens of

---

[1] Notes on the Paludina-species of Japan, in *Annotationes Zoologicæ Japonenses*, I, Part 3, pp. 83–92, Pl. V, 1897.

[2] *Fauna Molluscorum Extramarinorum Japoniæ*, Frankfurt, 1879.

these species, or in their absence the figures referred to above, will agree with me that no specimens referable to either of them have been made known from Japan.

> *Vivipara stelmaphora* Bourguignat, Rev. et Mag. de Zool., Mars, 1862, Pl. 6, figs. 7, 8; Spicil. Malac., p. 135, Pl. 10, figs. 7, 8. Type locality, Pekin, China.

While close to the Japanese *V. malleatus* (Rve.), this species differs in its comparatively longer spire and smaller aperture. It seems to me related to *V. lecythoides* (Bens.). Its introduction into the Japanese list was due to the three spiral punctured lines, which *stelmaphora* has in common with several other species.

Japanese species.

With the above-mentioned Continental species out of the way, we find the following described from Japan:

Paludina histrica Gould, 1859.
Paludina japonica v. Mart., 1860.
Paludina læta v. Mart., 1860.
Paludina malleata Reeve, 1863.
Paludina abbreviata Reeve, 1863.
Paludina nitens Reeve, 1863.
Vivipara sclateri Frauenfeld, 1865.

Of these seven names, three or four stand for species; the others being synonyms or varieties.

Viviparus malleatus (Reeve). Pl. IX, figs. 6, 7.

> *Paludina malleata* Reeve, Conch. Icon., Vol. XIV, Pl. 5, fig. 25 (February, 1863).
> *Paludina abbreviata* Reeve, Conch. Icon., Vol. XIV, Pl. 5, fig. 26 (February, 1863).
> *Paludina stelmaphora* Kobelt, Fauna Moll. Extramar. Jap., p. 122, Pl. 11, fig. 4.
> *Paludina stelmaphora* Iwakawa, Annot. Zool. Jap., I, p. 85, Pl. 5, figs. 1–4. Not *V. stelmaphora* Bgt.!

"Shell swollen, egg-shaped, thin, smooth, with a greenish epidermis; spire low with an obtuse apex usually worn out in old specimens. *Whorls quite rounded*, separated by deep sutures, each whorl wound round with *three punctured lines*."[3] These lines bear short bristles in young or perfectly preserved adult shells. They are sometimes very faint, in part obsolete, but I believe always visible on some part of the shell. Two are on the upper surface and one near the periphery. Even when the early whorls are preserved, there are no angles or spiral ridges on the shell, such as

---

[3] I can do no better than to quote Iwakawa's words.

usually occur in the next species, though specimens "often present hammered-like sculpture on the surface," hence the name *malleatus*.

Mr. Iwakawa has traced this species from the Province Mutsu, at the north end of Nippon, to the middle Riukiu Islands. Mr. Hirase sends specimens from the islands also. Fig. 6 represents a specimen from Kagoshima, Satsuma. Fig. 7 is from a very smooth and glossy shell from Okinawa.

This species is more globose than the Chinese *V. stelmaphora*, the tube enlarging more rapidly, producing a lower spire and larger aperture.

Paludina læta v. Martens (*Malak. Blätt.*, VII, 45), described from a specimen or specimens collected by Siebold, and not figured, is a glossy form with some puncture-lines, as in the smooth form of *V. malleatus*. The type has 6 whorls, and measures alt. 23, diam. 21 mm. The last whorl is distinctly angular. I think this is likely to prove to be a form of *V. malleatus*. If so, the name has priority.

Viviparus japonicus (v. Martens). Pl. IX, fig. 1.

Paludina japonica v. Mart., Malakozoologische Blätter, VII, 1860, p. 44. Reeve, Conch. Icon., fig. 13. Kobelt, t. c., p. 120, Pl. 11, fig. 1.
Paludina oxytropis var. *japonica* Iwakawa, t. c., p. 88, Pl. 5, fig. 17.
Paludina oxytropis var. *sclateri* Iwakawa, t. c., p. 89, Pl. 5, fig. 14.

Large, pyramidal, dark olive-green and glossy. The earlier whorls are encircled by two keels, later becoming mere angles, and then usually disappearing on the last whorl or two. There may also be some oblique malleation in places. The last whorl is obscurely angular, the angle darker. There are no puncture-lines, as in *V. malleatus*, though there are fine, subobsolete spiral striæ. The specimen figured is from Omaki, Yamashiro. The type locality is not known, the specimens brought home by Siebold being merely labeled Japan.

Viviparus japonicus var. **iwakawa** nov. Pl. IX, fig. 3.

Paludina oxytropis Bens., Kobelt, t. c., p. 123, Pl. 11, figs. 6, 6*a*, (exclusive of synonymy).
P. oxytropis Bens., Iwakawa, t. c., p. 88, Pl. 5, figs. 12, 13. Not *Paludina oxytropis* Benson, an Indian species belonging to an appreciably different group!

Differing from *V. japonicus* chiefly in the persistence in adult shells of the keel at the periphery, giving the shell "the shape of a double cone," and the greater prominence of several spiral cords or angles above and below. Iwakawa has abundantly proven that this form intergrades perfectly with the typical *V. japonicus*—a fact manifest in the series before me. He holds also that it intergrades with the form called "*P. sclateri*" by Kobelt, but which is far from being the typical *V. sclateri* of Frauenfeld. He also gives reasons for believing that this carinate form "represents the ancestral species whence the several varieties have arisen." It seems to be confined to the northern third of Nippon, so far as existing data show. Types of var. *iwakawa* are from Furukawa, Rikuzen, No. 80,639 Coll. A. N. S., from No. 61 of Mr. Hirase's collection.

I have not yet seen specimens of the form called *sclateri* by Iwakawa. It occurs in the same area as var. *iwakawa*, and so far as we know not in southern Nippon, where the true *V. sclateri* and where Kobelt's *sclateri* live.

Viviparus histricus (Gould). Pl. IX, fig. 5.

Paludina histrica Gld., Proc. Boston Soc. N. H., VII, p. 41 (June, 1859); Otia Conch., p. 106.
? *Paludina nitens* Reeve, Conch. Icon., fig. 59 (April, 1863).

The shell is umbilicate, pyramidal, brownish-green, and glossy when clean. There are no puncture-lines, though faint spiral striæ exist. The whorls are carinate at the periphery, the keel usually projecting above the sutures, but reduced to a mere low cord on the last whorl. A well-grown specimen measures, alt. 31, diam. 21 mm. Figured specimen is from Kagoshima, Satsuma.

Viviparus sclateri Frauenfeld. Pl. IX, fig. 4.

V. sclateri Ffld., Verh. zool.-bot. Ges. Wien, XV, 1865, p. 531, Pl. 22, upper figures on left side.
? *Paludina ingallsianus* Reeve, Conch. Icon., XIV, Pl. 7, fig. 39 *a*, *b* (1863).
P. ingallsiana Reeve, Kobelt, t. c., p. 124, Pl. 10, fig. 14–18; Pl. 11, fig. 2.
P. ingallsiana Reeve, Iwakawa, t. c., p. 86, Pl. 5, figs. 5–7 (not typical).
? *P. sclateri* Kobelt, t. c., p. 121, Pl. 11, fig. 3.
Not *P. ingallsiana* Lea, 1856!

A pyramidal, brownish species, with strongly angular periphery and several low angles above it. The shell attains a large size, the specimen figured measuring alt. 45, diam. 30 mm., though eroded above.

V. sclateri is, perhaps, a variety of *V. histricus*, but as I have not seen specimens connecting them, I allow it to stand here as a species, pending fuller information.

So far as we now know, its area of distribution does not overlap that of the carinated form of *V. japonicus*. Mr. Iwakawa writes: "This excellent species has hitherto been known only from Lake Biwa, to which I will now add two more localities: Lake Suwa in Prov. Shinano, and Nagoya in Prov. Owari, on the strength of specimens contained in the Imperial Museum." "In the north-eastern provinces of Hondo I could not obtain a single specimen of this species, in spite of my efforts to collect during the excursion of last summer. It is very desirable to ascertain its range of distribution in middle Japan and also in the southwestern provinces, where it probably also occurs."

Paludina sclateri of Kobelt's *Fauna* seems to be an ecarinate form of this species. It is far from being typical *sclateri*.

MELANIIDÆ.

Melania reiniana var. **hidachiensis** nov. Pl. IX, fig. 2.

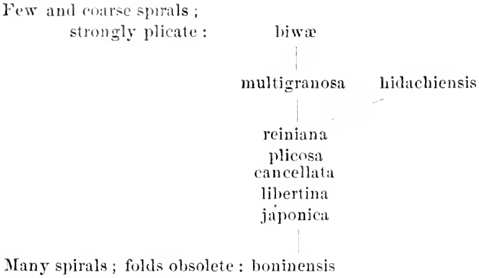
Shell moderately slender, greenish-yellow above, the last whorl olive-brown under a blackish incrustation. *Whorls strongly convex*, sculptured with strong, slightly curved ribs, rather wide-spaced, 11 or 12 on the penultimate whorl, those on the last whorl becoming smaller and closer, not extending below the periphery; the whole surface sculptured with spiral liræ, about 15 on the last whorl, those below the periphery continuous, those above more or less obsolete between the longitudinal ribs, conspicuous upon them.

Length 23, diam. 9, length of aperture $8\frac{1}{2}$ mm.; 6 whorls remaining.

Length 20, diam. 9, length of aperture $9\frac{1}{2}$ mm.; $4\frac{1}{2}$ whorls remaining.

Manabe, Prov. Hidachi (Mr. Y. Hirase). Types No. 80,680 Coll. A. N. S., from No. 145 of Mr. Hirase's collection.

This form has quite convex whorls, while they are flat in *M. multigranosa*. The ribs are strong, especially above, as in a strongly marked *Goniobasis plicifera*, and the spirals of the base are numerous and equal. *M. multigranosa* Bttg. is a species closely related to *M. niponica* Smith, and like that, known only from the neighborhood of Lake Biwa, while the present form is from Hidachi province, on the east coast northward from Tokyo Bay. It is far more strongly sculptured than *M. reiniana*, which is clearly only an extreme form of *M. libertina*. The somewhat complex relationships of this group of species may be roughly expressed in a diagram, thus:



M. hidachiensis is thus to be regarded as a modification of the *libertina* stock parallel to *multigranosa*, without direct genetic connection with the latter. *M. libertina* var. *plicosa* is a central or intermediate form, whence modification in the direction of stronger folds and in the opposite direction of weaker and then complete loss of folds has taken place.

Melania libertina var. **latifusus** nov. Pl. IX, fig. 8.

Shell wide, with comparatively short, conic spire and produced base; evenly striated throughout or with the middle smoother, without a trace of longitudinal folds; olive or brown.

Length 33, diam. 15, length of aperture 17 mm.

Mino, Settsu (Mr. Y. Hirase).

The forms *tenuisulcata* and *ambidextra* are simply variations in development of the spirals, and not of racial import. In American Melanians we now recognize that the same species is frequently dimorphic, having a smooth and a spirally striate form existing together in one locality, usually with all possible intervening forms. The same is unquestionably true of this Japanese species. In the varieties *decussata* and *plicosa* longitudinal folds appear, and lead the way to *M. reiniana* Brot, which is strongly plicate like *Goniobasis plicifera* of our West, with close spirals. Gould's description of *M. libertina* applies especially to the forms with spirals but without folds, though some of the original specimens now before me have the folds of "*plicosa*." Neither of the localities "Simoda and Ousima" given by Gould are in China, as Brot and Kobelt suppose.

Simoda (or Shimoda) is at the southern end of the Izu peninsula and "Ousima" is Oshima, a large island northeast of Okinawa, in the "Riukiu Curve." There is also an Oshima (Izu-no-Oshima) at the mouth of the Sagami Sea, one of the "Seven Islands of Izu." The name, meaning "big island," is somewhat common in Japan. *M. retifera* Tryon is a rather small form of *libertina*, with somewhat coarse spirals but no folds. *M. hakodadiensis* Hartman is normal *libertina* with even and rather fine spirals. The types of both are before me. *M. boninensis* Lea, of which two of the original lot, given by Lea, and several collected by Mr. S. Yoshiwara, lie before me, is a dwarfed island form of the *libertina* stock, distinct by its small size and somewhat attenuated contour. It has erroneously been referred to a separate section of the genus by some authors.

AMNICOLIDÆ.

Bithynia striatula var. **japonica** Pilsbry. Pl. IX, figs. 9, 10, 11, 12.

These *Proceedings* for 1901, p. 405.

Figs. 9, 10, 11 are from specimens of the type lot, from Manabe, Hidachi. Fig. 12 is the smoothest specimen of a series from Osaka.

The operculum has a distinctly spiral nucleus in this species. This feature has twice been made the basis of generic distinction, but I prefer to retain the species in *Bithynia* until a thorough study can be made of the opercula of the group. Probably several stocks have independently changed from the spiral to the concentric type.[4]

EXPLANATION OF PLATE IX

Fig. 1.—*Viviparus japonicus* v. Mart. Omaki, Yamashiro.
Fig. 2.—*Melania hidachiensis* Pils. Manabe, Hidachi.
Fig. 3.—*Viviparus japonicus* var. *Iwakawa* Pils. Furukawa, Rikuzen.
Fig. 4.—*Viviparus sclateri* Ffld. Near Kyoto.
Fig. 5.—*Viviparus histricus* Gld. Kagoshima, Satsuma.
Fig. 6.—*Viviparus malleatus* Rve. Kagoshima, Satsuma.
Fig. 7.—*Viviparus malleatus* Rve. Okinawa, Riukiu Islands.
Fig. 8.—*Melania libertina* var. *latifusus* Pils. Mino, Settsu.
Figs. 9, 10, 11.—*Bithynia striatula* var. *japonica* Pils. Manabe, Hidachi.
Fig. 12.—*Bithynia striatula* var. *japonica* Pils. Osaka.

---

[4] Dr. O. von Möllendorff has referred *B. striatula* to the genus *Fossarulus* Neumayr, and has discussed the status of Père Heude's Chinese species in a paper which came to hand since the above was written. *Annuaire du Musée Zoologique de l'Académie Impériale des Sciences de St. Pétersbourg*, VI, 1901, Binnen-mollusken aus West-china und Central-asien, p. 101 (1902).

THE GERMINATION OF THE SEEDS OF CARAPA GUIANENSIS Aubl.

BY JOHN W. HARSHBERGER, PH.D.

The genus *Carapa* (nat. ord. *Meliaceæ*) comprises a number of tropical forest trees with pinnate leaves and flowers borne in few- or many-flowered axillary panicles. The following species of the genus are recognized by the Index Kewensis, viz.: *Carapa guianensis* Aubl. from Guiana and tropical Africa; *C. moluccensis* Lam. from the Malay archipelago; *C. nicaraguensis* C.D.C. from Central America; *C. procera* D.C. from Asia and tropical Africa; *C. surinamensis* Miq. from Guiana. *Carapa moluccensis* is a mangrove, and Karsten has removed this species from the genus *Carapa*, placing it under the generic name *Xylocarpus*.

The fruits of the plants of the genus *Carapa* are spherical or ovoid capsules, thick, woody, mostly warted, opening by septifragal dehiscence into five valves. The seeds are large, thick, angular, with woody brown seed-coats (Pl. VIII, figs. 1, 2, 3, 6). The food substance in the form of endosperm is wanting, and the cotyledons are thick and conferruminate (fig. 8*a*). The only illustrations of the fruits and seeds of this genus, as far as the writer has been able to ascertain, are those published by Engler and Prantl,[1] where the flowers, ovary and fruit of *Carapa procera* D.C. are shown, but not in germination. Lubbock and Karsten have studied the germination of the seeds of several related genera of the same order, *Meliaceæ*, and the substance of their studies is here briefly given by way of summing up our knowledge concerning the sprouting of the seeds of the plants of this family. Lubbock[2] describes and figures the germination and seedlings of *Melia azedarach* L. and *Walsura piscidia* Roxb. In the pride of China (*Melia azederach* L.) the cotyledons are linear-oblong, obtuse, narrowed to a short petiole. The first leaves are opposite, tripartite; the succeeding leaves are compound pinnate. The cotyledons

---

[1] *Die natürlichen Pflanzenfamilien*, III, 4, s. 277.

[2] LUBBOCK, *Contributions to our Knowledge of Seedlings*, I, 335.

leave the seed and become aerial. The cotyledons of *Walsura piscidia* Roxb. are fleshy, remaining in the seed. The first pair of opposite leaves are reduced to small brown scales, the third to the sixth are small, oval, emarginate and entire. The seventh to the ninth are much larger, oval, emarginate and entire. Engler and Prantl[3] illustrate the germination of the seeds of a species of *Xylocarpus* (*Carapa moluccensis*), the illustration being copied from a paper by Karsten.[4] From the figure (*H*), it would appear that the cotyledons remain enclosed in the seed, the hypocotyl being thick and fleshy. The radicular part, from which the secondary roots arise, is swollen and bulb-like. The first twelve pairs of leaves are opposite and scale-like. The stem arises from the point where the hypocotyl emerges from the seed. The following description of the germination of the seeds of *Carapa guianensis* Aubl. from material obtained in July, 1901, at Castleton, Jamaica, and preserved in two per cent. formalin, is, therefore, given as in part a contribution to the biology of the order *Meliaceæ*.

The capsule of this plant is large, about the size and shape of a cocoanut. It is ridged with four prominent warty-looking ridges which come together in a heavy apical protuberance.

There are four valves, thick ($\frac{1}{6}$ inch) and woody, separating from each other from the base upward to the apex. The capsule is filled with angular seeds (figs. 1, 2, 3, 4, 6), with a smooth or slightly wrinkled, brown outer seed-coat. Ten or a dozen of these large seeds are snugly packed away inside the woody fruit walls. Germination begins after the capsule has dehisced and while the fruit still lies upon the surface of the ground beneath the parent tree. The seeds start to germinate (fig. 6) before they fall out of the capsule, and later they are held in place by the intricately woven mass of secondary roots which grow in all directions between the closely wedged seeds. The stem elongates some four to six inches and emerges from the interior of the partially opened seed vessel between the slightly sprung edges of the valves (figs. 4, 5). All of the seeds of a single capsule may germinate *in situ*, and the complex of roots makes it a rather difficult matter to separate the seeds from each other after germination has once begun. It would seem that the seeds lose their vitality more or less quickly

---

[3] ENGLER AND PRANTL, *Die natürlichen Pflanzenfam.*, III, 4, 279.

[4] KARSTEN, *Bibliotheca Botanica*, XXII, 21, Pls. 7 and 8.

if allowed to remain for some time in a dry place. Some seeds that were left in a cool but dry room began to lose water and to decrease in weight, so that it seems that immediate germination is a means of insuring the perpetuation of the species.

The period of germination is gone through quite rapidly. The seeds sprout quickly and in about a month's time the plants are a foot high with several well-developed pinnate leaves of a rich, glossy green color (fig. 9). The seeds are about an inch to an inch and a half in diameter with sharp angular edges (figs. 1, 3). They are tetrahedra, with one of their faces, that applied to the rounded interior of the capsule, with a spherical curvature (fig. 3). The seed-coats are woody and about $\frac{1}{8}$ inch thick. The interior of the seed is filled up with the fleshy conferruminate cotyledons, which are of a yellowish-white color in section (fig. 8*a*). The parenchymatous cells of the cotyledonary masses are large, with comparatively thin cell walls. Sections of the cotyledonary tissue treated with glycerine clears the material and lozenge-shaped crystalloids are seen imbedded in the protoplasm of the cells (fig. 8*b*). Other sections treated with chloroform and then with iodine show these crystalloids quite clearly by the brownish-yellow hue that they take, the protoplasm staining a bright yellow color. At first it was thought that globoids were present because of the aggregated rounded masses found in the cells that were treated with alcohol. The application of chloroform and ether showed these masses to be oily in character. The oil dissolves readily in the chloroform, but tardily in the ether. In some old seeds, here and there, parenchyma cells were found to be filled with a yellowish resin-like substance, but more careful investigation failed to demonstrate the resinous nature of this substance. Starch is absent as a reserve material from these seeds. The materials, therefore, stored in the cotyledon consist of oil, proteid bodies (crystalloids) and protoplasm. This determination is substantiated by the fact that from the seeds of *Carapa procera, C. guianensis*, a commercial oil is obtained, having a slightly unpleasant smell and a bitter taste. This oil is known variously as Carapa oil, Talliconah oil, Crap oil, Carap oil, Andiroba oil, Touloucouna oil, or Coondi oil. The natives of Guiana rub their bodies with it as a protection against mosquitoes.

Germination begins by the cracking of the testa, or outer seed-coat, with the lifting off of flaky pieces (figs. 4 and 5). The tegmen is also broken through by the knob-like protruding portion of the embryo (figs. 4, 5). The radicle first protrudes as a roughened thick tubercular mass about one-fourth of an inch long, and from this arise six to ten secondary roots (fig. 4). The plumule, which points away from the tip of the radicle, lies in a cup-shaped depression formed by the swollen petiole-like bases of the conferruminate cotyledons (figs. 7, 8*a*). It is about two-fifths of an inch long. The base of it appears as a small knob through the slit left between the bases of the cotyledons. The hypocotyl is about one-fourth of an inch long. As the radicle grows out and down, the plumule straightens out by first assuming a U-shaped form (figs. 8, 8*a*). Later it becomes straight and grows upright. The radicle of *Carapa guianensis* does not assume the rounded, tuber-like form of that of the mangrove plant (*Xylocarpus granatum* Koen., *Carapa moluccensis* Lam.), figured and described by Karsten, nor does it show the horizontal aerating roots which develop vertically horn-like upgrowths with numerous lenticels for breathing purposes. The germination of the seeds of these two species is somewhat similar. The greatest difference lies in the formation of tuber-like radicle and the pneumatodes in *Carapa moluccensis*, the latter being developed as an adaptation to the conditions of a littoral life and growth in the water. *Carapa guianensis*, a land plant, in not possessing these structures during germination, shows that it is more primitive than the tree of mangrove habit which lives with its roots submerged.

The stem of the seedling rapidly elongates, bearing at first closely appressed scale leaves (fig. 10). After a time, there arises a pair of opposite, abruptly pinnate, bijugate leaves; the stem becoming woody at the base. Then succeed a pair of sub-opposite leaves which are large and monojugate. Each leaflet has a swollen pulvinus-like base. The succeeding leaves are bijugate; each leaflet has a pulvinus and thick dark-green blade about three inches wide and five inches long.

EXPLANATION OF PLATE VIII.

Fig. 1.—Side view of seed of *Carapa guianensis* Aubl.
Fig. 2.—*Idem*, end view of seed.
Fig. 3.—Seed of tetrahedral form from centre of the capsule.
Fig. 4.—Seed with cracked seed-coats and protruding radicle.
Fig. 5.—Seed showing roots, radicle, hypocotyl and stem papilla (*p*).
Fig. 5*a*.—Longitudinal section of the lower part of the embryo.
Fig. 6.—Seed which has just started to germinate.
Fig. 7.—Seed that has germinated (partially diagrammatic), showing the lower bent ends of the two conferruminate cotyledons.
Fig. 8.—Seed in natural view, showing stem bent in U-shaped manner and the radicle.
Fig. 8*a*.—Longitudinal section of seed and embryo, showing solution of the reserve food.
Fig. 8*b*.—Several parenchyma cells from ungerminated seed, showing protoplasm and crystalloids.
Fig. 9.—Plantlet somewhat advanced.
Fig. 10.—Plant independent of reserve food; cotyledonary scars shown at (*a*).

A COLLECTION OF MAMMALS FROM SUMATRA, WITH A REVIEW OF THE GENERA NYCTICEBUS AND TRAGULUS.

BY WITMER STONE AND J. A. G. REHN.

The Academy of Natural Sciences of Philadelphia has recently received, through the generosity of Mr. Alfred C. Harrison, Jr., and Dr. H. M. Hiller, a valuable zoölogical collection from Sumatra, which was made by them during their exploration of the island, from August to November, 1901.

The mammals contained in this collection form the basis of the present paper. The authors are also indebted to the U. S. National Museum for the privilege of examining certain specimens in connection with their study of the genus *Nycticebus,* the material having been loaned by Mr. Gerrit S. Miller, Jr., Assistant Curator of Mammals.

The Harrison and Hiller collection comprises sixty-five specimens, secured mainly at Goenong Soegi, Lampong District, at an elevation of less than 500 feet, and partly in the highlands of Padang Bovenland, at Batu Sangkar, Tanah Datar, 1,500 to 3,000 feet.

Sus vittatus Müll. and Schl.

Sus vittatus Müll. and Schl., Verh. I, p. 172, Pls. 29 and 32, fig. 5.

Two head skins and skulls, male and female, loaned for examination by Dr. Hiller appear to belong to this species.

Tragulus napu (Cuv.).

Moschus napu (F. Cuvier), Hist. Nat. des Mam., IV, livre 37, November, 1822.

Three specimens, Goenong Soegi, Lampong District, October–November, 1901. These agree very well with the figure in the *Hist. Nat. des Mam.;* the color of the dorsal surface, the limbs and the sides agreeing very closely, the only difference being the presence of a well-defined transverse gular bar which is absent or else very faintly defined in the figure.

Tragulus kanchil (Raffles).

1822. *Moschus kanchil* Raffles, Trans. Linn. Soc. London, XIII, p. 262.

The relationship and synonymy of this species are discussed below. There is one skin in the collection from Goenong Soegi, Lampong District.

Revision of the Genus Tragulus.—The consideration of the proper specific appellation for the above species has led to a study of the nomenclature of the entire genus, the results of which are given below. The synonymy of the Chevrotains has long been intricately involved, although Blanford in his *Mammals of British India* has simplified it to a considerable extent. The main faults with his revision are his failure to recognize two apparently well-marked species and his misapplication of the name *javanicus*.

Exclusive of the new forms recently described by Mr. G. S. Miller, Jr., which are accompanied by such detailed diagnoses and exact localities that they can easily be identified, there seem to be six distinct species of *Tragulus* from the Indo-Malay region. These may be considered in groups as follows:

(1) The mottled *T. meminna* Erxl., about which there is no confusion.

(2) *T. stanleyanus* Gray, which is equally distinct.

(3) The "Napu," the largest of the group, and the one called by Blanford and other authors "*T. napu.*"

(4) Three small species which Blanford unites under the name "*T. javanicus.*"

One of these three is unquestionably the *Moschus javanicus* of Gmelin, which has for its basis the description of Pallas, *Spicil. Zool.*, XII, p. 18. And as Blanford considered the three as representing but one species, he did perfectly right in adopting this name, which was apparently the oldest known to him.

The trouble is that Osbeck, in 1765, independently described a Chevrotain as *Cervus javanicus*, and by those who begin with the tenth edition of Linnaeus this name must be considered. Osbeck's description is far from satisfactory, but applies without question to a species of *Tragulus*.[1] He comments on the lack of horns and describes the dentition of what he considers the male, though the

---

[1] His "nine back teeth" are accounted for by the ridges of the posterior molars, each of which he evidently took for a separate tooth!

length of the upper canines (equal to the incisors) indicates a female, then he says, "Die Farbe ist braunröthlich. Der Bock . . . . ist grösser als das Thier, und hat weisse Seiten streifen, die der Länge nach laufen."

Taken altogether there seems little doubt that he had a female of the "Napu" and a female of the smaller Chevrotain of Java. The former from its larger size he regarded as the male, and the white stripes could easily be accounted for by the whitish mottlings and lighter bases to the hairs on the sides of the "Napu," which produce the appearance of irregular stripes when the skin is wrinkled or the hair disturbed, and contrast strongly with the uniform coloration of the sides of the smaller species.

If this view be accepted, the name *T. javanicus* Osbeck will have to be applied to the "Napu," as the whole of Osbeck's description applies to the "Buch" or larger of his specimens. This view we propose to follow.

If, on the other hand, it is claimed that Osbeck's description is not sufficiently clear to refer it to a definite species it will nevertheless preclude the use of the later *javanicus* Gmelin, since Osbeck certainly described some species of Chevrotain. The larger animal (the "Napu") will then be known as *T. napu* Cuvier and the smaller one as *T. pelandoc* (Ham. Smith). His description [2] and reference to the plate of the "Pygmy Musk" in Shaw's *Naturalists' Miscellany*, I, Pl. III, seem to sufficiently indicate the small Javan Chevrotain, but the further description given by Blyth [3] leaves no doubt about the animal that he had in view.

Whether the "Napu" of Java is identical with that of Sumatra we are unable to say, but from the tendency it has to vary in each island, as shown by G. S. Miller's recent papers, it seems hardly likely, and we prefer to use *Tragulus napu* Cuvier for the Sumatran animal, leaving *T. javanicus* Osbeck for the Javan form. Should they prove identical the latter name of course must prevail.

Having disposed of the name *javanicus* and the two species upon which it has been bestowed, we come to the consideration of the relationship of the three small Chevrotains which are united under "*Tragulus javanicus*" in Blanford's work. The Javan species we have already shown must be known as *Tragulus pelandoc* Ham.

---

[2] *Vide* Griff., *Anim. Kingdom*, IV, p. 66, 1827.

[3] *Proc. As. Soc. Bengal*, 1858, p. 277.

Smith. The Sumatran animal, the ***Moschus kanchil*** of Raffles, seems from specimens before us to be perfectly distinct. It is well described by Raffles[4] and by Blyth,[5] and can always be distinguished by the fact that the two dark stripes on the throat are joined together anteriorly while in *T. pelandoc* they are separate, never forming a complete ʌ. The third species which Blanford has apparently failed to recognize as distinct is the *Tragulus rufiventer* of Gray[6] an animal resembling *T. kanchil* in pattern of markings, but of a very different color, being very bright tawny with nearly the whole of the belly distinctly fulvous. Gray attributes this species with a query to Malacca and the Indian Peninsula, while a specimen, No. 642 Coll. Acad. Nat. Sci., acquired many years ago, is simply labeled "India."

The following table will give an idea of the relationship of the several species—exclusive of those recently described by Mr. Miller:

a.—Body spotted, chin and throat hairy, . . . *T. meminna.*
b.—Body not spotted, chin and longitudinal strip between the rami of the mandible nearly or quite naked.
  I.—Larger, length 25 ins. or more.
    a′.—Color above brilliant orange-rufous, hairs tipped with black from the shoulders back, a black median longitudinal stripe down the face and a dark line from the eye to the nose. Hair on neck above and below coarse and rough. Diagonal orange lines on lower neck broad and united posteriorly by a transverse band, forming a triangle open at the apex, a pale-buff band down centre of belly, branching out to the base of the limbs, . . *T. stanleyanus.*
    b′.—Color above blackish with fulvous bases to the hairs. Head and neck mixed with buff, darkest on top of head, down the middle of the face and a band down the nape. Sides of body becoming nearly white at base of hair with dark-brown tips, rest of lower parts white except marks on neck, which are of the same pattern as in the last, but diagonal stripes longer and narrower, ... *T. napu.*
      Perhaps identical with this is . . . *T. javanicus.*
  II.—Smaller, length 18–21 ins. General color yellowish-brown with black tips to the hair, lighter on sides, under parts white and forelegs distinctly orange-rufous.

---

[4] *Trans. Linn. Soc.*, XIII, p. 262.
[5] *Proc. Asiat. Soc. Bengal*, 1858, p. 276.
[6] *P. Z. S.*, 1836, p. 65.

a'.—Sides of neck, diagonal stripes and back nearly the same color, top of head darker and a strongly marked black longitudinal stripe on the nape from the occiput to the shoulders, where it shades into the general color of the back. Diagonal stripes on the neck united anteriorly as well as at the base, making a complete triangle, a slender brown median stripe between the forelegs, ... *T. kanchil.*

b'.—Similar, but sides of neck and diagonal stripes on lower throat distinctly gray, contrasting with the yellow-brown of the back, darker nape band obsolete, and diagonal stripes always separated anteriorly, *T. pelandoc.*

c'.—Very different, and smallest of the group. Prevailing color dark orange-rufous, most of the hairs with black tips, producing a rich brown appearance on back and top of head; stripe on nape black, in sharp contrast to the sides of the neck; diagonal stripes orange-rufous mingled with black-tipped hairs joined anteriorly and posteriorly, leaving only a narrow white median stripe, a transverse rufous band at the base of the mandible; middlle of belly uniform light orange-rufous, leaving only the inside of the flanks and a spot on each side at the base of the forelegs white, . *T. fulviventer.*

Tragulus meminna (Erxl.).

1777. *Moschus meminna* Erxl., Syst. Reg. An., p. 322.
1843. *Meminna indica* Gray, List Mam. Brit. Mus., p. 172.

Hab.—Peninsular India and Ceylon.

Tragulus stanleyanus (Gray).

1836. *Moschus Stanleyanus* Gray, Proc. Zool. Soc., p. 65.

Hab.—Malacca, Java.

Tragulus javanicus (Osbeck).

1765. *Cervus javanicus* Osbeck, Reise nach Ostindien und China, p 357.
1858. *Tragulus fuscatus* Blyth, Jour. As. Soc. Beng., XXVII, p. 278.
1843. *Tragulus javanicus* Gray, List. Mam. Brit. Mus., p. 173.

Hab.—Java.

Tragulus napu (F. Cuv.).

1822. *Moschus napu* F. Cuv., Hist. Nat. Mam., Pl. 329.
1822. *Moschus javanicus* Raffles, Trans. Linn. Soc., XIII, p. 262.

Hab.—Sumatra.

Tragulus pelandoc (Ham. Smith).

1827. *Moschus Pelandoc* Ham. Smith, Griff., Anim. Kingdom, IV, p. 66.
1788. *Moschus javanicus* Gm., Syst. Nat., I, p. 174 (nec. Osbeck).
Tragulus javanicus Auct.

Hab.—Java.

Tragulus fulviventer (Gray).

1836. *Moschus fulviventer* Gray, Proc. Zool. Soc., p. 65.

Hab.—" Malacca and Indian Peninsula ?"

Tragulus nigricans Thomas.

1892. *Tragulus nigricans* Thomas, Ann. Mag. Nat. Hist., 6th Series, IX, p. 254.

Hab.—Philippines (no specimen examined).

Tragulus mimenoides Hodgs. Jour. As. Soc. Bengal.
Tragulus malaccensis Gray, Cat. Mam., 1843.

These are nomina nuda and have no standing.

Rusa unicolor equinus (Cuvier).

1823. *Cervus equinus* Cuvier, Ossemens Fossiles, 2d Ed., IV, p. 45.

One skin of a young male. Goenong Soegi.

Mus alexandrinus Geoffroy.

1818. *Mus alexandrinus* Geoffroy, Description de l'Egypte, Mammiferes, p. 733.

Five specimens in spirits. Batu Sangkar, Tanah Datar, Padangsche Bovenland. August–September.

Sciurus vittatus Raffles.

1822. *Sciurus vittatus* Raffles, Trans. Linn. Soc., London, XIII, p. 259.

Two specimens, male and female. Batu Sangkar, Tanah Datar, Padangsche Bovenland. August or September.

Mr. Bonhote, in his recent review of this group,[7] states that the red tip to the tail is a conspicuous and constant mark. The male of the above pair has it, but the female has not, so that it would seem to be of doubtful value as a diagnostic character.

Sciurus prevostii harrisoni subsp. nov.

One specimen, No. 6,651, Coll. Acad. Nat. Sci., Phila. Goenong Soegi, Lampong District, Sumatra. Coll. Alfred C. Harrison, Jr., and Dr. H. M. Hiller. October–November, 1901.

Apparently very similar to *S. prevostii bangkanus* of Schlegel, as

---

[7] *Ann. and Mag. Nat. Hist.*, 7th Series, VII, pp. 444–445.

defined by J. L. Bonhote,[8] but with slight grayish white tips to the hairs of the tail, from near the base to within about an inch of the tip. Very distinct from *S. p. rafflesi.* Pure black above, bright "orange-rufous" (Ridgway) below (contrasting strongly with the color of *rafflesi,* which is nearly the "bay" of Ridgway). White stripe on the side as in *rafflesi,* though the orange-rufous comes higher up on the outside of the hind legs. Sides of face iron-gray, but lighter than in *rafflesi,* almost white on the sides of the nose, chin of the same color as the cheeks without the longitudinal black line of *rafflesi.* A number of black hairs on the sides of the body adjoining the white stripe are tipped with orange-rufous, and those farther back with white; hairs of tail tipped with grayish-white as above described.

Dimensions as in *S. p. rafflesi.*

We should hesitate to describe another race of these squirrels were it not for Mr. Bonhote's statements regarding their constancy within geographic limits and the fact that no rufous-bellied member of the group has apparently been hitherto found on Sumatra.

The occurrence of this animal side by side with *S. p. rafflesi* makes us strongly suspect that the two are specifically distinct, but without more material it would be impossible to decide upon the proper arrangement of all the members of the group, should that view be accepted.

Sciurus prevostii rafflesii (Vigors and Horsf.).

1828. *Sciurus Rafflesii* Vigors and Horsf., Zool. Jour., IV, p. 113.

Five specimens from Goenong Soegi, Lampong District. October–November.

Funambulus insignis (Desmarest).

1822. *Sciurus insignis* Desmarest, Mammalogie, II, p. 544.

One male. Goenong Soegi, Lampong District. October and November.

This specimen seems to approach to *F. i. diversus* Thomas,[9] being indeed quite red on the sides and the white of the under part distinctly red-tinted. We have no other specimens for comparison, however.

---

[8] *Ann. Mag. Nat. Hist.*, 7, VII, pp. 171, 177.

[9] *Ann. and Mag.* (7), II, p. 248.

Ratufa bicolor hypoleuca (Horsfield).

1824. *Sciurus hypoleucos* Horsfield, Zool. Res. in Java (pages not numbered).

One specimen. Goenong Soegi, Lampong District. October and November.

As compared with two Javan examples, this specimen seems quite distinct. It is decidedly lighter, the central dorsal region being straw color instead of dull ochraceous, the rump pale-brown with ochraceous hairs interspersed instead of blackish-brown with silvery hairs; the under fur of the upper parts is smoky-gray instead of blackish-brown, and the ventral surface almost pure white instead of tinged with pale ochraceous.

Horsfield's specimen came from Sumatra and seems to agree with the one in hand.

Ratufa affinis (Raffles).

1822. *Sciurus affinis* Raffles, Trans. Linn. Soc., London, XIII, p. 259.

Two specimens, male and female. Goenong Soegi, Lampong District. October and November.

The male is darker than the female, especially the tail, which is nearly chocolate color instead of ochraceous brown; the white of the head is also more clearly defined.

Tupaia tana Raffles.

1822. *Tupaia tana* Raffles, Trans. Linn. Soc., London, XIII, p. 257.

Six specimens. Goenong Soegi, Lampong District. October and November.

These specimens seem to be all referable to the above species, although they present considerable variation in color and size.

The largest is nearly black above with an underlying tint of maroon, while the hairs of the head and shoulders are finely annulated with buff; below it is dull maroon, the tail a brighter shade of the same.

Another nearly the same size is lighter above with the buff annulations prevailing over the shoulders, and extending back nearly to the tail on some of the hairs. Tail bright maroon above and below, under parts bright tawny with a tinge of maroon.

Two small specimens, apparently young, have a still greater admixture of buff on the head, shoulders and back, while the under parts are more tinged with buff. The skulls are much shorter with the protruding maxillaries less developed.

Galeopithecus volans (Linn.).

Five specimens of this interesting animal were obtained. They exhibit some variation in the color of the back, one being distinctly browner than the others, but without material for comparison it would be impossible to say whether they are identical with specimens from other parts of the Malay region. The nomenclature of the animal is somewhat involved, and a number of proposed names would have to be considered if a subdivision should be deemed desirable. Geoffroy[10] proposed three species, *rufus*, *variegatus* and *ternatensis*. The descriptions are very brief and for only one is the type locality given, *i.e.*, *T. variegatus* from Java. *G. ternatensis* is based upon Seba's plate, which was also in part the basis of Linnæus' *Lemur volans*.

Temminck, in the introduction of his *Monogr. Mammalium*, states that there are only two species of *Galeopithecus*, and that Geoffroy's three species are not valid. He does not, however, name his " two species."

Fischer also recognizes two species, calling the Malay one *volans* and the Philippine one *variegatus* Geof., in spite of the fact that the latter name was based on a Javan specimen! He also mentions that Temminck recognized two species, "*G. variegatus*, from Java and islands of the Indian Archipelago, and *G. marmoratus*, from Sumatra and Borneo." Where Temminck described *G. marmoratus* we have been unable to discover, though Wagner in Schreber's *Saugthiere*, Suppl. I, p. 324, says " fauna japon. auct. Siebold."

Blainville, in his *Osteographie*, fasc. 3, p. 48, also quotes Temminck's two species giving the latter one as " *macrurus !*"

Waterhouse first clearly separated the Philippine species as *G. philippensis*,[11] and at the same time named the species of the Indian Archipelago *G. temmincki*.

Wagner in Schreber's *Saugthiere* also proposes *G. undatus* for an animal which he thinks may be the same as *G. marmoratus* Temm. The Sumatran animal, if distinct, should bear Wagner's name, unless it is found that Temminck actually did publish a diagnosis of his *G. marmoratus*. The other names, it seems to us, must all be regarded as synonyms of *G. volans* Linn., except, of course, *G. philippensis* Waterhouse.

---

[10] *Cours d' Hist. Nat.*, 1829, p. 37.

[11] *P. Z. S.*, 1838, p. 119.

Pteropus vampyrus (Linnæus).

1758. [*Vespertilio*] *vampyrus* Linnæus, Syst. Nat., X ed., p. 31.

Six specimens, five in spirits, one skin. Batu Sangkar, Tanah Datar, Padangsche Bovenland. August or September.

One skin. Goenong Soegi, Lampong District. October or November.

Cynopterus titthæcheilus (Temminck).

1827. *Pteropus titthæcheilus* Temminck, Monogr. Mamm., I, p. 198.

Two alcoholic specimens. Batu Sangkar, Tanah Datar, Padangsche Bovenland. August or September.

One alcoholic specimen. Goenong Soegi, Lampong District. October or November.

Pipistrellus tenuis (Temminck).

1827. *Vespertilio tenuis* Temminck, Monogr. Mamm., II, p. 229.

One alcoholic specimen. Batu Sangkar, Tanah Datar, Padangsche Bovenland. August or September.

One alcoholic specimen. Goenong Soegi, Lampong District. October or November.

Felis bengalensis Kerr.

1792. *Felis bengalensis* Kerr, Animal Kingdom, p. 151.

Three kittens in spirits. Batu Sangkar, Tanah Datar, Padangsche Bovenland. August or September.

Arctogale leucotis Blyth.

1851. Horsfield's Catalogue, East India Mus., p. 66.

One adult male.

Putorius nudipes F. Cuv.

1823. *Putorius nudipes* F. Cuv., Mam. Lith., III, Pl. 149.
1863. *Gymnopus leucocephalus* Gray, P. Z. S., p. 119.

One specimen of a bright golden-yellow with grayish-white head. From Lampong District.

This animal is unquestionably the *leucocephalus* of Gray, and since he refers to Cuvier's earlier name I have no doubt but they are identical, though I have not been able to consult Cuvier's plate.

Revision of the Genus Nycticebus.—The identification of the specimens of Slow Loris in the collection has led to a study of the several allied species and the nomenclature of the genus, with some interesting results.

These Lemurs fall naturally into two very distinct groups: (1)

The Slender Loris, "*Loris gracilis*" of most authors; and (2) the Slow Loris and its allies, "*Nycticebus tardigradus*" Auct.

The first specific name to be proposed for any of them was *Lemur tardigradus*.[12] This was based upon the following references:

(1) L. ecaudatus, *Mus. Ad. Fr.*, I, p. 3.

(2) Simia ecaudata unguibus indicis subulatis.[13]

(3) Animal cynocephalum tardigradum.[14]

(4) Animal elegantissimum robinsonii.[15]

The first reference seems to refer exclusively to the Slender Loris, the habitat being Ceylon and the characters given "naso productiore brachiis manibus pedibusque longis tenuibus."

The second is a mere catalogue name. Under the third come two plates of Seba with long descriptions; the first unquestionably refers to the Slender Loris, while, although the text to the second plate seems to refer in part to the Slow Loris, the figure itself looks more like the Slender Loris.

The last reference is again the Slender Loris from "Ceylon," and the produced rostrum is especially mentioned.

It will thus be seen that, with the exception of the second plate of Seba, which is of rather doubtful application, all of the quotations upon which *Lemur tardigradus* Linn. are based refer to the Slender Loris, "*L. gracilis*" Auct., and it is remarkable that the name should have been so universally applied to the *Nycticebus*.

Another important point brought out in our investigation is the failure of apparently all authors to consider Boddaert's observations on these animals, *Elenchus animalium*, p. 67 (1784). He there proposes a genus *Tardigradus* with two species, *T. loris* = Slender Loris and *T. coucang* = Slow Loris, and correctly refers *Lemur tardigradus* Linn. to the former.

As this is the first attempt to establish a separate genus for these animals, the name *Tardigradus* must be adopted for the Slender Loris. Furthermore, *coucang* being the first name proposed for the Slow Loris must be adopted for it.

Geoffroy did not propose his genus *Loris* until 1796, in *Magasin Encyclopedique*, Vol. I, pp. 48–49. This work being inaccessible to us, we are indebted to Mr. Outram Bangs for a transcript of

---

[12] Linnæus, *Syst. Nat.*, X, p. 29.

[13] *Syst. Nat.*, 5, n. 2.

[14] *Seb. Mus.*, I, p. 55, t. 35, f. 1, 2; t. 47, f. 1.

[15] *Ray. Quad.*, p. 161.

the reference, from a copy in the Boston Public Library. From this it seems that *Loris* Geoff. is a synonym of *Tardigradus* Bodd., being based upon the same two animals, *L. gracilis* = Slender Loris and *L. tardigradus* = Slow Loris. Although Geoffroy undoubtedly had the Slow Loris in mind for his second species, as shown by his reference to Vosmaer, whose plate is excellent, nevertheless in referring it to *L. tardigradus* Linn. he originated the unfortunate error which has been almost universally followed by subsequent authors. The genus *Nycticebus* proposed by Geoffroy in 1812 was unquestionably based upon the Slow Loris, and will hold for it and its allies, unless *Bradycebus* Cuv. et Geoffr. is available. Their genus is said to be published in *Mem. Class. Mamm.* and in *Mag. Encyclop.*, but we have not yet been able to locate it.

We shall have then the following synonymy for these genera:

TARDIGRADUS Bodd.

1784. Tardigradus Bodd., Elenchus Anim., p. 67 (type *T. loris* Bodd. = *Lemur tardigradus* Linn.).
1796. Loris Geoff., Mag. Encyclop., I, pp. 48–49.
1811. Stenops Illig., Prodrom. Syst. Mam. et Avium, p. 73.

NYCTICEBUS Geoff.

1812. Nycticebus Geoff., Ann. du Mus. Paris, XIX, p. 162. Type.
? 1795. Bradycebus Cuv. et Geoffr., Mem. Class. Mamm.

After studying a number of specimens, partly from the Academy's collection and partly loaned by the U. S. National Museum through Mr. G. S. Miller, Jr., Assistant Curator of Mammals, it appears that the variation in the Slow Lemurs, recognized by Anderson and Blanford as simply varietal, is worthy of a more definite treatment.

It would seem from the material at our disposal that there are five distinct forms, which we would regard as subspecies rather than as species, as they are obviously geographic races of one species. The *N. menagensis* of the Philippines has not been considered, as no specimens are available and it is therefore impossible to judge of its relationship with the Malayan group.

The forms may be distinguished as follows:

a.—General color ashy-gray, slightly tinged with rufous. Crown of head without an extensive patch of brown.
  b.—Head with indistinct lines extending to the eyes and ears. Dorsal line fading away on crown of head, *coucang* Boddaert.

bb.—Head with four distinct lines extending to a common centre on the crown of the head. Dorsal line distinct on the crown of head, . . *c. javanicus* E. Geoffroy.

aa.—General color rufescent gray. Crown of head with a considerable blotch of brown.

b.—General tint pale rufescent; dorsal line and crown patch not very distinctly marked and of a rufous tint, the latter involving the ears, . *c. malaianus* Anderson.

bb.—General tint deep rufescent; dorsal line and crown patch very distinct and of a deep chestnut tint, the latter not involving the ears, . . . *c. natunæ* n. subsp.

bbb.—General color chestnut rufescent, more or less washed with gray; dorsal line very distinct, deeply colored; crown patch large, fading into the general surrounding tint, ... *c. hilleri* n. subsp.

Regarding the Tenasserim form[16] we can say nothing, as no specimens from that region are available.

Nycticebus coucang hilleri n. subsp.

1822. *Lemur tardigradus* Raffles (not of Linn.), Trans. Linn. Soc. London, XIII, p. 247.

Type. ♂, No. 6,590, Acad. Nat. Sci. Phila. Batu Sangkar, Tanah Datar, Padangsche Bovenland, Sumatra. August or September, 1901. Collected and presented by Mr. A. C. Harrison, Jr., and Dr. H. M. Hiller.

Distribution.—Specimens from the type locality only have been examined, but it is possible the form is found throughout the island.

Characters.—This form is most nearly related to *malainus* and *javanicus*, but differs from the former in the much more strongly marked dorsal line, and in the predominance of chestnut-brown and not ochraceous in the general tint. From *javanicus* it differs in the much less definite head bars, in the broad crown patch and in the gradual transition from the latter to the surrounding tint.

Color.—General color of the upper parts reddish-cinnamon (between Ridgway's russet and cinnamon), more or less washed with ecru, the more noticeable toward the extremities. Dorsal line very distinct, seal-brown and more or less visible to the caudal region. Crown patch broad, mars brown with the four head bars not well marked, all merging gradually into the general hoary tint which suffuses the head; eyes surrounded by the customary black ring; interocular stripe clear white; cheeks whitish, sometimes

---

[16] *Vide* Blanford, *Mamm. Brit. Ind.*, pp. 45 and 46.

slightly suffused with blackish-gray. General color of the lower surface pale fawn, throat whitish.

Specimens examined.—Three in spirits, all from the type locality.

Nycticebus coucang javanicus (E. Geoffroy).

1812. *Nycticebus javanicus* E. Geoffroy, Ann. du Museum, XIX, p. 164.

Type locality and distribution.—Java.

Two specimens examined: Java, Acad. Nat. Sci. Phila.

Nyctioebus coucang natunæ n. subsp.

1894. *Nycticebus tardigradus* Thomas and Hartert, Novitates Zoologicæ, I, p. 655.
1895. *Nycticebus tardigradus* Thomas and Hartert, Novitates Zoologicæ, II, p. 489.
1901. *Nycticebus tardigradus* Miller, Proc. Wash. Acad. Sci., III, p. 138.

Type. ♂, No. 104,599, United States National Museum, Bungaran, Natuna Islands, July 28, 1900. Collected and presented by Dr. W. L. Abbott.

Distribution.—As far as known only the type locality.

Characters.—Comparison of this form with any others of the species is unnecessary as the color and pattern are quite distinctive.

Color.—General color of the upper parts rich russet brown (close to mars brown of Ridgway), palest on the limbs, strongest on the shoulders. Dorsal line rich vandyke brown, tending toward seal brown, the stripe brown on the shoulder, decreasing in width and intensity posteriorly, becoming almost obsolete on the rump; general tint on each side of the dorsal line is overcast with a silvery "bloom," which is caused by the tips of the hairs being of that tint.[17] Crown patch broad, rich burnt umber, extending from ear to ear, but not involving them, anteriorly sending a broad bar to the upper margin of the customary black ocular rings; cheeks suffused with dusky brown. Anterior limbs with the extremities much lighter in color than the remainder of the limbs. Lower surface pale cinnamon, throat silvery white.

Specimens examined.—One, the type.

---

[17] The hair on all the dorsal surface is more or less tipped with silvery, but this character is much more apparent in the portion mentioned above. The presence of the silvery suffusion near the dorsal line is shared by *javanicus*, but in that form distinct longitudinal bars are formed.

Nycticebus coucang (Boddaert).

1783. *Tardigradus coucang* Boddaert, Elenchus Animalium, p. 67.
1812. *Nycticebus bengalensis* E. Geoffroy, Ann. du Museum, XIX, p. 164.
1867. *Nycticebus cinereus* Milne-Edwards, Nouv. Archiv. du Museum Bull., III, p. 11.

Type locality.—Bengal.

Distribution.—According to Anderson,[15] this form is found from Assam through Upper Burma to Siam.

No specimens are available for examination.

Nycticebus coucang malaianus (Anderson).

1881. *Nycticebus tardigradus* var. *malaiana* Anderson, Catal. Mamm. Ind. Mus., I, p. 95.

Type locality.—None stated.

Distribution.—Chittagong, through Arakan at least as far south as Tringanu, Lower Siam.

Two specimens examined: "Bengal," Acad. Nat. Sci. Phila.; Tringanu, Malay Peninsula, U. S. N. M.

Semnopithecus melalophos (Raffles).

1822. *Simia melalophos* Raffles, Trans. Linn. Soc., London, XIII, p. 245.

Two specimens in spirits. Batu Sangkar, Tanah Datar, Padangsche Bovenland. August or September. These specimens still retain the milk dentition, and the dusky suffusion of the upper parts extends along the upper surface of the tail.

One skin. Goenong Soegi, Lampong District. October or November.

This specimen has the upper parts much lighter and more uniformly colored than the alcoholic specimens.

Semnopithecus maurus (Schreber).

1775. *Simia maura* Schreber, Säugthiere, I, p. 107, Pl. XXII B.

Two skins. Goenong Soegi, Lampong District. October and November.

Semnopithecus mitratus (Esch.).

Adult female and young. Lampong.

---

[18] *Catal. Mamm. Ind. Mus.*, I, p. 95.

Symphalangus[19] **syndactylus** (Raffles).

1822. *Simia syndactyla* Raffles, Trans. Linn. Soc. London, XIII, p. 241.

One old male, preserved entire in spirits. Batu Sangkar, Tanai Datar, Padangsche Bovenland. August or September. And two males and a female, Goenong Soegi. October and November. The first specimen measures:

Length, crown to anus, ...	531 mm.
Extreme reach from tip of longest fingers (approximately), ...	1536 mm.
Length of forearm, ...	309 mm.

---

[19] For the adoption of *Symphalangus* Gloger (*Hand.-u. Hilfsb. Naturgesch.*, I, p. 34, 1841) in place of *Siamanga* Gray (*List. Mam. Brit. Mus.*, p. 1, 1843), see Palmer, *Science*, n. s., X, p. 493, 1899.

MAMMALS COLLECTED BY DR. W. L. ABBOTT IN THE REGION OF THE INDRAGIRI RIVER, SUMATRA.

BY GERRIT S. MILLER, JR.

During August and September, 1901, Dr. W. L. Abbott visited the Indragiri river, eastern Sumatra, and the two large islands opposite its mouth, Linga and Sinkep. The valuable collections which he secured were all presented to the United States National Museum. This paper contains an account of the mammals, and is published here by permission of the Secretary of the Smithsonian Institution.

Linga Island was visited by Dr. Abbott and Mr. C. Boden Klott in July, 1899. At this time nine species of mammals were obtained:[1] *Tragulus* "*napu*" (= *T. pretiosus*), *Sciurus tenuis*, *S. notatus*, *Mus lingensis*, *Tupaia tana*, *T. malaccana*, *Pteropus vampyrus*, *Macacus* "*cynomolgus*," and *Semnopithecus maurus*. In 1901 the list was nearly doubled by the addition of *Tragulus javanicus*, *Sus vittatus*, *Ratufa notabilis*, *Rhinosciurus laticaudatus*, *Mus fremens*, *Mus firmus*, *Viverra tanglunga* and *Arctogalidia simplex*. The presence of all of these, except the *Rhinosciurus* and the two rats, was, however, suspected during the earlier visit.

Hitherto the mammal fauna of Sinkep Island has been quite unknown; and I cannot find that any of the accounts of the mammals of Sumatra refer specifically to the region of the Indragiri river.

Manis javanica Desmarest.

An adult female was dug from a burrow in a hillside on Sinkep Island, September 1, 1901. Total length, 440; head and body, 220; tail, 220. Weight, 4.7 kg. The uterus contained a fœtus 92 mm. in length. In this specimen the tail measures only 25 mm. The outlines of the scale are clearly marked on head, body and tail, but very indistinctly on the legs.

Tragulus javanicus (Gmelin).

Five skins from Sinkep Island and eleven skins and three specimens in formalin from Linga. Traguli of this and the two follow-

---

[1] Miller, *Proc. Washington Acad. Sci.*, II, p. 212, August 20, 1900.

ing species were trapped in the jungle by natives and brought in considerable numbers for sale.

The series from the two islands show very little individual variation. The constancy of coloring in this species as compared with the extreme plasticity of the napu is very striking, particularly when it is remembered that the ranges of the two coincide, and that the animals are everywhere exposed to like conditions of environment.

Tragulus pretiosus sp. nov.

1900. *Tragulus napu* Miller, Proc. Washington Acad. Sci., II, p. 227, August 20, 1900. Not of F. Cuvier.

Type.—Adult male (skin and skull), No. 113,031 United States National Museum. Collected on Linga Island, South China Sea, August 27, 1901, by Dr. W. L. Abbott. Original number 1,238.

Characters.—A richly colored yellowish member of the *napu* group. Throat markings normal, the anterior white stripes not elongated or margined with black, the dark stripes brown. Neck yellowish-brown with narrow median black stripe. Belly heavily shaded with yellowish-brown.

Color.—Upper parts orange-ochraceous darkening toward ochraceous-rufous on sides of neck and outer surface of legs, and lightening to orange-buff on sides of body, the hairs everywhere ecru-drab at base and black at tip. The black tips are most conspicuous over middle of back, where they produce a heavy dark shading slightly in excess of the orange-ochraceous. On sides of body they are much less noticeable, and on sides of neck and head and outer surface of legs would readily pass unnoticed. Crown and median line of neck black, the latter noticeably sprinkled with ochraceous-rufous. Throat markings normal, the hairs of the dark bands blackish at base and heavily annulated with dull ochraceous-rufous. Collar narrow but distinct, its color like that of sides of body. Under parts behind throat markings mostly orange-buff mixed with drab. There is always, however, a pure white patch on chest between front legs, and another in hypogastric region between hind legs, the former generally continuous with narrow white line on inner side of leg, the latter always so. The two white patches occasionally spread toward each other so that they meet along median line. Tail rather dull ochraceous-rufous above, pure white below and at tip.

Skull and Teeth.—The skull and teeth are similar to those of *Tragulus canescens.* The supposed peculiarities[2] of the first specimen obtained by Dr. Abbott prove to be merely the result of senile changes.

Measurements.—External measurements of type: Total length, 625; head and body, 545; tail vertebræ, 80; hind foot, 142; hind foot without hoofs, 125. Weight, 3.4 kg. Average of five specimens from the type locality: Total length, 654 (625–670); head and body, 566 (545–580); tail vertebræ, 88 (80–95); hind foot, 141 (140–142); hind foot without hoofs, 126 (125–127); weight, 3.7 (3.1–4.3).

Specimens Examined.—Ten (one in alcohol), all from Linga Island.

Remarks.—Examination of the extensive series of *Tragulus* in Dr. Abbott's second Linga collection convinces me that I was wrong in referring the specimen obtained during his first visit to the island to *T. napu.*[3] The reasons are briefly as follows: The animal described and figured by F. Cuvier was much more gray than the Linga species; the outermost of the white throat stripes was considerably longer, extending "beyond the cheeks;" and both of the lateral white stripes were bordered with black. The throat pattern is now known to be so constant in each local form of this group that the very striking characters mentioned by Cuvier cannot be regarded as due to mere individual variation. Finally, the marked differences between the napu of Linga and that of the neighboring island of Sinkep furnish additional ground for the belief that a third form occurs in Sumatra.

Tragulus nigricollis sp. nov.

Type.—Adult male (skin and skull), No. 113,121 United States National Museum. Collected on Sinkep Island, South China Sea, September 6, 1901, by Dr. W. L. Abbott. Original number 1,292.

Characters.—Similar to *Tragulus pretiosus* but slightly larger; color of body lighter, but neck and dark throat markings black, inconspicuously speckled with brown.

Color.—General color as in *Tragulus pretiosus*, but ground tint everywhere a shade less yellow, that of the sides scarcely darker

---

[2] See *Proc. Biol. Soc. Washington*, XIII, p. 186, December 21, 1900.

[3] *Proc. Washington Acad. Sci.*, II, p. 227, August 20, 1900.

than the cream-buff of Ridgway. The black clouding of the back is never in excess of the orange-ochraceous. As if to compensate for the relative lack of black on the body, the entire neck is of this color, as in *Tragulus bunguranensis*, its uniformity scarcely broken by an inconspicuous speckling due to the presence of a narrow yellowish-brown annulation on many of the hairs. These annulations are more numerous at sides of neck, but a few may be found even along median line. Throat markings normal and exactly similar to those of *Tragulus pretiosus*, except that the dark streaks are black, speckled with yellowish-brown to about the same extent as sides of neck. Collar well defined and coarsely grizzled, its light ground color nearly the same as that of sides of body though a trifle more yellow.

Skull and Teeth.—Except for their slightly greater size the skull and teeth of *Tragulus nigricollis* do not differ appreciably from those of *T. pretiosus*, though there appears to be a tendency toward greater narrowness in the general form of the skull.

Measurements.—External measurements of type: Total length, 620; head and body, 540; tail vertebræ, 80; hind foot, 138; hind foot without hoofs, 123. Weight, 4 kg. Average of five specimens from the type locality: Total length, 647 (620–670); head and body, 566 (540–590); tail vertebræ, 81.6 (77–85); hind foot, 142 (138–147); hind foot without hoofs, 126 (123–130). Weight, 4.4 kg. (4–4.6).

Cranial measurements of type: Greatest length, 116 (108);[4] basal length, 109 (101); basilar length, 104, (95); occipito-nasal length, 103 (99); length of nasals, 34 (33.6); diastema, 11 (10); zygomatic breadth, 50 (49); least interorbital breadth, 31 (29); mandible, 92 (88); maxillary toothrow (alveoli), 40 (36); mandibular toothrow (alveoli), 45.4 (42).

Specimens Examined.—Five, all from Sinkep Island.

Remarks.—In general appearance *Tragulus nigricollis* more closely resembles the black-necked *T. bunguranensis* than it does *T. pretiosus*. It is readily separable from the Bunguran animal by its somewhat paler general coloration and by its normal throat markings. The series shows no individual variation worthy of note, except that in one specimen (♂, No. 113,124) the white

---

[4] Measurements in parentheses are those of the type of *Tragulus pretiosus.*

throat stripes are interrupted by the brown, producing a pattern suggestive of that of *T. bunguranensis.*

Sus vittatus Müller and Schlegel.

A female pig from Linga Island and a similar specimen from the Indragiri river, Sumatra, appear to be referable to the Sumatran representative of *Sus vittatus.* They are small animals, scarcely exceeding *Sus nicobarensis* in size, therefore quite distinct from *Sus cristatus.*

Sus oi Miller.

1902. *Sus oi* Miller, Proc. Biol. Soc. Washington, XV, p. 51, March 5, 1902.

The discovery of the nang-oi, the Sumatran representative of *Sus barbatus* and *Sus longirostris,* is one of the most interesting results of Dr. Abbott's work in the East Indies. The animal is among the largest of wild pigs, the type specimen, an adult but not aged boar, weighing 113 kg. (250 lbs.). Its measurements are as follows: Total length, 1,870; head and body, 1,575; tail, 295; height at shoulder, 850; height at rump, 800; ear from meatus, 88; ear from crown, 97; width of ear, 75. Skull: Greatest length, 480; basal length, 405; zygomatic breadth, 162. Although only one specimen was secured, the nang-oi is abundant in the forests and sago plantations along the banks of the Indragiri river. Its footprints may always be distinguished from those of *Sus vittatus* by their much greater size.

Ratufa palliata sp. nov.

Type.—Adult male (skin and skull), No. 113,162 United States National Museum. Collected on the Indragiri river, eastern Sumatra, September 23, 1901, by Dr. W. L. Abbott. Original number 1,327.

Characters.—In general similar to *Ratufa bicolor* of Java, but yellow areas less bright, blackish of tail appearing conspicuously at surface, and whole back from shoulders to hips light yellowish brown in striking contrast with blackish thighs, neck and outer surface of front legs. Skull with nasals shorter and broader than in the Javan animal.

Color.—Back and sides uniform cream-buff a little tinged with clay color, especially along median dorsal region. Posteriorly this darkens abruptly through dull ochraceous-rufous to the clear blackish-brown of thighs and outer surface of hind legs. In median line the dull ochraceous-rufous extends between thighs to cover about 100 mm. of base of tail. Anteriorly the light mantle darkens much more gradually through the same dull ochraceous-rufous to the dark reddish-brown neck and blackish outer surface of front legs. Forehead and anterior portion of crown like mantle. At region just in front of ears the abrupt change takes place to color of neck. Under parts, cheeks, sides of neck and inner surface of limbs light yellow. The exact shade is very nearly the cream-buff of Ridgway (like that of mantle, but without the tinge of clay color), except on chest, throat and inner surface of front legs, where it brightens to buff. On belly the cream-buff is somewhat obscured by the appearance at surface of the dark slate-gray basal portion of hairs. Feet blackish-brown, the cream-buff of inner surface spreading conspicuously over wrist and forearm, and slightly just below ankle and on outer edge of sole. Tail (except proximal 100 mm.) dark bistre throughout, the hairs everywhere with whitish cream-buff tips, 10–15 mm. in length. These tips nowhere conceal the bistre, which by contrast appears nearly black. On under surface they are so arranged as to form a grizzled yellowish-white border to the clear bistre median stripe. Above they cover the surface almost uniformly, producing a frosted appearance, through which may be detected a faint indication of dark cross bars, ten of which are distinguishable in favorable light.

Skull and Teeth.—Skull similar to that of *Ratufa bicolor,* but braincase more arched and rostrom shorter. The nasals are distinctly broader posteriorly, and as a result the nasal branches of the premaxillaries are narrower. Teeth as in *Ratufa bicolor* and *R. melanopepla.*

Measurements.—External measurements of type: Total length, 770; head and body, 345; tail vertebræ, 425; hind foot, 84 (78).

Cranial measurements of type: Greatest length, 68 (69);[5] basal length, 57 (58); basilar length, 53 (54); length of nasals (along median suture), 21 (23); breadth of both nasals together anteriorly, 12 (13); breadth of both nasals together posteriorly, 9 (5); least interorbital breadth, 29 (27); zygomatic breadth, 42 (43); mandible, 42 (45); maxillary molar series (alveoli), 12.8 (13); mandibular molar series (alveoli), 13.8 (14).

---

[5] Measurements in parentheses are those of an adult female *Ratufa bicolor* from western Java.

Specimens Examined.—Three, the type; also two other specimens from Sumatra, exact locality not known.

Remarks.—The three specimens show no marked variation in color. The type is rather lighter than either of the others, both of which are in somewhat worn pelage. Both of these have the base of the tail nearly black, and in one the pale mantle is divided by an indistinct dark-brown dorsal line about 30 mm. in breadth. In *Ratufa bicolor* the back is black, thickly sprinkled with yellowish-white hair tips, particularly on posterior half. There is thus no indication of the pale mantle of *R. palliata.* The tail in the Javan animal is clear buff above, the black bases of the hairs not appearing at surface except at tip. The Javan and Sumatran forms are, therefore, readily distinguishable.

Ratufa affinis (Raffles).

Twelve specimens from Sinkep Island. These are not distinguishable from true *Ratufa affinis*, but the material representing the latter is not wholly satisfactory and the Sinkep form may eventually prove to be distinct.

Ratufa hypolecua (Horsfield).

1824. *Sciurus hypoleucos* Horsfield, Zoological Researches in Java and the neighboring islands (pages not numbered).

Three adults (♂, No. 113,163; ♂, No. 113,164, and ♀, No. 113,165) were taken in heavy forest on the banks of the Indragiri river, September 24, 1901. They represent a whitish-bellied species closely related to *Ratufa affinis*, but readily distinguishable by the darker ground color of the upper parts (approximately cinnamon in *hypoleuca*, isabella color in *affinis*) and by the grayish-white cheeks and face which form a strong contrast with the crown and sides of neck. As the type of Horsfield's *Sciurus hypoleucos* was obtained by Raffles, it was probably taken near Bencoolen, on the southwest coast of Sumatra. It is not improbable, therefore, that the Indragiri form may prove to be distinct, though so far as can be determined from the original description Dr. Abbott's specimens closely resemble those examined by Horsfield. The measurements of the three individuals are as follows (arranged in order as above): Total length, 705, 700 and 700; head and body, 330, 320 and 330; tail vertebræ, 375, 380 and 370; hind foot, 77, 78 and 79; hind foot without claws, 70, 71 and 73. Cranial measurements of adult male (No. 113,163): Greatest length, 62

(61);[6] basal length, 52.4 (52); basilar length, 49 (49); length of nasals, 19.6 (19.8); least interorbital breadth, 26 (26); zygomatic breadth, 39 (39); mandible, 38.4 (37); maxillary molar series (alveoli), 12 (12.8); mandibular molar series (alveoli), 13 (14).

Ratufa notabilis sp. nov.

Type.—Adult male (skin and skull), No. 113,064 United States National Museum. Collected on west coast of Linga Island, August 24, 1901, by Dr. W. L. Abbott. Original number 1,210.

Characters.—Size large, fully equal to that of *R. bicolor* and *R. melanopepla.* Upper parts uniform rich dark-brown; under parts, feet, cheeks and face yellowish-white in conspicuous contrast.

Color.—Upper parts and outer surface of legs burnt umber, slightly variegated by the faint tawny annulations which are present on most of the hairs. These annulations are less distinct than in *R. pyrsonota*, but nevertheless quite evident, particularly on neck and shoulders. On middle of back and in lumbar region many of the hairs are buffy white, producing a faint lighter cast. Under parts, feet, cheeks and inner surface of legs clear cream-buff, more yellow over middle of belly. Muzzle and face somewhat less yellowish, but distinctly grizzled by a fine admixture of brown, particularly on anterior portion of crown and in region between eyes. Tail with the hairs everywhere whitish cream-buff at base. On dorsal and lateral surfaces of tail the terminal half is burnt umber, but ventrally the cream-buff is clear, except for the darker line caused by the appressed short hairs, many of which are brown.

Skull and Teeth.—The skull resembles that of *Ratufa melanopepla* in size, but in form appears to be slightly less elongate, a difference which may readily prove to be inconstant. Teeth as in *R. melanopepla.*

Measurements.—External measurements of type: Total length, 780; head and body, 345; tail vertebræ, 435; hind foot, 82 (73).

External measurements of an adult female from the type locality: Total length, 770; head and body, 335; tail vertebræ, 435; hind foot, 80 (72).

Cranial measurements of type: Greatest length, 68; basal length,

---

[6] Measurements in parentheses are those of an adult male *Ratufa affinis* from Singapore, the type locality.

58; basilar length, 55; length of nasals, 22; least interorbital breadth, 27.4; zygomatic breadth, 44; mandible, 45; maxillary molar series (alveoli), 13; mandibular molar series (alveoli), 15.

Specimens Examined.—Two, both from the type locality.

Remarks.—*Ratufa notabilis* is such a conspicuous, easily recognizable species that it requires no comparison with its allies. The Javan squirrel described by Desmarest under the name *Sciurus albiceps* has a similar whitish face; but Desmarest's animal was much smaller than *Ratufa notabilis*, and will doubtless prove to be the Javan representative of *R. hypoleuca*.

The two specimens are in all respects similar to each other, except that the tail of the female is just beginning to change from the bleached pelage to the fresh coat of the breeding season. On the body the change is completed. The annulations on the hairs of the back are more distinct in the female than in the male, but the latter has the more noticeable sprinkling of whitish hairs over the lumbar region.

Sciurus vittatus Raffles.

Two skins from Linga Island, four from Sinkep Island, and six from the Indragiri river, Sumatra. The Sinkep specimens are slightly paler than the others, and the black lateral stripe is a little less well defined. The characters, however, are too inconstant to be regarded as of much importance.

Sciurus tenuis Raffles.

An adult male and female from the Indragiri river, Sumatra. They are in every respect indistinguishable from the Singapore animal.

Sciurus melanops sp. nov.

Type.—Adult female (skin and skull), No. 113,152 United States National Musuem. Collected on Indragiri river, eastern Sumatra, September 15, 1901, by Dr. W. L. Abbott. Original number 1,307.

Characters.—A member of the *S. prevostii* group. Color exactly as in *S. humei* (Bonhote), except that the cheeks are black, scarcely grizzled with gray.

Color.—Tail and entire dorsal surface of head and body clear shining black. Cheeks and sides of neck black, but the color dulled by a very faint admixture of gray and red. This grizzling is so inconspicuous as to be scarcely noticeable when a specimen is held at arm's length. A faint grayish patch immediately behind ear. The whiskers spring from a sharply defined grayish white area about 15 mm. in diameter. A similar whitish patch, 3 mm. in diameter, surrounds roots of suborbital bristles. Lateral stripe buffy white. As in *S. humei* it extends from axillary region to heel and includes entire outer surface of hind leg. Under parts, feet, inner surface of hind legs and entire lower portion of front legs a bright brownish-red, intermediate between the chestnut and rufous of Ridgway. On outer side of hind leg the red comes in contact with the white lateral stripe, but on inner side it is separated from the white by a line of black about 10 mm. in diameter, which extends as far as heel. Shoulder and outer surface of humerus orange-ochraceous, sharply defined from the black contiguous area, but fading gradually through various shades of ochraceous into the buffy white of the lateral stripe.

Skull and Teeth.—The skull is similar to that of *Sciurus humei*, but the audital bullæ are slightly smaller and the interpterygoid space is a trifle narrower. Molars uniformly smaller than in the species from the Malay Peninsula, the difference particularly noticeable in the posterior lower tooth.

Measurements.—External measurements of type: Total length, 505; head and body, 255; tail vertebræ, 250; hind foot, 60; hind foot without claws, 58. Two other adults measure: Total length, ♂ 535, ♀ 500; head and body, ♂ 270, ♀ 255; tail vertebræ, ♂ 265, ♀ 245; hind foot, ♂ 64, ♀ 60; hind foot without claws, ♂ 60, ♀ 56.

Cranial measurements of type: Greatest length, 57 (60);[7] basal length, 51 (53); basilar length, 48 (50); palatal length, 26 (26.6); length of nasals, 18.8 (19.4); interorbital breadth, 23 (24.4); zygomatic breadth, 34 (37); mandible, 38 (41); maxillary toothrow (alveoli), 11 (11.8); mandibular toothrow (alveoli), 11.4 (14).

Specimens Examined.—Three, all from the type locality.

Remarks.—This squirrel is so readily distinguishable from its allies by the coloration of the cheeks that no further comparisons are necessary. The three specimens show no individual variations worthy of note.

---

[7] Measurements in parentheses are those of an adult female *Sciurus humei* from Trong, lower Siam.

Nannosciurus pulcher sp. nov.

Type.—Adult female (skin and skull), No. 113,131 United States National Museum. Collected on Sinkep Island, South China Sea, September 4, 1901, by Dr. W. L. Abbott. Original number 1,274.

Characters.—Like *Nannosciurus melanotis* Müller and Schlegel, but back paler, belly more ochraceous, and light nuchal patch very distinct.

Color.—The colors of this squirrel are difficult to describe, as they cannot be exactly matched in Ridgway's *Nomenclature.* The back, sides, and outer surface of legs rather closely resemble wood-brown, with a tinge of olive and a scarcely perceptible grizzle caused by the black tips of the hairs, but the brown itself is more nearly a pale raw umber. Crown similar to back, but strongly tinged with russet. Nape whitish, in strong contrast with surrounding parts, the hairs faintly tipped with black. Inner surface of ear rather thickly sprinkled with hairs in color similar to back. These extend over anterior border of outer side of ear, but the remainder of the outer surface is black, continuous with an elongated black patch which lies behind ear and sends back a narrow, ill-defined border to whitish nape patch. Side of head with yellowish white line about 3 mm. in width, beginning at side of muzzle just above nostril and extending back to a point slightly behind posterior border of ear. This stripe includes lower eyelid. From inner canthus of eye to muzzle it is faintly bordered with black. The stripes of the opposite sides are separated on muzzle by a space of about 2 mm. Under parts, feet, and inner surface of legs a pale tawny, closely approaching the ochraceous-buff of Ridgway, but somewhat more yellow. Tail a uniform coarse grizzle of tawny, black and white, each hair with six color bands. These are as follows, beginning at base: (1) Tawny, 2 mm.; (2) slate-gray, 1.5 mm.; (3) tawny, 4 mm.; (4) black, 5 mm.; (5) white, 3 mm.; (6) black, 1 mm. At tip the pattern changes to 10 or 11 alternating bands of black and tawny, the black terminal area increasing to 7–10 mm. As a result the white element of the grizzle is absent in this region.

Skull and Teeth.—The skull and teeth apparently resemble those of *N. whiteheadi* rather closely, except that the rostrum is less elongate and the upper incisors less projecting forward. The specimens of both species at hand are, however, in poor condition. The skull is readily distinguished from that of *N. exilis* by its larger size.

Measurements.—External measurements of type: Total length, 165; head and body, 88; tail vertebræ, 77; hind foot, 25 (23).

Specimens Examined.—One, the type.

Remarks.—In all probability this is the Sumatran form of *Nannosciurus melanotis* described and figured by Temminck and Schlegel.[8] It is not impossible, however, that the Sinkep animal may prove to be distinct from that of the larger island. *Nannosciurus pulcher* is readily distinguishable from *N. melanotis,* as well as from all other known members of the genus, by the conspicuous, sharply defined, whitish nape patch.

Rhinosciurus laticaudatus (Müller and Schlegel).

A very old male was taken on Linga Island, August 28, 1901. It was brought in by Malays, who had secured it in a jerot or snare. As compared with a young female from Sirhassen Island, South Natunas, this specimen is darker above and less yellowish below.

Mus lingensis Miller.

Seventeen specimens (seven skulls without skins) from Linga Island, and thirty-three (eight in alcohol and twelve skulls without skins) from Sinkep Island. The two series agree well with each other in bearing out the characters of the species—that is, in less yellow coloration and narrower, more elongate palate, as compared with *Mus surifer.*

Mus sp.

The imperfect skull of a small brown rat taken on Linga Island, August 30, 1901 (♂, No. 113,053), represents a species closely related to *Mus asper.* Its exact identification is impossible.

Mus fremens sp. nov.

Type.—Adult male (skin and skull), No. 113,087 United States National Museum. Collected on Sinkep Island, South China Sea, September 4, 1901. Original number 1,273.

Characters.—A member of the *sabanus-vociferans* group, but color less tawny than in any of the forms hitherto known.

Color.—Back and sides a fine grizzle of drab, ochraceous-buff, and blackish horn color, the latter much in excess everywhere except

---

[8] Verhandel. over de Natuurlijke Geschiedenis der Nederl. overzeesche Bezittingen, p. 98, Pl. XIV, fig. 5.

on lower part of sides, where it gives place to the ochraceous-buff and drab. The general effect is drab, much overlaid with blackish on back and lightened by the ochraceous-buff on sides, shoulders, neck and flanks. Outer surface of front legs drab, darkening to hair-brown. Outer surface of hind legs similar but distinctly suffused with ochraceous-buff. Top of head like back, but more finely grizzled, sides of head dull ochraceous-buff. Muzzle hair-brown. A blackish ill-defined eye ring. Under parts whitish cream-buff. Feet the same, but metapodials heavily shaded with hair-brown. Ears and tail dark brown, the latter indistinctly whitish beneath and throughout distal third.

Skull and Teeth.—The skull and teeth appear to be essentially similar to those of *Mus vociferans.*

Measurements.—External measurements of type: Total length, 558; head and body, 234; tail, 324; hind foot, 47 (44.6). External measurements of an adult female from Linga Island: Head and body, 234; hind foot, 46 (44).

Specimens Examined.—Two, one from Sinkep and one from Linga.

Remarks.—In coloration *Mus fremens* is unlike any of the members of the group to which it belongs. The general pattern is the same, but the yellowish tints are greatly reduced, both in extent and brightness, while there is a corresponding increase in the drab and black. In *Mus strepitans* there is as much black on the back, but in this species the yellow tints retain all their brightness, and the drab is scarcely visible. Both specimens of *Mus fremens* are in fresh, unworn pelage. The Linga skin differs somewhat from the type in the paler color of its head and more yellowish outer surface of the limbs. Whether these differences are due to anything more than individual variation it is, of course, impossible to determine without more material.

Mus firmus sp. nov.

Type.—Adult female (skin and skull), No. 113,038 United States National Museum. Collected on Linga Island, August 25, 1901, by Dr. W. L. Abbott. Original number 1,215.

Characters.—Similar to *Mus integer* from Sirhassen Island, South Natunas, but size slightly greater and color much less yellow. Mammæ 8.

Color.—Back and sides a fine grizzle of blackish-brown and pale, dull buff, the two colors nearly equally mixed on back, but the buff in excess on sides, where, however, it is clouded by the appearance at surface of the gray (very nearly Ridgway's No. 6) of the under fur. The longer hairs show a distinct bluish metallic lustre. Under parts and inner surface of legs buff to base of hairs. Head similar to back, but grizzle much less coarse, and cheeks washed with buff. Lips and chin whitish. Feet dull dark brown. Ears and tail dark brown.

Fur and Other External Characters.—As in *Mus integer.*

Skull and Teeth.—The skull and teeth closely resemble those of *Mus integer*, except that the interpterygoid space is wider and the first upper molar somewhat larger.

Measurements.—External measurements of type: Total length, 500; head and body, 245; tail, 255; hind foot, 50 (48.6); ear from meatus, 24; width of ear, 18.

Cranial measurements of type: Greatest length, 53; basal length, 46; basilar length, 43; length of nasals, 21.4; diastema, 15; zygomatic breadth, 27; mandible, 32.4; maxillary toothrow (alveoli), 9.4; mandibular toothrow (alveoli), 10.

Specimens Examined.—Seven (one skull without skin, and one entire animal in alcohol), all from Linga Island.

Remarks.—Two specimens of *Mus firmus* have been compared with the type of *Mus mülleri* by Dr. F. A. Jentink, of the Leyden Museum. They prove to represent a larger animal with more black on the back, and differing also in certain cranial peculiarities, which, however, Dr. Jentink does not specify.

Viverra tangalunga Gray.

An adult female was trapped on Linga Island by Malays, August 27, 1901. The uterus contained three embryos.

Arctogalidia simplex sp. nov.

Type.—Adult male (skin and skull), No. 113,069 United States National Museum. Collected on Linga Island, South China Sea, August 30, 1901, by Dr. W. L. Abbott. Original number 1,254.

Characters.—Size and general appearance as in *Arctogalidia inornata*, of Bunguran Island, North Natunas, but color distinctly darker and median dorsal line plainly visible.

Color.—Back, sides and outer surface of legs a rather dark, finely grizzled, silvery-gray, the elements of which are as follows:

Under fur dark broccoli-brown, the shorter hairs tipped with dull, light cream-buff, the longer with black, and all showing a distinct gloss in certain lights. The general effect is darker and less yellow than in *Arctogalidia inornata.* A distinct trace of the median dorsal line extends from shoulders to lumbar region, but the lateral lines are absent. Head, ears, feet, lower portion of front legs and distal half of tail blackish, the forehead, crown and cheeks finely and inconspicuously grizzled with gray. Basal half of tail like back, but slightly darker. Under parts dirty gray, slightly but distinctly tinged with yellow, particularly on throat and under surface of neck. Sides of neck buff (a little less yellow than that of Ridgway), forming a rather conspicuous contrast with surrounding parts.

Skull and Teeth.—The skull and teeth are essentially as in *Arctogalidia inornata,* but the premolars appear to be more robust.

Measurements.—External measurements of type: Total length, 1,050; head and body, 515; tail, 535; hind foot, 81 (77).

Cranial measurements of type: Greatest length, 106; basal length, 98; basilar length, 94; median palatal length, 56; breadth of palate between anterior molars, 14.6; zygomatic breadth, 58; constriction in front of postorbital processes, 17; constriction behind postorbital processes, 14; mandible, 78; maxillary toothrow (exclusive of incisors), 37; mandibular toothrow (exclusive of incisors), 41.

Specimens Examined.—Two, the type from Linga Island and an immature male from Sinkep.

Remarks.—By its small size and obsolete dorsal markings this species is readily distinguishable from *Arctogalidia leucotis* and *A. stigmatica.* Its relationship with the small *A. inornata* of Bunguran Island is much more close; but the two small species differ very considerably in general coloration.

Tupaia malaccana Anderson.

An adult male from Linga Island, two adult females from Sinkep Island, and an adult male from the Indragiri river.

Tupaia phæura sp. nov.

Type.—Adult male (skin and skull), No. 113,148 United States National Museum. Collected on Sinkep Island, South China Sea, September 4, 1901, by Dr. W. L. Abbott. Original number 1,275.

Characters.—Like *Tupaia ferruginea* from Singapore, but with much darker tail, its upper and lower sides concolor with corresponding surfaces of body.

Color.—Dorsal surface of head, body and tail a fine grizzle of seal-brown and dark ferruginous, the ferruginous in excess on head, shoulders and anterior portion of back, the seal-brown in excess on tail and posterior half of back. The color is most dark on rump, lumbar region, flanks and basal third of tail. Chest, throat, chin, cheeks, muzzle, sides of neck and front legs olive-buff, rather darker than that of Ridgway, brightest along middle of throat. On the thinly haired posterior half of the ventral surface the olive disappears, leaving a dull tawny, which extends over inner surface of hind legs, and, somewhat brightened, forms the light element of the grizzle of under side of tail, where it is distinctly in excess of the seal-brown. Feet dusky brown.

Skull and Teeth.—The skull and teeth do not differ appreciably from those of *Tupaia ferruginea.*

Measurements.—External measurements of type: Total length, 335; head and body, 195; tail vertebræ, 140; hind foot, 46 (43.6). Two adult females from the type locality (Nos. 113,147 and 113,149) measure respectively: Total length, 325 and 335; head and body, 185 and 195; tail vertebræ, 140 and 140; hind foot, 43 (40) and 44 (41).

Specimens Examined.—Three, all from the type locality.

Remarks.—*Tupaia phæura* is closely related to true *T. ferruginea* the type locality of which may be assumed to be Singapore, though easily recognizable by its much darker tail.

Macacus "cynomolgus" Auct.

This monkey was common on the banks of the Indragiri river, Sumatra. An adult male taken on September 21, 1901, does not differ appreciably from specimens from the Malay Peninsula.

Semnopithecus maurus (Schreber).

Two were shot from a drove of twenty or more in a sago plantation on Linga Island, August 25, 1901. Along the banks of the Indragiri river the animal was plentiful. Four specimens were secured. In the Linga skins the gray tips of the hairs on back and shoulders are less conspicuous than in those from the Indragiri river.

Semnopitheous sumatranus Müller and Schlegel.

1830. *Semnopithecus femoralis* Horsfield, Appendix to Memoir of Life of Raffles, p. 642. *Nomen nudum.*
1839–44. *Semnopithecus sumatranus* Müller and Schlegel, Verhandel. over de natuurlijke Geschiedenis der Nederl. overzeesche bezittingen, p. 73.
1851. *Semnopithecus femoralis* Horsfield, Catal. Mamm. Mus. Hon. East Ind. Company, p. 10.

This monkey was met with on the banks of the Indragiri river, where it was less numerous than *S. maurus*. Native name, káhka. Two specimens taken.

Hylobates hoolock (Harlan).

Five gibbons taken on the banks of the Indragiri river appear to be referable to this species. They agree perfectly with the description given by Blanford, and are evidently distinct from *H. lar*, numerous specimens of which have been collected by Dr. Abbott on the Malay Peninsula.

A REVISION OF THE GENUS MORMOOPS.

BY JAMES A. G. REHN.

During the preparation of this paper quite an interesting series of forty-nine specimens has been examined, forty-four of them loaned from the collection of the United States National Museum, through the kindness of Mr. Gerrit S. Miller, Jr., of that institution. The author also wishes to acknowledge his indebtedness to Dr. C. Hart Merriam for the loan of two Jamaican specimens from the collection of the U. S. Biological Survey; to Prof. D. G. Elliot for the loan of one specimen from San Domingo from the collection of the Field Columbian Museum, Chicago, and to Dr. F. A. Jentink, of the Leyden Museum, for kindly furnishing information concerning two Cuban specimens in the collection under his care.

The material examined covers all the localities from which the genus has been recorded with but few exceptions, and in such cases the specimens are not available for examination.

MORMOOPS Leach.

1820. *Aëllo* Leach, Trans. Linn. Soc. London, XIII, p. 70. Type, *Aëllo cuvieri*, a mutilated and almost unrecognizable specimen of *M. blainvillii*.
1820. *Mormoops* Leach, Trans. Linn. Soc. London, XIII, p. 76. Type, *M. blainvillii* Leach.
1840. *Lobostoma* Gundlach, Wiegmann's Archiv. für Naturgesch., VI, band I, p. 357 (part).
1856. *Mormops* Peters, Monatsber. K. Preuss. Akad. Wissensch., Berlin, p. 410.

Generic Characters.—Crown of the head greatly elevated above the face line; ears actually or nearly united basally by the internal margins; nostrils not margined by extensive cutaneous developments. Facial portion of skull bent strongly upward, the basicranial and facial axes being thus almost at right angles. Dentition i. $\frac{2-2}{2-2}$, c. $\frac{1-1}{1-1}$, p. $\frac{2-2}{3-3}$, m. $\frac{3-3}{3-3}$.

History.—The genus *Mormoops* was founded by Leach in 1820[1] on his species *M. blainvillii*, which was described from Jamaica. In the same work, having precedence by a few pages (p. 70), is a

---

[1] *Trans. Linn. Soc.* London, XIII, p. 76.

genus *Aëllo*, which Leach described from a mutilated specimen of *Mormoops blainvillii*, according to Dobson,[2] who examined the type. While the genus and species *Aëllo cuvieri* have page priority over *Mormoops blainvillii*, the very poor definition and absolute unidentifiability of the former (without a close examination of the type such as Dobson has made) should give occasion to use the better defined, almost simultaneous and universally recognized name. Gray,[3] in speaking of the occurrence of the genus in Cuba, placed *Mormoops* and the genus *Chilonycteris* in the tribe *Noctilionina* in the vicinity of the *Taphozoi*, on account of the possession of no true nose leaf. In 1840, Gundlach[4] described a specimen of this genus from Cuba as *Lobostoma cinnamomeum*, and Peters[5] and Saussure[6] both confused Leach's species with another form of the genus to which Peters later[7] gave the name of *megalophylla*. Saussure, in the above-mentioned paper, placed the genus in a subtribe of the "Noctilioniens," which he designates as the "*Mormopsins*," and associates *Chilonycteris* with it in the same division. In 1865, Peters,[8] in a revisionary table of the order, placed *Mormops* (*Mormoops* Leach), *Chilonycteris* and *Pteronotus* in a subfamily *Mormopes* of the family *Phyllostomata*. Dobson[9] considered these allied genera as constituting a subfamily *Lobostominæ* and group *Mormopes* of the *Phyllostomatidæ*. Quite recently Miller[10] has described a form allied to *M. megalophylla*, inhabiting the island of Curaçao, as *Mormoops intermedia*.

General Relations.—The three genera, *Mormoops*, *Chilonycteris* and *Dermonotus* (*Pteronotus* Auct.[11]), comprise a well-defined subfamily, the differential characters of which are the absence of a distinct nose leaf and the presence of leaf-like appendages on the lower lip. The former character is shared by the genus *Centurio*, but the latter character easily distinguishes the group from the *Centurioninæ*. The genus *Mormoops* may be distinguished from

---

[2] *Catal. Chiropt. Brit. Mus.*, p. 454.

[3] *Ann. Nat. Hist.*, IV, p. 3, 1839.

[4] Wiegmann's *Arch. f. Naturgesch.*, VI, bd. I, p. 357.

[5] *Monatsber. k. preuss. Akad. Wissensch.*, Berlin, 1856, pp. 410–415. *Abhandl. k. preuss. Akad. Wissensch.*, Berlin, 1856, pp. 287–301.

[6] *Revue et Magasin de Zoologie*, 2d ser., XII, pp. 290–293.

[7] *Monatsber. k. preuss. Akad. Wissensch.*, Berlin, 1864, p. 381.

[8] *Monatsber. k. preuss. Akad. Wissensch.*, Berlin, 1865, p. 257.

[9] *Catal. Chiropt. Brit. Mus.*, pp. 446–447.

[10] *Proc. Biol. Soc. Washington*, XIII, p. 160.

[11] *Vide* Gill, *Proc. Biol. Soc. Washington*, XIV, p. 177.

the other two genera by the greatly elevated brain-case, which throws the basi-cranial axis almost at right angles to that of rostrum, and in the presence of prominent internal, basally annectant, flaps to the ears.

After a study of the names applied to this section as a group, I have concluded to designate the subfamily, containing *Mormoops*, *Chilonycteris* and *Dermonotus* (*Pteronotus* Auct.), as the *Mormoopinæ*, which term I have used in a previous paper.[12] The name *Lobostominæ* of Dobson is not available as *Lobostoma* is a synonym of *Mormoops* and *Chilonycteris*.

Key to the Forms.

a.—Chin pad slightly divided. Cutaneous lap connecting the inner side of the conch with the supraocular region united with its fellow of the opposite side.
  b.—Greatest thickness of the first upper premolar centrally located, the tooth being crudely rhomboid in outline, *blainvillii* Leach.
  bb.—Greatest thickness of the first upper premolar posteriorly located, the tooth being subconoid in outline, *b. cinnamomea* (Gundlach).

aa.—Chin pad considerably divided. Cutaneous lap connecting the inner side of the conch with the supraocular region not united with its fellow of the opposite side except at the extreme base.
  b.—First upper premolar narrow, centrally constricted, the posterior margin well separated from the second premolar.
    c.—Second upper premolar triangular in basal outline, equally broad as long, the internal lobe of the tooth moderately developed, *megalophylla* (Peters).
    cc.—Second upper premolar much broader than long, the internal lobe of the tooth very much developed, *m. senicula* Rehn.
  bb.—First upper premolar rather broad, subrectangular in outline, in contact with or very slightly separated from the second premolar, . . . *m. intermedia* Miller.

Mormoops blainvillii Leach.

1820. *Aëllo Cuvieri* Leach, Trans. Linn. Soc. London, XIII, p. 71 (founded on a badly mutilated specimen).
1820. *Mormoops Blainvillii* Leach, Trans. Linn. Soc. London, XIII, p. 77, tab. VII.

---

[12] *Proc. Acad. Nat. Sci. Phila.*, 1901, p. 297.

1872. *Mormops Blainvillii* Peters, Monatsber. k. preuss. Akad. Wissensch., Berlin, p. 359 (part).
1878. *Mormops blainvillii* Dobson, Catal. Chiropt. Brit. Mus., p. 456.

Type Locality.—Jamaica.

Distribution.—Jamaica.

General Characters.—Size rather small; ears with the prominent internal wing united with its fellow; lower margin of chin-lappet with two central projections; labial fold very deeply cleft centrally.

Head.—Broad, long and shallow. Ears very large, the lower margins extending forward to the commissure, thus, with the anterior trend of the internal connecting membrane, forming a cavity in which is located the rather minute eye; internal connecting membrane carried forward and connecting with its fellow posterior to the nasal region; the apex of the ear with a concave emargination; internal ridge well developed, extending to the tip of the ear, inferiorly rather deep, the tip broadly rounded; antitragus high, apex circular; tragus rather large, apically with an additional sublanceolate, subpetiolate process, inner border with a median emargination, outer border inferiorly emarginate, centrally with a rounded process. Eye with wart near both the anterior and posterior corners. Nostrils opening in the lateral portions of a fleshy disk, which has the superior margin concavely emarginate, below which the disk bears a median ridge; nasal apertures surrounded by slightly raised margins; the central formation laterally flanked by rectangular fleshy processes; upper lip deeply notched opposite the first upper premolar, an acute process projecting forward from the commissure. Chin-lappet of lower lip subquadrate, upper margin with a central concavity, lower margin with a pair of small processes in the center; surface papillose. Labial fold ample extending much below the chin-lappet, deeply divided into four portions by incisions, one median and two lateral.

Limbs.—Forearm moderately long, considerably bowed; third finger rather long, very slender, the latter character applying to all the digits; thumb delicate. Femora, tibiæ and feet long and very slender; calcanea long, about equaling the tibiæ.

Membranes and Fur.—Membranes very thin and semi-transparent, very finely tucked and wrinkled by cross nerves, the pattern of the latter being very regular; propatagium large, the anterior border totally free; uropatagium ample, extending quite a distance beyond the tail. Fur long, soft and silky, the posterior part of the neck with a collar of longer hair; throat and chin with short floccose fur; ectopatagium considerably furred; forearm not furred; upper lip heavily haired.

Color.—General tint above and below orange-rufous, slightly darker over the shoulders, palest around the head and on the throat.[13] Membranes pale chestnut.

Skull.—Rather light and fragile; cranial portion abruptly elevated and thrown forward; foramen magnum very large and wholly above the level of the orbital region. Brain-case comparatively large, and forming a right angle with the line of the face; auditory bullæ moderately prominent, projecting under the glenoid fossæ, the latter being large and subquadrate. Rostrum low, the upper surface deeply channeled centrally; palate considerably excavated, posterior projection narrow, the cleft acute-angulate with narrowly rounded apex; zygoma slightly projecting, sublamellate. Mandible rather long, thin, moderately deep; condyle greatly elevated; coronoid process low.

Teeth.—Central pair of upper incisors much longer than the small lateral pair, flat, the cutting edge bilobate; upper canines long and falciform, the tips slightly spread; first upper premolar with the basal outline of the tooth crudely rhomboid; second upper premolar with a large caniniform, posteriorly placed cusp; upper molars broad, the first and second with W-shaped arrangement of the ridges, the protocone being more strongly developed on the first than on the second molar; third molar transverse, with N-shaped fold (para-hypoconoid) and a marked protocone. Lower incisors equal in size, trilobate; canines moderately long, the bulk of the tooth being anterior; premolars with the same general unicuspidate form, the cusp of the first being placed anterior to the centre of the

---

[13] The color is best seen by examining the specimen while immersed in alcohol, the wet specimen taken from the preservative appearing much darker. Mr. Osborn (*Proc. Zool. Soc. London*, 1865, p. 72) describes the fur of a freshly killed specimen as being bright chestnut, above rather paler. The same writer (p. 73) observes that the tint varies from a sandy buff to deep reddish-brown. It is possible from this that two marked phases exist. Since writing the above I have been enabled to examine a skin from the collection of the United States National Museum. My notes on it are as follows: General color a rufous-orange tint, suffused above with smoky brown, this tint restricted to the tips of the hair, and strongest on the lateral portions of the back and rump; long hair on the interscapular region naturally parted showing a patch of the lighter general color. Membranes brownish-black.

tooth, cusps of the first and third of equal length, longer than the second; molars with five cusps, the anterior one low and not prominent, the posterior four tall and sharp.

Measurements.—Average of two Jamaican specimens: Length of head and body, 50 mm.; head, 15.7; tragus, 4.2; forearm, 44.5; thumb, 6.2; third finger, 81.5; tibia, 20; calcaneum, 19.5; foot, 8.1; tail, 28.3.

Remarks.—This species is not liable to be confused with any other form except the subspecies *cinnamomea*, which is distinguished by the outline of the first upper premolar. From *M. megalophylla* and its subspecies this species is immediately distinguished by the form of the ears, the chin-lappet and the labial folds.

Specimens Examined.—Two alcoholic specimens and one skin: Jamaica (Coll. Biological Survey); Moneague, St. Ann, Jamaica (Coll. Biological Survey); Kingston, Jamaica (skin) (Coll. U. S. Nat. Mus.).

Mormoops blainvillii cinnamomea (Gundlach).

1839. *Mormops Blainvillii* Gray (not of Leach), Ann. Nat. Hist., IV, p. 3.
1840. *L[obostoma] cinnamomeum* Gundlach, Wiegmann's Archiv. für Naturgeschichte, VI, bd. I, p. 357.
1872. *Mormops Blainvillii* Peters, Monatsber. k. preuss. Akad. Wissensch. Berlin, p. 359 (part).
1873. *M[ormops] Blainvillii* Gundlach, Anales Socied. Esp. Hist. Nat., I, cuad. 3, p. 244.

Type Locality.—Casetal St. Antonio el Fundador, Cuba.

Distribution.—Cuba, San Domingo and Mona Island (in the Mona Island passage between San Domingo and Porto Rico).

General Characters.—Similar to the Jamaican *M. blainvillii*, but the first upper premolar attains its greatest thickness posteriorly, the outline of the tooth being subconoid with the apex directed forward.

Membranes, ears and other external characters as in *Mormoops blainvillii.*

Teeth.—The first upper premolar greatly expanded posteriorly on the internal portion, the cingulum forming a heavy raised border to a deeply impressed valley; the whole structure giving the tooth a subconoid or subpyriform outline, the apex being formed by the anterior border of the cingulum.

Color.—General tint walnut-brown above, ecru-drab beneath, the hair of the upper surface basally the same tint as the lower surface. Ears and membranes blackish-brown.

The Mona Island specimens are all uniformly colored, but a San Domingo specimen (No. $\frac{1109}{5202}$ Field Columb. Mus.) is ochraceous above, slightly darker toward the tips of the hair, the tint of the lower surface being tawny ochraceous; two Cuban specimens examined are identical with true *blainvillii* in coloration. From the evidence available it is seen that this form presents two color phases, one brownish, the other ochraceous.

Measurements.—Average of ten specimens: Length of head and body, 51.2 mm.; head, 16.8; ear, 15.1; tragus, 4.4; forearm, 44.5; thumb, 6.6; third finger, 83.1; tibia, 19.5; calcaneum, 19.4; foot, 8.5; tail, 25.8.

Remarks.—The difference in the form of the first upper premolar exhibited by this form is quite striking, and is constant in the series of specimens examined. No difference can be detected between the specimens from Mona Island and those from San Domingo. While no intergradation is known to occur with *M. blainvillii*, in view of the slight differentiation I prefer to call this form a race and not a species.

Specimens Examined.—Twelve—three skins, nine alcoholics:

Baracoa, Cuba. Two alcoholics (Coll. U. S. Nat. Mus.).

Mona Island, Porto Rico. Seven specimens—two skins (with skulls), five alcoholics (Coll. U. S. Nat. Mus.).

San Domingo. Two alcoholics (Coll. Acad. Nat. Sci. Phila.).

Aquacate, San Domingo. One skin with skull (Coll. Field Columb. Mus.).

Mormoops megalophylla (Peters).

1856. *M[ormops] blainvillii* Peters (not of Leach), Monatsber. k. preuss. Akad. Wissensch., Berlin, p. 411. ("Cuba.")

1856. *Mormoops Blainvillii* Peters (not of Leach), Abhandl. k. preuss. Akad. Wissensch., Berlin, p. 289, taf. 1, figs. 1–5. ("Cuba.")

1860. *Mormops Blainvillii* Saussure (not of Leach), Revue et Magasin de Zoologie, 2e ser., XII, p. 290, Pl. XV, fig. 5.[14] (Mexico.)

1864. *Mormops megalophylla* Peters, Monatsb. k. preuss. Akad. Wissensch., Berlin, p. 381. (Mexico.)

1872. *Mormops megalophylla* Peters, Ibid., p. 359. (Mexico and Venezuela.)

1878. *Mormops megalophylla* Dobson, Catal. Chiropt. Brit. Mus, p. 455. (Dueñas, Guatemala, Colombia and South America.)

---

[14] There is no way of telling to which form of the species this reference properly pertains.

1879. *Mormops megalophylla* Alston, Biol Cent.-Amer., Mamm., p. 37. (Part.) (Mexico [form?]; Tehuantepec.)
1893. *Mormops megalophylla* Thomas, Journ. Trinidad Field Naturalists' Club, I, No. 7, p. 162. (Trinidad.)

Type Locality.—As originally noticed (see above) this form was supposed to have come from Cuba, but Peters in his paper, in which the name *megalophylla* was proposed, shows that the species is from Mexico. Examined in the light of present material, it is seen that the typical form of the species is limited in Mexico to the southern portion and Yucatan, which section should be regarded as the type locality. This is ascertained by an examination of Peters' figure mentioned above and by comparing it with specimens; the differential characters of the races would be visible in the figure, but it clearly represents the form to which I have limited it.

Distribution.—Southern Mexico and Yucatan, south as far as Colombia, northern Ecuador,[15] Venezuela and Trinidad. Some specimens recorded from "South America" no doubt came from the northern portion of that vast continent.

General Characters.—Internal connecting membrane of ear not united with its fellow of the opposite side, except at extreme base; chin-lappet broadly and deeply divided. Skull with the rostral portion much inflated.

Head.—Ear large, not high; apex subtruncate; the internal connecting membranes rather low, only confluent at the extreme base on the rostrum, this section developing a pair of subcircular appendages which conceal the anterior aspect of the point of attachment; internal ridge rather high, moderately haired; lower external margin of the ear voluminous, forming a very considerable pocket, which when extended projects a distance on each side of the head equal to the thickness of the same; antitragus longitudinal, low, rounded; tragus with the apical appendage subspatulate, the median whorl thickened internally, basal lobe truncate and more developed than in *M. blainvillii.* Eye small, with a large V-shaped warty projection placed posterior to it, below the axis of the ocular opening. Nostrils oval, slanting upward and outward, the whole arrangement of callous pads being similar to *M. blainvillii*, but the internasal pads more robust and the laterals oblong instead of subcircular. Upper lip very fleshy, the incision near the commissure being wide and rounded. Chin-lappet roughly

---

[15] Oldfield Thomas in epist.

the same in outline as *M. blainvillii*, but the lower margin deeply divided between the two processes, the incision being widened at the end, the margins adjoining these processes but slightly emarginate with the lower angles rounded; surface of lappet similar to *M. blainvillii*. Labial fold very much as in the above-mentioned species.[16]

Limbs.—Forearm long, metacarpal of the third finger not reaching the elbow; thumb short and weak. Tibia and femur slender.

Fur.—Fur rather sparse in the region of the nape, the crown of the head being devoid of hair. Upper fur silky, under fur woolly.

Color.—Upper surface prout's-brown, the hair lighter basally, which under tint shows in the sparsely haired region of the nape, imparting a dull ochraceous touch to that portion. Membranes clove-brown. Under surface varying from wood-brown to tawny-olive.

Skull.—Rather large, strongly inflated, brain-case capacious, gently curving down into the rostrum which is strongly inflated posteriorly. Zygoma not bowed, widest posteriorly. Basi-cranial axis forming an obtuse angle with the facial axis.

Teeth.—Middle upper incisors broad, with a faintly bilobed cutting edge; outer upper incisors minute, placed in close proximity to the middle incisors. Lower incisors arranged in a semi-circle, each finely trilobed. Upper canines long, slightly divergent at the tips. Lower canines rather long, divergent, with the cingulum well marked posteriorly. First upper premolar low, conical, slightly directed inward; second premolar with the external cusp long, hastate, the internal portion forming a low rounded shoulder, the basal proportions of the tooth being longer (on the external margin) than wide. Lower premolars conical, the second shorter in lateral outline than the first or third, the latter more attenuate than the others. Upper molars broad, the first and second with W-shaped external cusps, the internal paraconoid ridge heaviest anteriorly, posteriorly low and free from the external cusps; third molar with a V-shaped pattern, the metacone not being developed,

---

[16] Dobson's figure (*Catal. Chiropt. Brit. Mus.*, Pl. XXIII, fig. 5) of this species shows the chin-lappet quite different in form from that of *M. blainvillii*. This is not so apparent in my specimens and was probably due to a disarrangement in the specimen figured.

and the internal cusp parahypoconoid in relation. Lower molars each with five cusps, the W-shaped disposition not being so strongly marked as in the upper molars, the metahypoconoid and protoparaconoid cusps more elevated than the remaining connecting ridges.

Measurements.—Average of three dried skins: Length of head and body, 71 mm. (67.5–74.7); forearm, 53.2 (52.7–54); tibia, 21.1 (21–21.5); foot, 9.6 (9.5–10).

Remarks.—This species can be readily distinguished from *blainvillii* by the characters given above. From *m. intermedia* it is separated by the freer and less-crowded first upper premolar. The subspecies ***senicula*** is distinguished by the form of the second upper premolar.

Specimens Examined.— Three skins with skulls:

Merida, Yucatan (two) (U. S. N. M.).

San Juan Bautista, Tabasco, Mexico (one) (U. S. N. M.).

Mormoops megalophylla senicula n. subsp.

1870. *Mormoops* (*Blainville?*) Dugés (not of Leach), La Naturaleza, I, p. 137. (Guanajuato.)

1879. *Mormops megalophylla* Alston, Biol. Cent.-Amer., Mamm., p. 37. (Part.) (Mirador)

1900. *Mormoops megalophylla* Mearns (not of Peters), Proc. Biol. Soc. Wash., XIII, p. 166. (Fort Clark, Texas.)

Type. — Adult ♀; Fort Clark, Kinney county, Texas. No. 84,801 U. S. National Museum. December 3, 1897. Collected by Dr. E. A. Mearns.

Distribution.—Southern Texas (type locality only known record), northern and central Mexico, probably intergrading with the typical form to the south of the central plateau country.

General Characters.—This form differs from the typical form of *megalophylla* in the much heavier and broader second upper premolar, which bears a very heavy and wide internal shoulder. The forearm seems to average slightly longer, but this was rather unsatisfactorily determined as all the available specimens of the typical form are skins.

Teeth.—Essentially as in *megalophylla* except for the form of the second upper premolar. This tooth is broader than the length of the labial border, the internal portion of the tooth is much more extensive, a broad rounded shallow shoulder being formed, which development is comparatively slight in *megalophylla.*

Color.—Upper parts broccoli-brown, the whole with a faint silvery suffusion; hair of the nape and upper part of the head basally pale ecru, which tint shows through the general color, producing a lighter appearance in those regions. Lower surface wood-brown, becoming ecru on the sides and flanks. Membranes hair-brown.

Measurements.—Type (collector's measurements): "Length, 90;[17] tail vertebræ, 28; alar expanse, 373; finger (longest), 90; head, 17; forearm, 56 mm." Average of thirteen alcoholic specimens: Length of head and body, 58.8 mm.; head, 16.7; ear, 15.9; tragus, 6.3; forearm, 53.3; thumb, 7.6; third finger, 93.1; tibia, 21.6; calcaneum, 21.8; foot, 9.5; tail, 25.8.

Remarks.—This form can readily be distinguished from typical *megalophylla* and *m. intermedia* by the form of the second upper premolar. Its distribution seems to coincide with the tableland of Mexico (and its more northern remnant), though two specimens from Tampico are perfectly typical.

Specimens Examined.—Seventeen—two skins, thirteen alcoholics, two skulls—all from the United States National Museum:

Fort Clark, Tex. (1).
Tampico, Tamaulipas, Mex. (2).
Guanajuato, Guanajuato, Mex. (1).
Mirador, Vera Cruz, Mex. (8).
Orizaba, Vera Cruz, Mex. (2).
Morelos, Mex. (3).

Mormoops megalophylla intermedia (Miller).

1900. *Mormoops intermedia* Miller, Proc. Biol. Soc. Washington, XIII, p. 160. October 31, 1900.

Type Locality.—Cave at Hatto, north coast of Curaçao, West Indies. Type, adult female, No. 102,174 Coll. U. S. National Museum.

Distribution.—Apparently limited to the island of Curaçao, where it frequents "caves and rock crevices in all parts of the island."

General Characters.—Differing from typical *megalophylla* in the smaller general size, and the greater size and general crowded condition of the first upper premolar.

Teeth.—Essentially as in *M. megalophylla*, but differing in the thicker and heavier first upper premolar, which tooth is crowded

---

[17] This without doubt includes the tail.

between the canine and second premolar, completely filling the space.

Color.—In describing the color one cannot do better than quote the original description—" Brown phase: entire dorsal surface sepia, the fur paler beneath the surface and each hair tipped with light drab. The drab tips produce a distinct bloom in certain lights. Under parts very pale yellowish broccoli-brown, lightest on belly, flanks and pubic region, faintly darker across chest. Red phase: like brown phase but entire pelage suffused with cinnamon. Pale phase: light salmon-buff above and below, becoming more red about shoulders and head. Ears and membranes dark brown in all three color phases." The brown phase appears to be simply an intermediate between the two extremes.

Measurements.—Average of seven alcoholic specimens: Length of head and body, 55.5 mm.; head, 16.7; ear, 14.5; tragus, 5.4; forearm, 50.8; thumb, 6.3; third finger, 86.9; tibia, 20.9; calcaneum, 21.7; foot, 9.7; tail, 23.7.

Remarks.—In view of the slight differentiation of this form I prefer to consider it a subspecies and not a full species. Future study may show that it is strictly insular and that no intergradation occurs, but I prefer to treat it on the same basis as the other newly recognized form of this group, the dental characters of which are even more striking, though the difference in size is not so apparent.

Specimens Examined.—Fourteen—six skins, seven alcoholics, one skull—all from the U. S. National Museum:

Curaçao, West Indies (14).

Comparative Measurements (in millimeters).

	Length of head and body	Head.	Ear.	Tragus.	Forearm.	Thumb.	Third finger.	Tibia.	Calcaneum.	Foot.	Tail.		Total length of skull.	Greatest zygomatic width.	Interorbital width.	Height at base of 2d premolar.	Height of brain-case.	Width of palatal constriction	Length of palate from ant. pal. foramen.	Width of palate with teeth.
Average of two specimens of *M. blainvillii*, Jamaica. (Alc.)	50	15.7	15	4.2	45	6.2	81.5	20	19.5	8.1	28.3	One skull meas.	14	8.5	4	3.7	7.5	1	8.1	6
Average of seven specimens of *M. b. cinnamomea*, Mona Island. (Alc.)	50	16.6	14.7	3.7	43.4	6.3	80.5	19.2	19	8.5	25.4	Average of two skulls.	13.5	8.8	4.2	4	7	.8	8	6
Average of three specimens of *M. megalophylla*, Tabasco, Yucatan. (Skins.)					53.2			21.1		9.6		Average of three skulls.		9.5	5.2	5		1	8	6.9
Average of thirteen specimens of *M. m. senicula*, Texas, north and central Mexico. (Alc.)	58.8	16.7	15.9	6.3	53.3	7.6	93.1	21.6	21.8	9.5	25.8	Average of four skulls.	15	9.6	5.4	5	8	1.5	8	6.9
Average of seven specimens of *M. intermedia*, Curaçao. (Alc.)	55.5	16.7	14.5	5.4	50.8	6.3	86.9	20.9	21.7	9.7	23.7	Average of seven skulls.	14.2	9.3	5.1	5.3	8	1.5	7.6	6.5

APRIL 1.

Mr. CHARLES MORRIS in the Chair.

Twelve persons present.

Papers under the following titles were presented for publication:
"Two Diseases of the White Cedar," by J. W. Harshberger, Ph.D.
"A Revision of the Genus Mormoops," by James A. G. Rehn.

APRIL 8.

Mr. BENJAMIN SMITH LYMAN in the Chair.

Eight persons present.

The death of Charles G. Sower, a member, March 22, was announced.

APRIL 15.

Mr. CHARLES MORRIS in the Chair.

Eighteen persons present.

Papers under the following titles were presented for publication:
"On Phylogenetic Classification," by Thomas H. Montgomery, Jr.
"On the Localities of A. Adams' Japanese Helicidæ," by Henry A. Pilsbry.

April 22.

Mr. Charles Morris in the Chair.

Fifteen persons present.

A paper entitled "Observations on Galeopithecus volans," by Henry C. Chapman, M.D., was presented for publication.

* * *

April 29.

Mr. Charles Morris in the Chair.

Twelve persons present.

Papers under the following titles were presented for publication:

"Descriptions of Some New Polynoidæ, with a List of Other Polychæta from North Greenland Waters," by J. Percy Moore.

"The Classification of the Aleyrodidæ," by T. D. A. Cockerell.

Edwin C. Jellett, Frederick A. Packard, M.D., and Robert C. Banes were elected members.

The following were ordered to be printed:

A COLLECTION OF REPTILES AND BATRACHIANS FROM BORNEO AND THE LOO CHOO ISLANDS.

BY ARTHUR ERWIN BROWN.

Through the courtesy of the officers of the Wistar Institute of Anatomy and Biology, I have been permitted to examine the fine collection of reptiles and batrachians, numbering 327 specimens, made by Dr. William H. Furness, Dr. H. M. Hiller and Mr. Alfred Harrison, Jr., in west and northwest Borneo and the Loo Choo Islands, between the years 1893 and 1897.

The thoroughness of previous collecting in the portions of Borneo visited by these gentlemen, is attested by the fact that the present series yields but one Bornean species hitherto undescribed; but a complete list of the species represented in the collection is here given, with such notes as contribute to our knowledge of the herpetology of those regions.

BORNEO.

REPTILIA.

CHELONIA.

Bellia borneensis (Gray).

Five specimens; Kapuas river.

All about 70 mm. long. Dark olive-brown above; plastron dirty green with dark sutures. Soft parts colored like the carapace. There are some irregularities in the plates. No. 2,413 has the fourth and fifth vertebrals and the fourth costal broken up into six irregular plates. No. 2,406 has the fourth costal on one side, and the fifth vertebral transversely divided. The front of the forearm has enlarged transverse scales, but on the outer side of the hind leg they are small.

Cyclemys platynota (Gray).

One specimen, 70 mm. long; Baram.

Green above and below; each vertebral with a pair of small black spots and each costal with one similar spot. Sutures between all ventral shields dark.

Cyclemys dhor Gray.

Three specimens, Kapuas river; one, Sarawak; two, Borneo.

Largest, ♀, 196 mm. In the adults the carapace is distinctly flattened on the vertebral area, and an indistinct ridge is outlined by the centres of the areolæ on the costals; this does not appear in very young examples, and is first indicated in No. 2,436. 74 mm. long. In the adults the dark markings on the plastron have disappeared.

Geoemyda spinosa Gray

Two from Kapuas river; one, Baram (collected by Charles Hose); one, Borneo.

Largest measures 200 mm. ♂. No. 5,688, from Baram, 85 mm. long, is much darker than the larger specimens.

Trionyx subplanus Geoff.

One specimen, 73 mm. long; Kapuas river.

LACERTILIA.

Gymnodactylus marmoratus Kuhl.

Two ♀; Borneo

Gonatodes kendalli (Gray).

One specimen; Kuching

Hemidactylus frenatus D. and B.

Two, Borneo, ♂, ♀; five, Kapuas river.

Hemidactylus platyurus (Schn.).

Five, Kapuas river.

Gehyra mutilata (Wieg).

One, Sarawak; one, Kuching.

Gecko stentor (Cantor).

One, Kapuas river; one, Borneo.

Gecko monarchus (D. and B.).

One, Borneo; one, Sarawak; three, Kuching.

Draco volans L.

Eight ♂ and six ♀; Kuching, Baram.

Draco quinquefasciatus Gray.

One, Borneo; one, Kuching.

Gonyocephalus liogaster (Gunth.).

One, Borneo.

Japalura nigrilabris Peters.

One ♀, Borneo.

Calotes cristatellus (Kuhl).

Ten, Borneo; five, Kapuas river; one, Kuching; one, Baram.

Mr. Boulenger's conclusion that *C. moluccanus* can not be separated from the present species is fully justified by the specimens in this collection, which exhibit equal variability to those studied by him.

Varanus salvator (Laur.).

One adult, Borneo; one young, Kapuas river.

In both specimens the ventral scales are smooth.

Varanus heteropholis Boul.

P. Z. S. of London, 1892, p. 506, Pl. XXIX.

No. 2,380, collected by Messrs. Harrison and Hiller at Baram, Sarawak, is somewhat intermediate between *V. dumerili* and the single specimen from Mt. Dulit, described by Mr. Boulenger under the above name; but as it presents the characteristic vertebral area of granules, entirely separating the large dorsal and lateral scales, shown by that specimen, they would seem to be identical. It differs from Mr. Boulenger's specimen in that the nuchal scales are not flat, but distinctly subconical, and the ventrals are without a keel. The large nuchal and dorsal scales are more or less separated from each other by granules. The whole upper surface is dark-olive, with the black markings much as in *V. dumerili*, but the crossbands on the body are narrow and indistinct and are more or less prolonged on to the ventrals. The under surface is yellow; throat and neck with short, longitudinal black markings.

Total length 530 mm. (tail 308).

Tachydromus sexlineatus Daud.

Three, Kuching; three, Borneo.

Mabuia rugifera (Stolic.).

Nos. 2,370, 2,444, 2,445, from Kuching, correspond exactly to *M. rugifera*, except that a postnasal is present, and the anterior loreal is rather more elevated than the second; the dorsal scales are in 28 and 29 rows. I am not inclined to separate them on account of these differences.

Mabuia multifasciata (Kuhl).

Nineteen, Sawarak; one, Kuching; seven, Borneo.

Mabuia rudis Boul.

No. 2,241, from Kuching.

Lygosoma vittatum (Edel.).

Three, Sarawak; two, Kuching; one, Borneo.

Lygosoma nitens Peters.

One, Borneo.

Tropidophorus brookii (Gray).

Nos. 5,697, 5,853, Borneo.

These specimens are each about 220 mm. long. In each of them the prefrontals are widely separated, as in the type specimen.

OPHIDIA.

Python reticulatus (Schn.).

Two, Borneo; two, Baram.

Cylindrophis rufus (Laur.).

Two, Kuching; two, Borneo; one, Celebes, collected by Charles Hose.

Largest specimen 380 mm.

Xenopeltis unicolor Reinw.

One, Kapuas river.

Ventrals 179; subcaudals 29.

Polydontophis geminatus (Boie).

No. 2,338, from Baram.

Length 485 mm. (tail 120); ventrals 150; subcaudals 51.

This specimen corresponds exactly to Gunther's description of *Ablabes flaviceps*, but is characterized by an extremely short tail, with a reduced number of subcaudals; the lowest given by Mr. Boulenger being 89.

Tropidonotus trianguligerus Boie.

Nos. 5,692, 5,702, Borneo.

No. 5,702 I refer to this species, with which it agrees in scutellation, although there is a considerable difference in the color pattern, which is very obscure, but seems to consist of a row of black vertebral spots and an indistinct series of smaller ones on each side, much closer together than in typical *trianguligerus*. Each ventral heavily edged with black at the ends.

Length 720 mm. (tail 246); ventrals 140; subcaudals 105.

Dryocalamus trilineatus sp. nov.

Rostral barely visible from above; internasals much shorter than prefrontals; frontal longer than the snout, shorter than parietals; loreal long and entering orbit; no preocular, the supraocular extending down to meet the loreal; one narrow postocular; temporals 1 (2)–2; seven upper labials, third and fourth in the orbit; posterior chin shields short. Scales in 15 rows. Ventrals 228; anal entire; subcaudals 87 pairs.

Total length 285 mm. (tail 70).

Olive-brown above, with a narrow greenish-yellow vertebral stripe, and another on each side, on the fifth row of scales. Top of head olive-brown. Ventrals, outer row of scales and both series of labials of the same color as the light stripes.

Type specimen, No. 5,825 from Baram district, collected by Drs. Furness and Hiller.

This species much resembles *Dryocalamus tristrigatus* Gunth., of unknown locality, but compared with Mr. Boulenger's plate[1] the head is flatter and the upper labials less elevated, the rostral is smaller, there is but one postocular, and the color appears to be different.

Xenelaphis hexagonotus (Cantor).

One, Baram; collected by Charles Hose.

Coluber oxycephalus Boie.

Three, Kapuas river; one, Baram; one, Borneo.

Coluber melanurus Schl.

One, Kuching; three, Baram, collected by Charles Hose.

No. 5,810 has the preocular divided on one side, and 5,814 has the anterior ends of the first row of temporals cut off, forming an extra series of small temporals.

Dendrophis pictus (Gm.).

Seventeen specimens; Kuching, Kapuas river, Baram, Sarawak.

No. 2,374, from Baram, 780 mm. long (tail 250), ventrals 169, subcaudals 121, is bluish-black above with the lateral stripes very indistinct; belly yellow, much marked with blue posteriorly. No. 5,691 has the loreal horizontally divided on both sides; temporals 1–2.

---

[1] *Cat. of Snakes in Brit. Mus.*, I, p. 372, Pl. XXV, fig. 3.

Dendrophis formosus Boie.

One, Kapuas river.

Dendrelaphis caudolineatus (Gray).

Eight specimens; Kapuas river, Kuching, Baram.

No. 2,378, from Baram, 1,160 mm. (tail 300), ventrals 183, subcaudals 97, is dark bluish-black with obscure lateral stripes; belly slate color.

Simotes octolineatus (Schn.).

One, Sarawak; two, Baram; one, Borneo.

Ablabes tricolor (Schl.).

One, Borneo.

Calamaria vermiformis D. and B.

Two, Borneo.

No. 5,816 has the body completely encircled by alternating rings of brownish-black and pale-yellow, the dark rings being widest on the back and the light ones exactly the reverse; whole head pale-yellow; length 172 mm. (tail 13). This corresponds to the form described by Gunther as *C. flaviceps*.

Hypsirhina enhydris (Schn.).

Two, Kapuas river.

No. 2,561 has ventrals 157; subcaudals 31.

Hypsirhina doriæ (Peters).

No. 2,311, Kapuas river.

The example which I refer to this species corresponds nearly to Peters' description and plate. It has, however, but 27 rows of scales. The head shields are quite anomalous; the left internasal is divided, as is also one of the parietals, and the anterior temporal on one side. Length 810 mm. (tail 95); ventrals 160; subcaudals 44. The yellow of the ventral surface extends to the four outer rows of scales, where it becomes reddish, as it does on both series of labials.

Dipsadomorphus dendrophilus (Boie).

Three, Borneo.

Dipsadomorphus cynodon (Boie).

Two, Baram; one, Kapuas river; one, Borneo.

Psammodynastes pulverulentus (Boie).

No. 2,569, Kapuas river, length 625 mm. (tail 128); ventrals

164; subcaudals 70. No. 2,567, same locality, length 515 mm. (tail 120); ventrals 161; subcaudals 69.

Psammodynastes pictus Gunth.

Three specimens from Kapuas river.

No. 2,236 is 518 mm. long (tail 118); ventrals 159; subcaudals 80. Body slender and stripes only indicated. In form and proportions this species is very closely approached by No. 2,567 (*P. pulverulentus*), and the distinctness of the two species appears to me questionable.

Dryophis prasinus Boie.

Ten specimens; Kapuas river, Kuching, Baram.

Chrysopelea ornata (Shaw).

No. 5,690, Baram district, 898 mm. (tail 250); ventrals 213 (the last one divided); subcaudals 135. The light spots on the back are confluent into an almost continuous vertebral stripe, becoming obscure toward the tail. The ventrals are unmarked, and the subcaudals have narrow black margins.

Enhydrina valakadien (Boie).

One, Baram; one, Borneo.

The Baram specimen, 840 mm. long (tail 115), has a pair of elongated shields detached from the inner border of the parietals, immediately behind the frontal.

The color is greenish-gray above in one specimen, and lead color in the other; beneath, yellow.

Bungarus fasciatus (Schn.).

One, Baram; one, Borneo.

Bungarus flaviceps Reinh.

One, Baram. Collected by Charles Hose.

Naia naia (L.).

One, Kuching.

Dark-olive, without markings except side of head and throat yellowish.

Lachesis wagleri (Boie).

Thirteen specimens; Kapuas river, Kuching, Baram. There is much variation in the color of these specimens. Some are green, many dorsal scales and the ventrals with yellow borders; others are green above, some scales with yellow centres, the wholly green ones being arranged in narrow crossbands, the ventrals yellow, edged with dark-green. No. 2,337, from Baram, 355 mm. long, is bluish-brown on the body, green on the tail, all the scales with narrow pale margins; ventrals greenish-white with pale borders.

Lachesis sumatranus (Raffles).

One, Baram. Collected by Charles Hose.

BATRACHIA.

ECAUDATA.

Rana macrodon Kuhl.

Two, Borneo.

Rana tigrina Daud.

Nine, Baram river; Borneo.

These specimens are all young; the head and body in the largest measuring but 65 mm.

Rana erythræa (Schl.).

One, Kapuas river; one, Baram; two, Borneo.

Length of head and body in the largest 67 mm.; hind limb 108 mm.

Rana everetti Boul.

Cat. Bat. Sal. in Brit. Mus., p. 73, Pl. VI.

Two, Borneo; one, Baram river.

These specimens correspond closely to Mr. Boulenger's description and plate. No. 5,768 is the largest and measures 78 mm. from snout to vent; hind leg 127. In each of them the anterior end of the vomerine teeth is about even with the inner anterior border of the choanæ.

Rana glandulosa Boul.

Cat. Bat. Sal. in Brit. Mus., p. 73, Pl. VII.

No. 5,778, Baram river; No. 5,767, Miri, Sarawak; No. 5,764, Borneo.

The three specimens which I refer to this species have the interorbital space rather wider than it is figured by Mr. Boulenger. The color is either dark-brown or olive above, slightly spotted or marbled with black; beneath yellow, spotted with black, most heavily on the throat and under surface of thighs; jaws black, with three or four vertical yellow bars, the largest of which is between the eye and the tympanum. The Miri specimen, 55 mm. head and body, is much more distinctly marbled with black on both surfaces than the two older examples; the legs are distinctly crossbanded with black.

Rhacophorus maculatus (Gray).

No. 5,808, Borneo, measuring but 32 mm. head and body, is referred with some hesitation to this species, both the tympanum and digital disks being small. This may be a juvenile character.

Calophrynus pleurostigma Gunth.

One, Borneo; three, Baram river (collected by C. Hose).

Bufo melanostictus Schn.

Four, Baram river (coll. by C. Hose); two, Borneo.

The largest is 112 mm. head and body; hind leg 160.

No. 5,776, but 43 mm. long, is probably the young of this species.

Bufo biporcatus Gunth.

Ten specimens; Baram river, Kuching, Tegora.

No. 5,783, from Baram, and 5,769, 40 mm. long, might about as well be assigned to *B. divergens* Peters, but with the small amount of material at my disposal, I am not inclined to separate them.

Bufo asper Graven.

Seven specimens; Kapuas river; Baram river (collected by C. Hose); Miri, Sarawak; Borneo.

The largest measures 140 mm. snout to vent; hind leg 185.

LOO CHOO ISLANDS.

The collections of Drs. Furness and Hiller in the Loo Choo Islands, in 1896, were made in Oöshima and Okinawa; the collectors' labels unfortunately do not distinguish between the two localities.

REPTILIA.

LACERTILIA.

Hemidactylus frenatus D. and B.

No. 5,722, ♀; 5,723, ♂, Loo Choo Islands.

Gehyra intermedia sp. nov.

Head large and ovoid; snout a little longer than the distance from eye to ear opening, about once and a fifth the diameter of the orbit. Forehead concave. Ear opening small, broadly oval. Body somewhat depressed; no lateral membrane on body, limbs nor tail. Digits short, not webbed; inner ones well developed, but without a claw; inferior lamellæ double, oblique and separated by a groove. Upper surface covered with small rounded granules, largest on the snout; ten or eleven series of small round tubercles on the back, extending on the base of the tail; no tubercles on the head.

Abdominal scales larger than the tubercles, flat and slightly imbricated. Rostral nearly twice as broad as high, without distinct groove above. Nostril formed by the rostral, first labial and three nasals, of which the upper is largest and separated from its fellow by a small scale. Upper labials 9–10; lower 10–11. Mental large, pentagonal, the postero-lateral angles obtuse. Chin shields small, hexagonal and in several transverse series, the anterior largest, the others gradually decreasing in size to the small throat granules. Tail rather short, rounded and covered above with flat scales rather larger than the granules of the back; beneath with a median series of large scales. Nine preanal pores in an angular series, meeting centrally.

Color: dark-brown above, lighter beneath. Each lower labial with a dark spot in the centre.

Total length 104 mm., tail 46. Length of head 16, breadth 12. Body 42.

Type No. 5,721, Loo Choo Islands. Collected by Drs. Furness and Hiller, 1896.

This species differs from the rest of the genus by the presence of dorsal tubercles, such as are found in most *Hemidactylus*. In most details of scutellation it closely resembles *H. marmoratus* Hallowell,[2] and I would be disposed to regard them as identical, but the fact that Hallowell refers his specimen to the section *dactylotèles* of Duméril and Bibron, which included only species with fully clawed digits, makes such a conclusion impossible, and Hallowell's type being lost, no further investigation is now practicable.

Japalura polygonata (Hallow.).

Nos. 5,742, 5,743, 5,745.

Two have eight upper labials, one has seven.

Tachydromus smaragdinus Boul.

No. 5,736.

---

[2] *Proc. Acad. Nat. Sci. Phila.*, 1860, p. 491.

Lygosoma pellopleurum (Hallow.).

Nos. 5,739, 5,740, 5,741.

The largest measures 100 mm. Color: rather pale-brown, with a narrow, indistinct, dark vertebral line beginning on the neck, and a wider lateral stripe beginning at the eye.

Eumeces marginatus (Hallow.).

Eight specimens.

No. 5,737 has two postmentals, and the third supraocular is longitudinally divided.

OPHIDIA.

Dinodon semicarinatus (Cope).

Nos. 5,724, 5,725.

The scales in the black crossbands are mostly marked on their centres with the pale ground color.

The small basal keels and apical pits are barely distinguishable.

Lachesis flavoviridis (Hallow.).

Eleven specimens; the largest measures 1,710 mm. (tail 272).

BATRACHIA.

ECAUDATA.

Rana gracilis Wieg.

Seven specimens, the largest measuring but 48 mm.

Rhacophorus viridis (Hallow.).

Polypetades viridis Hallow., Proc. Acad. Nat. Sci. Phila., 1860, p. 500.

Nos. 5,718, 5,719, 5,720 are unquestionably to be referred to this species, and as Hallowell's description is very meagre, I give the full characters.

Vomerine teeth in two slightly oblique series, beginning at the inner anterior edge of the choanæ. Head rather large; snout short and blunt; canthus distinct and rounded; loreal region slightly concave; nostril near the end of the snout; interorbital space nearly twice the width of upper eyelid; tympanum two-thirds the horizontal diameter of the eye. Fingers half, and toes two-thirds webbed; finger disks nearly as large as the tympanum, those of the toes smaller; subarticular tubercles rather small; inner metatarsal tubercle elongated; outer absent. Tibio-tarsal joint reaches to the snout in the largest specimen and just beyond the eye in the smallest. The skin on the back is smooth, on the belly and under side of thighs strongly granular. A slight fold from orbit to shoulder above the tympanum.

Upper surface pale-olive in spirits (probably blue or green in life); underneath yellowish, with small irregular dark spots on the groin. The anterior and posterior surfaces of the thigh are whitish, with small dark spots which extend on the inner tarsus, and in one specimen on the dorsum of the foot.

Largest specimen: snout to vent 83 mm.; hind limb 125. Next largest: snout to vent 76 mm.; hind limb 114.

Microhyla undulata sp. nov.

Nos. 5,726, 5,727, 5,728 are referred to this genus, although they show no trace of a transverse ridge between the choanæ, a condition which may be due to immaturity.

The snout is short; interorbital space wider than the upper eyelid. Fingers and toes blunt, but not distinctly dilated; first finger shorter than second; toes nearly half webbed; tubercles small; outer and inner metatarsal tubercles distinct. The tibio-tarsal joint reaches beyond the eye. Skin smooth. Color: light-olive above, with an undulating dark-brown dorsal band, beginning on the vertex and broadening on the rump, with a narrow prolongation running forward to the snout, and a transverse one to the upper border of each eyelid. A dark stripe from the orbit through the shoulder and a little beyond. Hind legs light-olive, lighter beneath, crossbanded with black on the anterior side of lower leg and tarsus, and an indistinct dark stripe on the anterior border of the thigh. Ventral surface brown, without spots. In 5,728 the markings are obscure.

5,726. Length of head and body 23 mm.; hind limb 34.
5,728. " " " 20 " ; " " 34.
5,727. " " " 17 " ; " " 28.

This species much resembles the Indo-Chinese *Microhyla ornata* D. and B. in color pattern, but the toes are more extensively webbed and the legs are longer.

CAUDATA.

Molge pyrrhogastra ensicauda (Hallow.).

Six specimens.

ON PHYLOGENETIC CLASSIFICATION.[1]

BY THOMAS H. MONTGOMERY, JR.

INTRODUCTION.

The great diversity in plans of classification is, in part, the result of the diversity of standpoints held by their framers. Whether the observer is conscientious in endeavoring to represent the facts as they are, or whether he with more elastic conscience disregards all which do not coincide with his preconceived standpoint, the consequence is a bewildering confusion of individual, wholly subjective interpretations. While one relies upon embryological data to great extent, another trusts to the evidence of comparative anatomy, and a third unites a combination of these two methods in such a manner as he sees fit. All unite in holding similarity in structure to represent phyletic affinity, but they depart from one another on the question as to what constitutes similarity. And again, among the comparative anatomists, some attribute more value to this organ or organ system, others to that, and while some contend that similarities may be determined by the study of one particular conservative character, others argue that no character should be neglected. And he who finds only likenesses is to be ranked little or no better than he who sees only differences.

As one scheme of classification follows upon another, and in its return receives emendation and perhaps subsequent lack of support, we may well inquire whether, after all, phyletic classification may ever be earnestly considered as more than speculation. Yet those who maintain this view forget that classification is interpretation, and that interpretation here is as allowable as in any other series of facts. Classification is a grouping of concepts necessary for the mind to make, in order to secure a foothold among the enormous mass of facts of structure which no one man can grasp. And the reason for the diversity of the interpretations is the enormous number of the organisms themselves; the greater the array, the more

---

[1] From the Zoological Laboratory of the University of Pennsylvania.

difficult the explanation. Lamarck pointed out that no groups existed in Nature but only individuals, yet he arrayed these individuals into certain mental groupings, such as was necessary for an understanding of them.

Classification, orderly arrangement, is demanded, so that the field of facts may be better surveyed from the vantage points thus gained. But a purely arbitrary and artificial classification, such as many museum curators of an earlier time invented in order to arrange an animal according to superficial examination alone—and such as is still used by many who would avoid patient toil of thorough examination of all the parts—is not a help to the mind, for it does not represent the organisms in their natural relationships, and hence it and the morphology must be memorized separately. Phyletic classification should be an epitome of our knowledge of the genetic relations of organisms, and many tireless workers are striving to make it so. Insomuch it may be regarded as the statement of our knowledge of the succession of evolution, and consequently, therefore, one of the main aims of zoological research. It is not only a naming and arranging of the individuals we study, not only a subservient preliminary to such study, but in its perfected condition a statement of all we have learned about the organisms. All careful, accurate observation of structure and function, and of the ecological phenomena which help to explain these, must eventually be considered in such classification, by a gradual and critical synthesis of all these facts.

All that we learn is expressed in its relations, and we define one organism in terms of another. Thus there arises a whole connected representation of the data, and whether we walk by the anatomical, the embryological, the physiological or the ecological path, all must use the same method to test their conclusions, namely, comparison. The classification that we strive for is based upon comparison, and is to represent the path of evolution as far as the facts allow us to determine it.

There has been shown by a more modern school of investigators a spirit of disapprobation if not of disgust against the plotting of "genealogical trees." To some extent they are justified in this disapproval, when we note the variety of opinions as to the relationships of many groups of animals. Thus, how few are the groups which have not been called upon to serve as the ancestors of the Vertebrates! Any one can recall the manifold opinions as to the affinities of the Rotifera, of *Macrobiotus* and the Gordii, of the Diplopode Myriopoda, of *Limulus*, of the Pycnogonida, and of *Sagitta* and *Pentastomum;* indeed, these examples could be much increased, and we could say that only in regard to very few groups is there any unanimity of opinion. Yet the phylogenist may well, in his turn, note the lack of unanimity in the conclusions reached in other lines of investigation. Has the cause of variation been explained, or have the phenomena of cleavage and differentiation, or those of cell division and inheritance, and how much is known of the interaction of sense organ and central nervous system? The phylogenist does not answer his critics in a vindictive spirit, but to show that he as well as they must reach correct interpretations slowly. A view disproved is, after all, something gained, for it serves to narrow the field. The phylogenetic classification of animals is perhaps the greatest task that a naturalist has before him, the aim to represent the sequence and relations of all known organisms, which presupposes a thorough knowledge of their structure and an understanding of the phenomena of growth and change.

Whether such a perfect classification can ever be obtained or not, it is the part of the naturalist to aid in its pursuance, even if not by working upon it directly. One does not stop before a task for fear he cannot complete it. When one looks upon it not only as a determination of relationships, but also as involving an understanding of growth phenomena, it is found to be a project demanding the highest mental effort.

It seems that perhaps more logical and true ideas of the relationships of animals may be gained by a critical consideration of the standpoints employed—of attempting to eliminate those that may be erroneous. If the standpoints can be logically lessened, the amount of the present confusion would be reduced. The animals now living do not represent more than a fragment of the forms that have once existed, and very few of the latter have been preserved geologically. For the vast number of forms, most of those of softer structure, no paleontological remains can be expected; and therefore for the determination of the ancestry of those now existent we must rely upon the study of the anatomy of the latter. This may be the anatomy of the adult stage or of the earlier stages;

and the present contribution is in the main a discussion of the values of the comparative anatomical and of the embryological methods in the determination of phylogeny.

The materials that the phylogenist has before him are, first, the animals themselves; and second, the accumulation of previous studies upon their morphology. If the latter were always accurate representations, they would give one, in a short space of time and with a minimum of labor, the facts he needs; but very few of the large array of morphological monographs are even tolerably accurate, and because of this one frequently goes astray in trusting to the descriptions of others. Hence, first and foremost, our ideas of morphological details must be accurate—*i. e.*, without preconceived bias of interpretation—and, as far as possible, we should ourselves study the organisms which we compare. In the next place the whole method must be synthetic, comparing object with object until gradually a connected mental superstructure is formed, all the parts of which have been separately studied. This by no means implies the avoidance of working theories, for it has been the experience of the naturalist that such theories are exceedingly fruitful in directing research; but it does imply that the working theory should be considered as such and as nothing more, until it can be demonstrated that there are no overlooked facts which may be in contradiction to it. At every point the method should be tested as well as the observation. By adding comparison to comparison, provided we are working with a method in whose relative correctness we can feel confidence, we may expect fuller unanimity of result and gradual lessening of confusion in interpretation.

I. The Possible Modes of Classification.

A classification is necessary to enable a concise grouping of the facts; a phylogenetic classification should be the statement of the origin and transformation of organisms. Obviously there is a necessity of considering whether the study of structure alone is sufficient for determining this racial progress, or whether the other attributes of organisms should be considered. In a word, why should the strictly morphological classification, the one dominant in present thought, be granted precedence?

Any of the following classifications might be instituted, besides the morphological: (1) *Physiological*, one based upon the degree, kind, and mode of interaction of those activities of parts known as functions. Here would presumably be found a progress from the more generalized to the more specialized, accompanying the evolution of the organism, just as in structural relations. (2) *Physical* or *Dynamical*, one based upon the so-called physical energies or motions; for such motions might be found to show successive complexity, according to changes within the organism. (3) *Chemical*, for increasing complexity and instability of the substances composing the organism might go on parallel with the course of racial development. (4) *Ecological*, based upon the relations of the organism to its environment, its kinds of habits and their modifications, its geographical distribution, its general responses to environmental stimuli. (5) *Psychical*, dealing with its mental operations (this might be classed with the physiological).

Now these possible kinds of classification fall into two groups, the physical and chemical, and the morphological, physiological, ecological and psychical; for while the physical phenomena of an organism may be considered by themselves, and the chemical equally so, all the other kinds of phenomena are closely correlated. We might term the physical and chemical aspects *inorganic*, and the others *organic*, were these expressions not now becoming somewhat obsolete. There may have been an evolution of the "inorganic" as well as of the "organic" energies of organism, so that *à priori* a phyletic classification might be based upon the physical or the chemical phenomena. But how much has been determined of the evolution of physical and chemical energies? Certain of their present actions are becoming explained, by gradual synthesis many compound substances have become built up, and in change in the substances possibly the physical movements of these substances become changed; but are there facts to show that all substances have been derived from one primeval substance, or that all kinds of physical motion are referable to one ancestral kind? The uncertainty on these points, the lack of relatively positive facts, the great hiatus in our knowledge of physical and chemical relations as studied particularly in organisms, are sufficient reasons for neglecting at the present time any attempt to base a phyletic classification of organisms upon such relations. Until all the phenomena of growth and structure in organisms can be expressed in purely physical and chemical terms, which so far has not been possible, it would be incorrect to build upon classifications which would neglect many of the energies and phenomena of organisms which particularly distinguish them from non-organisms.

There then remain to be compared the morphological, physiological, ecological and psychical classifications, and to be determined which of them can be most profitably employed in tracing the course of evolution. All these are closely related, for the nervous system, *e. g.*, shows a structure, a function, a relation to habits and environment, and to so-called mental phenomena. The living structure and its activity are inseparable, and both have close connection with the environment. The fact that they are all so closely and inseparably correlated that in treating of an organism the naturalist is obliged to regard it in all of these aspects, would argue that a classification might be based equally well upon any one of them. Much more has been determined in regard to structural than to physiological, psychical or ecological relations of organisms, so that a morphological classification, having more facts at its command, is at present more practicable than any other. In time the morphological classification must be tested by the others, and now no phyletic classification is justifiable which would not regard the functions and the interactions to the environment, for these have modified the structure. Function has produced structure, and structure so formed in turn tends to restrain change of function, and the stimuli of the environment are the strong masters of the organism. Hence structure, function, relation to environment, each mirrors the others, any one of them might be the basis of the classification; and if we now select the morphological characteristics as the basis for determining the phylogeny, it is because they offer us at present the richest material. But starting as we do with a classification based upon similarities determined on structure, we are not to consider that on structure alone our ultimate phyletic classification is to rest; for to understand the phylogeny of organisms we should not view them as seen in certain instants of time only, but must explain the continuous change that has occurred between those instants by analyzing the phenomena of growth and of reaction to environmental stimuli. The phenomena of structure, when the comparisons have been rightly instituted, may go far toward explaining the path of evolution, but the change produced by evolution, which is equally necessary for our ideas of phylogeny, can be determined only by considering in addition the energies and activities of organisms, and their interaction with the environment.

II. The Individual.

Organisms are living entities, yet, since each organism is known to be composed of parts, there arises the necessity of determining the degree or kind of individuals that are to be classified. In Nature occur only individuals, as was clearly pointed out by Lamarck, and is generally acknowledged at the present time, species and other groups being arbitrary concepts. Hence it is individuals that are to be classified and mentally arranged into groups characterized by similarity of structure; but before this can be done it is necessary to decide what is meant by the term "individual."

The primary idea of an individual is independence, as in saying "an individual is that which is capable by itself of performing all the activities necessary for its existence"; or "that which cannot be subdivided without ceasing to be." But neither of these statements are quite correct, for no organism is wholly independent of other organisms and of its environment, and experiment has shown (in cases of regeneration) that what are commonly known as individuals may be subdivided, and yet not cease to exist; the independence then is one of relative degree. Another criterion is that of structural disassociation: an individual is an organism structurally complete in itself, not a part of a larger structural whole; though in practice this definition is often found of little value, as in organisms forming corms and stocks, yet perhaps it is as far-reaching as any that can be offered. Another criterion would be the ability of reproducing itself through an ontogenetic cycle similar to that by which it had been formed. Yet, with this definition difficulties at once arise. For while, *e. g.*, the ovum of a bird, once fertilized, can form an adult bird containing ova in its ovary, the last-named ova are unable to give rise to a second generation of adult birds until they are first fertilized. And the adult hen bird cannot produce a new generation until its ova are fertilized by spermatozoa from the male. The ovum of a bird, deposited outside the body of the mother, would generally be regarded as an individual, and so would the adult hen or cock; but the ovum cannot reproduce itself without being fertilized, nor can the hen or cock reproduce themselves without mutual union of their reproductive elements. In other words, this criterion makes no allowance for the general occurrence of organisms which complement each other in ensuring procreation. It is doubtful whether any organism can reproduce itself indefinitely without at least occasional interaction with another organism; in the Metazoa the dioecious condition would appear to be the primitive one; accordingly, the lowest organisms at some period in their reproductive cycle, the highest organisms at each period of reproduction, need coöperation with complemental individuals in order to insure successful reproduction. Whether the complemental individuals are structurally alike, as in the Infusoria and hermaphroditic Mollusca, or whether they are structurally dissimilar, as in most dioecious forms, it would still hold that the single organism would not be capable by itself to reproduce itself. And again, accidentally infertile organisms or normally infertile organisms, such as the worker females of the Hymenoptera, could on this definition not be classed as individuals since they are unable to procreate themselves; yet, no one would maintain that an ox or a worker ant is not an individual.[2] Therefore this criterion of individuals, the ability by itself to reproduce itself, must be changed to "ability, on interaction with complemental individuals, to reproduce itself." But this definition will not enable us to determine the individuals to be considered in phyletic classification, as we shall proceed to show.

There are found among organisms, as has been so frequently reiterated, many degrees and kinds of individuals. For each more complex organism must be decided what is the higher individual, and what the individuals of lower grades. The ideas of corm, stock, person, organ, intergrade, sometimes for the same organism, almost always when we compare complex organisms of different kinds. Thus we may term "colony" or "corm" the connected individuals of the protozoan *Globigerina*, a proliferating Hydroid stalk, the unified bundles of spermatozoa of an Isopod Crustacean, or a compound Tunicate. And yet how these several organizations

---

[2] This objection to the definition is not, however, perfectly fair, since in classification we deal with normal and not accidentally mutilated organisms, and since a worker ant may in one sense be considered embryonic, because its genital organs and ova do not attain a complete development, but are arrested in their growth.

differ structurally! In the Tunicate organization itself a great series of "individuals" may be distinguished, as one will. Thus (1) a cellular individual, such as a chromosome or a centrosome; (2) a tissue individual, a cell; (3) an organ individual, a tissue or some specialized part of the organ; (4) what is generally spoken of as an organ, such as the heart or the intestine; (5) an organ system, such as the body wall; (6) what is generally regarded as the individual in this particular case, and (7) what is termed the corm. For the cytologist, the embryologist and the anatomist the idea of what constitutes the individual will differ. Likewise, there are many possibilities of interpretation of the organization of a Siphonophore; and in the case of a proliferating *Hydra* or *Microstomum,* it is practically impossible to decide at just what time two individuals appear in the place of the original one.

All the preceding bears out what each naturalist finds in his own experience, that there occur many degrees of individuals, and that a sharp definition to cover all cases is practically impossible. Perhaps the nearest to it is found in the idea of structural disassociation, though this too breaks down when we consider the various kinds of corms and colonies found in organisms, and the cases of intimate symbiosis (such as the Turbellarian *Convoluta* with its enclosed plant cells). And yet to work upon our phyletic classification, it is necessary to know what are the individuals which should be the materials of the study; perhaps they may be more closely determined by the following line of reasoning.

Progressive evolution is a change from the more simple and generalized to the more complex and specialized in both the individual and the race. In the evolution of the race we consider the organism as a whole. This gives us the working criterion of individual, which is concisely the largest disassociated whole. And it is in this sense that the term individual is generally employed by phylogenists—that is, "individuals" are the units which make up our concept of "species," as the latter term is usually employed by naturalists. This definition will not apply to all cases, as, for instance, certain corms; but in many, if not all, such cases the "individual" and the "colony of individuals" may be eventually distinguished by comparison of undoubted single individuals with corms of united individuals of genetic affinity with the former. And it is necessary wherever possible to distinguish an individual from a corm, so that relatively similar units may be compared.

III. THE ORGANISM AND THE STAGE AT WHICH IT IS TO BE CLASSIFIED.

For purposes of phylogenetic classification it is perhaps best to regard " organism " as synonymous with " individual "—*i. e.*, the largest disassociated whole. Yet under the idea of " organism " have been grouped living units of different values, just as we have seen to be the case with the idea of " individual." And on this account it is necessary to see what these degrees of organisms are, and why a particular degree of organism should be made synonymous with a particular degree of individual.

In a multicellular animal parts of a cell have been regarded as organisms. Thus Altmann has considered certain granules, which according to him compose the living substance, to be each of them separate organisms, so that the cell would represent a symbiotic state of many organisms.[3] The centrosome is frequently spoken of as an organism, and by Eisen the nucleus, the cytoplasm and the attraction sphere have been regarded as three distinct organisms in a state of symbiosis. Chromosomes, by those who have corroborated the original position of Boveri, are looked upon as cellular individuals, though it is recognized that these elements stand in intimate functional connection with the rest of the cell. But what concerns us here most particularly is the standpoint of those who consider the multicellular animal to be an aggregate of organisms, the cells; and the view which regards an Annelid to be composed of a chain of organisms, its metameres or segments, or a Cestode to be made up of a row of organisms, its proglottids.

Now these various degrees or kinds of " organisms " would not be so confused if a distinction were drawn sharply between " organism " and " element of an organism." Under " organism " we should then understand " the largest disassociated whole," and its parts, as organs, tissues, cells or parts of cells, would be the " elements " which compose it. Whitman in his paper, *The Inadequacy of the Cell-Theory of Development*, has pointed this out most incisively. There he shows that structure is dependent upon the general organization, not upon the particular nature of the cell components; acellular and cellular organs may be com-

---

[3] That the protoplasm of the cell is an aggregate of minute but visible separate granules, as Altmann endeavored to prove, has not been corroborated by the more careful studies on the cell.

pared, unicellular with multicellular, and intracellular with intercellular. In other words, we might say that it is not the cells which make the organism, but the organism which makes the cells. This thought may be carried further: the cell contains particular parts or elements, such as chromosomes, centrosomes and cytoplasm, but is more than a mere aggregate of these; and the Annelidan organization contains parts, such as the metameres, but the latter are not separate organisms. Thus the Metazoan is not a mere symbiotic aggregate of cells regarded as individual organisms, but these cells are merely subservient parts of the whole organization. Under "organism" then we must consider the whole organization, if we would not confuse entities of different values; and for the parts of such organisms the terms "structural element" or "micro-organism."

The organization as a whole is, then, of primary importance, not its elements. And by employing "organism" to mean the "organization as a whole," we are justified in classing "organism" as synonymous with "individual," as defined above, namely, "the largest disassociated whole." It is the organism defined in this sense that is the unit to be treated in phylogenetic classification. It is necessary to be clear upon this point, and not to regard parts of cells, or cells, or tissues, or organs as the primary materials to be treated in classification. The organisms or individuals of our classification are then primarily the kind which are mentally grouped under what we generally understand as "species." And since a species is simply a mental association of similar individuals or organisms, it cannot be perceived; so that species are not the materials for classification, but the perceptible individuals or organisms which compose them.

This conclusion as to what are the organic units primarily to be classified is further emphasized when we come to consider at what stage of its life-history the organism should be classified. The organism may be treated at any or all stages of its cycle, in order to understand its structure and growth phenomena; but it must be determined at what stage it is to be classified, in order to show its phyletic progress.

Now classification must represent not only similarities of descent, but divergence from the original ancestor; must show how far each organism has progressed in its evolution. The stage at which it is to be classified, arranged in the genealogical system, would then be that of its perfected condition, for then is to be found its furthest degree of specialization. And to classify it at an earlier stage would be to neglect the full degree of its evolution. This is a conclusion of importance when we consider certain attempts to classify organisms considered wholly at embryonic and larval stages, as in the so-called "embryological classifications." No objection is made to consider organisms at any stage, as an ovum, an embryo, a larva, or an adult, nor yet to consider a particular organ by itself in any of these stages, for such examination is necessary for understanding structure and growth; but these considerations are preliminary to the phyletic classing of the organism, which must be done when it has attained its full development and is most different from other organisms. Organisms at their perfected stages are then the materials to be classified.

But it is difficult to determine just what is the perfected or mature stage of an organism. In general the period of reproduction may be said to be the perfected stage. This would especially be the case for many free-living organisms which die after reproduction, as the males of most insects immediately after copulation, and the females of many after oviposition. In these particular cases the organisms attain their fullest development at the period of reproduction, and die without passing through further structural phases. But in other free-living animals there are several periods of generation before the animal dies; and in some animals, as in certain birds, the dimensions of the body and the character of the plumage change with each reproductive period—that is, the size and color changes more or less with each prenuptial moult. And in mammals, those whose reproductive period may extend over several years, a gradual change of the whole organism takes place during this time, so that in the stage of its last reproductive period it may be quite different in its characters from what it was at the first. Also, in species with individuals capable of reproduction occur sometimes individuals with arrested genital organs, such as the worker Hymenoptera; for the latter reproductive activity cannot be considered the criterion of structural perfection or maturity. Then, in cases of neotenia, the reproductive elements may attain their full growth before the other parts of the body: the organism here is reproductively mature before it is somatically. Again, at the stage of reproductive activity the organism may be less differentiated structurally than at preceding stages, as in some extreme cases of endoparasitism. Where alternation of generations (metagenesis) occurs, there may be, as in the case of certain Hydrozoa, two generations, each reproductively active, and the individuals of which are structurally different: which of these is the perfected stage? And finally, when it is recalled that for certain organisms there is a succession of stages of senility, it will be seen how difficult it is to define what is meant by maturity or perfection of organization.

We have just seen that the period of reproductive activity does not always fix sharply the stage of greatest perfection of the organism. This stage, from the phyletic standpoint, is that when the organism has attained the end of the period which precedes senile modification. This may be the stage of greatest structural differentiation of the organism, or it may not. In the case of an extreme parasite, such as certain of the highly degenerated Cirripedes and Copepods, the larval stage may be the most perfect, from the standpoint of general structure, for then the locomotory appendages, sense organs and separateness of the metameres are clearly pronounced, while they degenerate later. But, if such a degenerate parasite were classified at its earlier, non-parasitic, more structurally perfect stage, such a classification would not represent the degree in which its evolution has diverged from that of its relatives, and would therefore rank the organism in a more primitive stage than it deserves. It is the end stage which shows how far the individual has proceeded in its evolution, whether progressive or regressive, while classification at an earlier stage, even though then the organism be structurally more complex, would not show the whole path of descent. Maturity, from the phyletic standpoint, is the stage preceding senility. It is not my purpose here to define senility, or what characterizes it, and indeed, senility may appear in one part before another has reached its full development, and at its first appearance is difficult to detect. But we would say that the organism as a whole is not senile so long as it continues the power of reproduction; and if there are several periods of reproduction, we should not consider the organism to be senile as a whole until after the last period. Thus, in the cases of birds which show successive nuptial plumages and structures, or of mammals which change more or less with each successive period of reproduction (as the male deer which multiply the number of prongs upon their antlers), it would be the last period of reproduction at which the individual should be classified. In a case of excessive parasitism, many organs of the body may have been in degeneration before the time of reproductive activity, yet the organism should not be classified before it is functionally reproductive. And it is correct to consider the organization as a whole as non-senile up to the time of the reproductive activity, since non-senile powers of growth are transmitted to its ova. In cases of complete successive hermaphroditism, where the individual is first functionally male, then hermaphrodite, then female (protandry), or where the succession is the reverse (proterogyny), the terminal stage also would be the one at which the individual should be classified, even though, as in many pulmonate Gasteropods, certain organs have during the reproductive period become degenerate (as the genital organs characteristic of the first functional stage).

Accordingly, in cases where alternation of generations does not occur, the mature or perfected stage from the phyletic standpoint would be found not before the last reproductive period. Generally it would be at that last period, if not always. For even in the case of neotenia, where the reproductive cells are mature before the somatic structure is fully differentiated, such procreative precocity in parasites is evidently only an adaptation to accidents inducing a precocious departure from the body of the last host (as in *Gordius*), and as a rule the soma has time to differentiate fully before the reproductive elements are deposited. In mammals, neotenia may be said to occur, since considerable somatic differentiation takes place after the first period of reproduction; but in mammals the case of neotenia need not perplex us, since, as has been shown, a mammal is to be classified at the time of its last reproductive period. The organization as a whole is then non-senile until after the last reproductive period; the individual is to be classified at that period, and not before, for classification at a preceding state would not show the full extent of its development. Classification after that stage is not permissible, unless for some cases of neotenia, since cessation of reproductive activity denotes the beginning of senility (catalysis of the organization as a whole), and since after such cessation further changes of the organism could not be transmitted to the offspring.

There remain to be considered the cases of alternation of generations (metagenesis), where the individuals of one generation differ structurally from those of the next generation, as in many Hydrozoa, where from the polyp is produced a medusa, from the medusa a polyp. Each generation here is reproductively active, so that the state of such activity does not decide for us whether the classification should consider primarilythe polyp or the medusa condition. Now, in the Hydrozoa many variations are found in the cycle of generation. *Hydra* can produce new polyps asexually, by budding, and also by fertilized eggs, *i. e.*, sexually; here there is change of generation, but not polymorphism of the successive generations. In certain Hydromedusæ there is true change of generation, with free-swimming medusæ budded off from the polyp individual ("metagenetic" Hydrozoa); in others the change of generation is not so clearly marked, but the medusoid individuals remain attached to the polyp as medusoid buds or gonophores (Hydrozoa with masked change of generation); in still others there is no polyp stage, but a medusa develops from the egg, and the latter becomes another medusa ("hypogenetic" forms, with suppression of one generation). Again, while most medusæ are incapable of asexual division, and reproduce by ova and spermatozoa, certain of them reproduce also asexually, by budding. In the Hydrozoa is found a fund of differences in the degree and kind of generation, such as no other metazoan group evinces (not even the Trematoda), and on this account they furnish a broad field for examination. Now in such Hydrozoa as show no change of generation, the individual should be classified at its last stage of reproductive activity, in order to represent its degree of racial development. Where true change of generation occurs and the different generations are separated individuals, such individuals should be classified as stand at the end of each metagenetic cycle. This is a consequence of the argument given before, to show that the organization as a whole is most advanced and perfect, and therefore expresses most fully the phyletic divergence of the organism from its ancestors, at the time of the last period of reproduction. Where the change of generation appears less pronounced, by reason of the egg-producing individuals remaining attached as gonophores to the body of the polyp, the same conclusion would hold—*i. e.*, that the egg-producing individual should be the one classified, provided that such a medusoid bud or gonophore be sufficiently specialized in structure from the polyp condition to be regarded as another individual and not merely a part or organ of the polyp. For, granting the correctness of the general view that such gonophores represent modified medusæ, which at an earlier racial period led an independent, free-swimming existence, they may in extreme cases lose all the original medusoid characters except that of producing eggs, show no independence of the polyp stalk, and, in fact, be more correctly considered organs (gonads) of the latter than separate individuals. This would be a case where a part once cut off as a separate individual with an independent existence has been gradually reduced to the state of an organ. In such a case, then, where the gonophore shows no independent existence, but is a part of the polyp stalk, the whole organization—*i. e.*, the polyp stalk with its gonophores—should be the one classified, because all together represent one organization. This whole organization should be classified when its reproductive organs, the gonophores, are in functional activity, that being the period of the greatest perfection of the organism. The difficulty in putting this principle to practice is to be found in those cases where it is hard to determine whether the egg-producer is to be considered an independent medusa or an organ of the polyp stalk. But at present we are considering only the principles of classification; two processes or states which in their extreme conditions are easily separated, are often found in natural phenomena to be connected by gradual steps; this is to be expected in any gradual evolution. Each case difficult of decision must then be considered in turn.

The principle, then, in cases of pronounced change of generation, where the successive individuals are structurally different, is to classify the organism at the end stage of each cycle. A cycle is in a sense a circle, without beginning or end; yet a little thought convinces that there must have been a commencement to every cycle. In the case of a Metazoan, where from the egg develops the mature organism, and from that an egg again, we commonly speak of the mature organism as the end and the egg as the beginning; and with right, since development is from the more generalized to the more specialized. Or regarding only the germ-cells of a Metazoan, apart from the soma, we find also a cycle: *n* generations of ovogonia, a stage of synapsis of the chromosomes, a stage of maturation, a stage of conjugation (fertilization), all constituting one cycle, which is followed by another like it. This germinal cycle too must have had a commencement, and, as I have attempted to show elsewhere, the period of fertilization (conjugation of ovum and spermatozoon) is to be considered the starting point. In the case of change of generation for the particular objects under examination, the Hydrozoa, the polyp stage is generally regarded as the beginning, and the medusa as the end of the cycle. This has its justification, for the medusa is more complex in structure than the polyp, that is, has passed through a longer ontogenetic stage. Here, too, however, the cycle really begins with the fertilized ovum, and ends with the stage that produces ova, if we would draw a parallel to the germinal cycle of Metazoa. In the metagenetic Hydrozoa it is the medusa which produces the ova. If, on the other hand, greatest complexity of structure should not coincide with the end of the reproductive cycle, such complexity would of course not be a criterion of this stage of the cycle, which nevertheless should be the one classified. Such a case would be an organism with change of generation, but with a regressive development in the latter part of its ontogeny (as might be induced by parasitism), so that the terminal stage would be less complex than some preceding one. No such case is known, however; so that with the facts at hand we are justified in concluding that greatest complexity of structure is the test of the last stage of the cycle in alternating generations; and it is that last stage which is the one to be classified.

IV. THE CLASSIFICATION OF POLYMORPHIC INDIVIDUALS.

In the preceding section have been considered such polymorphic individuals as succeed each other in alternation of generations. In many species are found together in the same generation individuals which differ from each other, as either in sexual dimorphism or in polymorphism. The former shows the distinction singly of males and females, and is found in dioecious species; while the latter shows the males and females in several different forms (as the polymorphic Hymenoptera). Polymorphism also may show in the same species a distinction of sexual from asexual individuals, as in certain corms. Sexual dimorphism and polymorphism are the results of a division of labor between the individuals of a species, as the structural differences in the parts of one organization are due to a similar specialization between them; in the one case the units are individuals, having physical disconnection, while in the other they are not individuals, but parts of one whole. In the former they compose not a perceptible but a thinkable whole, which we term a species.

The question is, accordingly, where the individuals of a species are heteromorphic, on which of them should the classification be based? On the males or on the females, on the sexual or the asexual individuals? Our classification must start with the single individual, and proceed next to an arrangement of the individuals into those lowest groups known as species. If all the individuals of a given generation of a species are monomorphic, the consideration need not pass beyond any one individual, for each individual would show the full characteristics of the species. And since this is not the case in species in which the individuals are heteromorphic, in such species all the component individuals must be studied before the species can be mentally defined. In other words, while individuals are the primary materials of classification, species are the primary group units and so must be defined as to include all the kinds of individuals composing them.

Starting then with the principle that individuals are to be first considered, and that a classification of the most primary groups—*i. e.*, species—demands a knowledge of all the individuals which compose such species, we must not in classification neglect the consideration of any individual. Therefore classification must be based upon all individuals, since otherwise our concepts of the lowest group would be incomplete.

To the systematist are known many instances of species with sexual dimorphism, where the individuals of one sex are less variable than those of the other with regard to closely related species. Thus among the insects, the females of Disptera are, as a rule, difficult to distinguish specifically, while in the less conservative males specific characters are much more clearly pronounced, and in this particular case much of the classification has been based upon the genital armature of the male.[4] In birds also the males generally show greater differences than the females; this is observed

---

[4] If the genital armature of the female, which is to greater or less extent adapted to that of the male, be examined more thoroughly than it has at present, perhaps it, too, would afford good specific distinctions.

also in many mammals, as the Cervidæ, in the Gordiacea, and in numerous other groups. But while a description of a new species is in practice often based upon individuals of one sex, in cases where those of the other sex have not been seen, yet such a description is only a partial characterization of the species, for the complemental individuals have been neglected; it is not, strictly speaking, a description of a species, but of only one kind of individuals of that species. Now, let us consider two species, A and B, each with sexual dimorphism, the females of the two not appreciably different, while the males show marked differences. Then on comparison of the females alone, one would conclude that they composed only one species; of the males alone, that they composed two perfectly distinct species. The error of basing the characterization upon either sex by itself is then obvious, for A and B are neither one species, nor are they *clearly* distinguishable species; the similarities of the females of the two show that the species are very closely related, while the differences of the males show that they are nevertheless distinct. The species would then be characterized, "females indistinguishable, males differing in such and such characters."[5]

This reasoning, based upon cases where neither sex is markedly degenerate, may be, to a certain extent, a guide also for such cases where either the male or the female is degenerate in comparison with the other sex. Such cases are numerous, as the degenerate character of the male in the Rotatoria, in the Echiurid *Bonellia*, the marked sexual dimorphism in the Coccidæ and some parasitic Copepoda, etc. If in these the classification were based upon the more degenerate individuals, the species would be ascribed too low a phyletic rank, and if upon the less degenerate alone, too high a rank. For here, as for the other cases, the characterization of a species must be the sum total of the characterization of its different individuals. In such a species the male and the female may have had a corresponding ontogenetic development up to a certain point, then the one developed regressively and the other progressively, a difference in mode of life being the determining factor

---

[5] In the particular case used for discussion we have excluded the possibility of the occurrence of two kinds of males complemental to a single kind of female, *i. e.*, dimorphism of the males. When females appear indistinguishable, however, after a thorough study of all their parts, while the males are easily distinguished, the classifier should disprove that it is not a case of male dimorphism before he founds two species.

(as it probably is in most cases of sexual dimorphism in the lower animals). If both sexes had a parallel ontogenetic development, we should not hesitate to classify the individuals at the terminal stage of their reproductive activity, whether the development had been progressive throughout or in part regressive. When there has been a divergence in the ontogeny of the two sexes, the males and females being complemental individuals, the species contains both progressive and regressive individuals, it is to be classified at the time of reproductive activity of the two sexes, and is to be ascribed a rank intermediate between that of the conditions of the two sexes.

Unless this principle of considering all the kinds of individuals in a species be strictly enforced, great confusion would ensue in the ranking of a species, depending as to whether the classifier considered the males alone or the females alone, or asexual individuals alone, or all together. It is necessary that all the individuals of a species be known before such a species can be thoroughly characterized, and for only a comparatively few species of certain animal groups have such broad definitions been given.

It will of course be understood that the writer does not imply that species would be perceptibly delimitable, were it not for the extinction of or our lack of knowledge concerning intermediate species. "Species" is a mental concept for a primary group of individuals of the closest genetic connection. If in any phyletic series we could know to-day all intermediate stages, so that the whole would be a continuous line of development, and assuming that such a development were perfectly gradual, nevertheless we should have to project the concepts of species into that whole, arbitrary though such concepts would be, in order to secure certain fixed points for observation and interpretation. Thus we study a section through the body of an animal if we cannot understand this animal in its entirety, and by supplementing our knowledge with sections from other regions of the body gradually reconstruct the whole. A species is a mental section of a line of evolution, and is necessary to enable us to interpret the whole. That is what is here understood by the determination of a species. Where, through extinction, we find disconnected species, we have sections made for us by Nature.

V. The Kinds of Homologies.

Before considering the methods of treatment of structural characters, and comparing the anatomical and embryological methods of determining genetic relationships, it will be well to discuss briefly the kinds of structural relations known as "homologies."

The working principle of the phylogenist who is studying a line of development represented to-day only by fragments, and who has not the resource of fossil remains of the extinct members of that line, is that similarity in essential particulars denotes genetic affinity. This principle would seem the more probable the more complex the organisms treated, for it would not be probable that two complex forms from very different beginnings could come to resemble each other in all particulars. The less complex and more plastic the organization, the more complete could be the convergence of structure. This principle is a necessary postulate, and though it remains to be thoroughly proved, yet it is allowable so long as the known facts do not contradict it. Without its aid no phylogenetic conclusions would be possible.

There have been distinguished various kinds and degrees of structural similarities or homologies. Owen, in his *Lectures on Vertebrata*, 1846, defines: "*Analogue,* a part or organ in one animal which has the same function as another part or organ in a different animal. *Homologue,* the same organ in different animals under every variety of form and function." This distinction, generally accepted to-day, terms "analogical" a similarity of function, and "homological" a similarity of structure. He distinguishes further three kinds of homological relations. *Special homology,* "correspondency of a part or organ, determined by its relative position and connections, with a part or organ in a different animal; the determination of which homology indicates that such animals are constructed on a common type." *General homology,* "a higher relation of homology . . . . in which a part or series of parts stands to the fundamental or general type. . . . . Thus when the basilar process of the human occipital bone is determined to be the 'centrum' or 'body' of the last cranial vertebra." *Serial homology* or *homotypy,* the relation of segmentally arranged parts of the same organism. "In the instance of serial homology . . . . the femur, though repeating in its segment the humerus in the more advanced segment, is not its namesake—not properly, therefore, its 'homologue.' I propose, therefore, to call the bones so related serially in the same skeleton 'homotypes' and to restrict the term 'homologue' to the corresponding bones in different species.[6] And in his paper *On the Archetype and Homologies of the Vertebrate Skeleton*, in 1848, he states: "Homological relationships . . . . are mainly, if not wholly, determined by the relative position and connection of the parts, and may exist independently of form, proportion, substance, function and similarity of development."

Owen implied by "homology" an essential agreement in structure and connections, a relation of essential structural agreement. But, as Cuvier before and L. Agassiz after him, he held the view of the occurrence of different plans or types of structure among animals which could not intergrade and were not gradually evolved. Under the present dominance of the theory of descent, the idea of separately created "types" or "plans" has been relinquished, so that while we retain the term "homology," we define it as a relation of genetic descent.

Of the kinds of homologies distinguished by Owen, the *general* and *serial homologies* are of not the same direct value to the phylogenist as the *special.* Relations of two sides of the same body to each other, of anterior to posterior end, of one antimere or metamere to another, of the right arm to the left arm, or of an arm to a leg, etc., are all relations between the parts of one organism. In phylogeny we are immediately concerned with the relations of different organisms, and with general homologies, including under that term also serial homologies, only in so far as they serve to explain the former. With the treatment of structural characters we shall have to consider general homologies, and now simply mention some kinds of special homologies.

Under the idea of "special homology" is now generally understood a relation of genetic affinity. "Homologie nennen wir eine Uebereinstimmung, die auf gemeinsamer Abstammung der betreffenden Organismen beruht. Der Ausdruck Homologie wird demnach vollkommen im Sinne der Homophylie gebraucht."[7] And so we must employ it, with the working theory of "unity of development" in the place of the earlier "unity of plan." In order to understand the relations of two organisms as wholes, it is generally first necessary to commence by comparing them part by part; the

---

[6] Vicq d'Azyr was the first recognizer of serial homology: *Parallèle des os qui composent les extrémités*, Mém. Acad. Sci., 1774.

[7] Hatschek, *Lehrbuch*, 1888.

correspondence of one part in organism A with a similar part in organism B is a special homology, when interpreted as a proof of genetic affinity. A special homology is then our interpretation of the similarity of the parts of two organisms as denoting homophyly, or likeness of genesis.

Various degrees of special homologies have been distinguished. Thus Gegenbaur:[8] *complete homology,* when the organ in position and connection is retained unaltered; *defective,* when a part originally present has been lost; *augmentative,* when a part not originally present is added; *imitatory,* as when one metamere produces a structure characteristic of a metamere further anterior or posterior (the three last being classed by Gegenbaur as *incomplete* homologies). Frequently also the distinction is made between *adult* and *embryonic* (or *larval*) homologies, a distinction based upon the stage of the individual in which the homology is determined. Another grouping of homologies, due mainly to the study of cell lineage, is *actual homology,* when at the stage considered the relation is found; *prospective,* as when two blastomeres (of different organisms) are considered homologous because they give rise to similar organs in the adults; and *retrospective,* as when two adult parts (of different organisms) are considered homologous because they are derived from corresponding cells or regions of the embryos (or larvæ) of these organisms. Still further classifications of homologies are possible, but these are sufficient for our present purpose.

Under the idea of "homology" we shall then understand "homophyly," and restrict in what is to follow the term "homology" to the idea of "special homology," unless otherwise specified. In the determination of homologies we may proceed with the adult structure (the anatomical method), or with the embryonic or larval structure (the embryological method). And we shall have to decide, if possible and without bias, which of these methods is the correct one: the one of Owen which lays stress upon the adult relations of structure, or the one which lays primary importance upon ontogenetic similarities, and has been defined by Darwin[9] as follows: "*Homology.*—That relation between parts which results from their development from corresponding embryonic parts, either in different animals . . . . or in the same individual."

---

[8] *Vergleichende Anatomie der Wirbelthiere*, I, 1898.

[9] *Origin of Species*, Glossary

VI. STRUCTURAL CHARACTERS, AND THE DETERMINATION OF THEIR RELATIVE VALUES FOR PHYLOGENETIC CLASSIFICATION.

The confliction of the judgments of different morphologists in regard to lines of evolution is due to the differences in their opinions as to what structural characters should be used as the basis of comparison. If there were some well-founded principle in determining the relative values for phylogeny of such characters, the number of points of view would be lessened and greater agreement thereby attained. But, as the case stands to-day, with each new point of view ideas of phylogenetic relationships are changed; and since in those whose standpoints have become fixed there is no adoption of the new points of view, the latter simply bring in additional schemes of classification, and will continue to do so until all possible points of view are exhausted. This oncoming of new interpretations is of the highest value in the study of morphology, and he sees best who can, unbiassed, consider facts under many standpoints. A new interpretation is a light strong in proportion as it is maintained by the facts. Yet too often the conclusion is reached before the thinker has taken time to consider the objections—before he has sought to prove his conclusion by first trying to disprove it. There is in every worker more or less of a tendency to defend his point of view and to be slow in relinquishing it; and this is good for the clear expression of the point of view, but bad for the thinker and his science when he continues to abide by it after it has been disproved. Each new point of view is to be welcomed, since we cannot say which one is right until all have been examined, provided that it has not been hastily conceived.

In the following we shall endeavor to express certain principles in the search for homologies, and to determine the general method in the search for them; bearing in mind that it is simply an attempt to reduce the confliction of opinion, rather than an essay of a new point of view.

(a) *The Organization and its Components.*

In Section III it has been shown that the organism is not a colony of relatively independent units, but is one whole containing parts; and that the whole gives its impress to the parts, rather than the parts to the whole. And then it was shown that an "organism" and an "organization," both terms being employed in the broad sense, are synonymous.

The organization being then one closely united whole, we reach the principle that the organization as a whole must be studied; and hence that any scheme of classification based upon one kind of organs alone is erroneous in its method.[10] The truth of this is further borne out by the following reasoning: The organization being one closely connected whole, there is a perfect physiological and morphological correlation of its parts; and although some of them have a greater value to the whole economy than others, yet each part is dependent upon the others. The parts are not individuals, in the sense in which the individual has been defined (Section II), since they are normally incapable of separate existence.[11] When we say "a gland cell of the intestine of a snail," we speak in succession of a part of a larger part of a whole. Not only from physiological facts does this correlation become apparent but from morphological as well, for none of the parts show sharp demarkations. A vertebra of an adult mammal might be considered at first as a well circumscribed part; yet besides being one of a series of vertebræ, all developed from one anlage, its fibrous sheath passes over gradually into the tendons of the muscles attached to it, and its nerves and blood vessels are mere portions of the nervous and vascular systems of the whole organization. Similarly with a limb, a sense-organ, a lung, etc. For none of the parts of the whole organization can sharp boundaries be found; even the cells are either connected by a fusion of their contiguous membranes or processes, or by a common intercellular substance.[12]

The parts of the organization are then not individuals, since between all the parts exists the closest correlation; and the "largest disconnected whole" is the organism of phylogeny. Further, no part can be understood alone by itself, but the place which it occupies in the whole organization must be considered.

It is not to be wondered at that the parts of organisms are not

---

[10] A case in point is Huxley's brilliant paper *On the Classification of Birds*, 1867, wherein birds are primarily grouped according to the structural characters of one region of the skull.

[11] The germ cells, however, in their mature stages come under a different point of view, for they are then individuals of a second generation which have not yet left the body of the first. In the present discussion, when not otherwise stated, only the somatic parts are considered.

[12] The migratory cells of the body of Metazoa show perhaps more independence than the other cells, yet they too are influenced by the state of the organism as a whole; and even such blood and lymph cells are normally incapable of existence outside of the organism.

easily delimited, since they are but local specializations of a whole. And the relative kinds of parts intergrade, so that it is purely arbitrary to distinguish, *e. g.*, between organ and organ system, between metamere and region, etc. Though it is necessary to give distinctiue names to particular parts, for purposes of description, it must be kept in mind that the parts or "organs" in being not sharply delimitable are purely arbitrary distinctions. Thus, an "organ" is more of a concept than an organism, since it is not so perceptibly delimitable; though less of a concept than a species, since the connection of its components is perceptible.

In one organization we find the general body plan, the major parts which compose this, and the minor parts which compose the latter. In a radiate body plan, as shown by a star-fish, the body is composed on the principle of converging rays, the antimeres; each of the latter is bilaterally symmetrical, with a distinction between dorsal and ventral, and contains a series of "organs"; and each of these organs has its minor parts. In a trematode there is a bilaterally symmetrical body plan, without antimeres; in an annelid, a bilaterally symmetrical united with a metameric, the larger parts being here the segments or metameres. Other body plans are the monaxonic, where there is more or less strictly radial grouping of the parts along one long axis; and the homaxonic, very rarely found, where all the axes passing through the central point are of equal length. But still other distinctions of body plans are possible. Thus: that in which the two ends of the body are dissimilarly developed, as head and tail, which might be known as the antipolar; where the body axis is straight and where it is bent, (Homaxonic and Heteraxonic, Hatschek); and various others which may be arbitrarily distinguished. Therefore there are many kinds of general body plans.[13] Of the major components of these body plans we may distinguish antimere and metamere, anterior and posterior, right and left, dorsal and ventral, etc. The major components of the latter are what are generally called "organs," such as

---

[13] Though we use here the term body plan, we cannot any longer restrict its use to that of Cuvier, von Baer, and L. Agassiz; the four fundamental body plans distinguished by these naturalists represented to them four separate *fiats* of creation, which were unbridgeable. In the light of modern Phylogeny we know that animals were not created separately in four separate moults, and know that gradations are found between the different body "plans" or "types."

nephridia, nerve cords, gonads, gills, etc.[14] There are finally parts of these organs.

Now we find from this brief examination that there are different degrees of structural parts in the organization, beginning with the general body plan and proceeding to the minor parts which compose it. Shall the relationship of two organisms be determined by the comparison of their body plans, or of their major organ complexes, or of the smallest complexes? And how is this comparison to be carried out, and on what kind of parts is the comparison to be instituted? We may immediately proceed to the discussion of these questions.

(*b*) *The Criterion of Morphological Value.*

It is not justifiable to give any *à priori* decision as to what parts are of value in determining questions of relationship, since the criterion must be empirically sought.

As essential similarity is interpreted as denoting genetic affinity, so also there is a second principle in determining phylogeny, namely, that conservatism or fixity of a structure implies morphological value. By conservatism or fixity is implied the continuance of a part with relatively little change through a long line of evolution. If in a line of evolution leading from a type of organization *A* to a type *N*, a certain structure should be found in *N* little changed from its appearance in *A*, it would be called conservative; if it had become much modified or even lost before the stage of type *N*, it would not be conservative. The value of a structural characteristic for phylogenetic purposes depends directly upon how fully it conserves ancestral characteristics, and the less completely it conserves them the less value it has. This is the well-based working proce-

---

[14] "Organ" is employed in comparative anatomy in a very loose sense, as is necessitated by the practical impossibility of sharply distinguishing the intergrading kinds of structural elements. As generally used for the Metazoa, it is not applied to an antimere or to a metamere, but to more segregated portions of them. Physiologically, it is a part with a particular function to perform; morphologically, a specialized part of particular structure. While no sharp definition is possible to cover all cases, we find that "organ" is generally employed by phylogenists in the sense of "the largest specialized part in an organization performing a particular function"; thus the respiratory organ of a vertebrate would be not a lung cell, but the whole complex of lung cells. And it is well to define the various degrees of structural parts as closely as possible, in order to compare in different animals only such parts as relatively correspond.

dure of the phylogenist. A character which leads far back into the ancestry is the guiding line in interpretation of descent. If, through the continuous change which a race of organisms undergoes during the process of evolution, a particular part becomes much less rapidly changed than the others, that part certainly represents the ancestral characters most fully, and for the phylogenist its persistence or conservatism is the criterion of its morphological value. A character which persists through a very long racial period must do so by virtue of being of particular value for the economy of the organization, or for the perpetuation of the race. Structures of less value are more readily modified, or substituted, or even lost.

It is then clear that the first step to take in determining the characters on which classification should be based, is to find out the relative stability or conservatism of these characters, at the same time recalling that no characters should be neglected in the examination, but that they be ascribed value in the order of their conservatism.

The ever-recurring problem to the classifier is that of determining the interrelationships of, *e. g.*, these organisms, *A*, *B* and *C*, when *A* agrees with *B* in character *d*, but differs from *B* in character *e*, while agreeing with *C* in character *e* but differing from *C* in character *d:* is the value of character *d* of greater or less value here than that of character *e?* The answer may be a purely arbitrary one, such as would best suit the classifier's preconceived views; or it may be made less arbitrary and more logically precise by the application of the principle of conservatism as denoting value.

The application of this principle would seem at first sight very simple, but in practice it has been found very difficult. For in a racial progress, as Kleinenberg has shown so well for the individual development, one organ may become gradually substituted for another, so that it is difficult to decide at what point the first disappears and the second takes its place. A case in point is the substitution of one kidney system for an earlier one, and of a third for the second, in the evolution of the Vertebrates. In this case a persistence of the first kidney (pronephros) is found even when the second kidney (mesonephros) has been substituted in its place, and even in the organization showing the substituting third kidney (metanephros) a small portion of the first is still retained. The case becomes more difficult to interpret when not separately arising parts succeed each other, but when in the progress of the race from an early ancestral organ of diffuse arrangement one part changes into one set of organs, another part into another set. Thus from the gastrovascular system of a simpler Cnidarian with, *e. g.*, a structure like ***Hydra***, are found in higher forms developing intestine and gonads (*e. g.*, Turbellaria). In all such cases where the substitution of parts is gradual, it is obviously difficult to determine where one organ ends and another begins, and hence to determine how far back into the phylogeny an organ extends. And the substitution is generally gradual, so that the new organ either arises from a part of the first, or the first becomes gradually moulded over to form the new; much more rarely is the first completely lost (ontogenetic development of the Diptera). It is not probable that a part in any case is completely lost without first aiding in the formation of another part; and this is the more true when we consider that accidental mutilations are probably not inherited. And further, it must be borne in mind that a character which is essentially conservative throughout one group may be variable in another: thus the external cuticle is comparatively uniform in structure throughout the Nematoda, but very variable in the Gordiacea (in some species of which it differs even in the two sexes).

A word may be said just here as to the value for classification of the statistical study of individual variation. The examination of the relative amount of variation in different parts of the same species shows of course which are most and least variable. It shows also that in some species there is less general variation than in others. The modern school of statistical variation has not brought to light any new points of view, but it has the advantage of deriving its statistics from a large number of individuals, and of reproducing these statistics in concise mathematical forms. Before its oncoming observers contented themselves with such loose expressions as "very variable" "slightly variable," etc. The accurate recording of individual variations is the scientific method of showing which parts are most conservative, and a character (*e. g.*, number of joints in an antenna) which has been shown to be very variable cannot be regarded as of much value; that is to say, such a character should be considered of little value in the diagnosis of the species. Yet in closely related species such a character may be eminently stable, so that in general no deductions can be drawn from these variation statistics to species other than those on which they were determined; they may be interpreted to show the mathematically probable further course of development of this species, but they do not show anything with regard to other species.

In one way this statistical study of variation may be of great service, namely, in regard to the distinguishing of "varieties" or "races" of a species. If the degree of variation between the individuals in one and the same portion of the area of distribution of a species be fully as great as the degree of variation between the individuals at the most separated points of this area of distribution, then it is not permissible to speak of "varieties" within such a species. Or, conversely, it is only allowable to distinguish "varieties," when in a portion *A* of the geographical area of a species the individuals show a different average of variation than in a portion *B*.

Davenport[15] has pointed out that the plotting of variation curves affords a criterion by which varieties may be distinguished from species, thus determining the indices of divergence—"if either of these indices is less than a certain number we have varieties; if above that number, species." But even with this method it is necessary to select a particular character as the "chief differential," and it is just with regard to this point that there is as yet no mathematical precision, and hence this method does not furnish a "precise criterion," though it is certainly a step in the right direction.

(*c*) *The Components of the Organization that are of Most Importance in Phylogeny.*

We have seen that the organization as a whole must be considered. The whole, however, can be understood only by synthetically considering the parts of which it is composed. These parts are of very different relative values, from the protoplasmic alveoli or microsome on the one hand, to the organ, organ system and general body plan, on the other. This leads us to the question, which category of parts should be considered in determining phyletic relationship? Is it immaterial whether we base the classification upon cell structure, upon tissue structure, upon organ structure, or upon arrangement of the organs? Or are there good reasons for using as the basis of examination a particular category of parts?

---

[15] "A Precise Criterion of Species," *Science*, N. S. VII, No. 177, 1898.

To commence with the smallest perceptible parts of the organization, the components of the cell. A classification limited to these would represent the facts of cellular structure, and might be based upon the finer cytoplasmic structure, upon the number and nature of centrosomes or chromosomes, etc. But it is clear that such a classification, even if it could be consequently perfected, would be no classification of the organization as a whole, for it would neglect the structure and grouping of the more complex parts of the body. In thus affording no representation of the whole organization, it would be contrary to the conclusion that the organization (organism) as a whole must be considered, and hence would not be allowable.[16] The same argument holds also for a classification based upon kinds of tissues. These two possible modes of classification need not confuse the phylogenist, for they are logically incorrect.

There now arises the more difficult question. What particular category of the more complex parts of the organization should be considered? Under these are the organs (as this term is generally used), the organ systems and the larger divisions of the body, such as antimeres, metameres, right and left side, etc. These being the larger structural complexes, their facts of structure show the organization as a whole, and hence on them the classification must be made. But should the facts of body plan, such as radiality or metamerism, be ascribed greater value than the facts of the organs which compose them? Or otherwise expressed, is structure or arrangement of the parts to be first considered? The answer to this must be empirically determined, and by determining which of the two is the more conservative, the structure of the organ or its spatial relations in the whole organization.

A little reflection upon the facts of comparative anatomy shows that " body plan " is generally very far from conservative. For, in the first place, different body plans or modes of arrangement of the parts are frequently found in different parts of the same organism. Thus in some Cestoda the scolex is more or less radial with regard to the arrangement of its parts, while each proglottid of the trunk may be bilaterally symmetrical (*Dipylidium*). In the

---

[16] Necessarily the Metazoa only are meant, for with the Protozoa there can be no other than a cellular classification; yet, even in these, the organization as a whole must be considered.

Echinodermata there is a general radiate plan of the larger parts (antimeres), but each antimere may be bilaterally symmetrical, and the intestine, unlike the other organs, is not rayed. In the Anthozoa there is at once bilateral symmetry and radiality. In the Turbellaria are forms, which, in respect to the intestinal branches, are more or less clearly radial, and at the same time, with regard to the excretory and genital systems, more or less bilaterally symmetrical; and the Trematoda have a radial arrangement of certain organs, an unpaired (monaxonic) and bilaterally symmetrical arrangement of others. The metamerism of the Articulata does not extend to the intestine; and in the Gasteropoda a true bilateral symmetry may be found in the parts enclosed within the foot, while such symmetry is to great extent obliterated in the spirally wound superior portion of the body. There is, in fact, no animal known in which all the parts are perfectly bilaterally symmetrical, or all perfectly metameric, and only in certain Cnidaria does there seem to be perfect radial symmetry.[17] The facts being so, we are not justified in considering as of much value the plan of arrangement of the parts, or what is known as the " body plan." And another well-known illustration bears this out. Throughout the group of the Platodes (comprising the Turbellaria, Cestoda and Trematoda) there is a uniform type of excretory organs (protonephridia); but the external opening of these organs may be very differently situated in different organisms, and in closely related forms (of the Trematoda) these organs may be paired or unpaired.

There is a further series of facts to show that the relative positions of parts may be very different in closely related organisms; thus, the mouth opening and the genital apertures in the Turbellaria; the mouth opening sometimes on the right, sometimes on the left side in the Gasteropoda (even in different individuals of the same species); the position of the abdominal nerve ganglia in the Diptera, etc.

Such facts, which any comparative anatomist can multiply, show that the general plan of arrangement of the parts is usually far from conservative, and hence, judged by the criterion of degree of conservatism, is of little value for determining broader phyletic

---

[17] Many of the Protozoa which were first regarded as of a perfect radial type, have more recently been shown to be asymmetrical in some respects.

relationships. The body plan is easily influenced by the mode of life, as demonstrated by Lang and others; Lang has shown that radiality and sessility are often associated, a creeping motion and bilateral symmetry. Perhaps such a relation would be better expressed in the statement: the position of the mouth opening is determined by the mode of life, and the relative arrangements of the other parts become modified by change in its position. And there is another relation, also referable to the mode of life, namely, modifications of the arrangements of parts caused by the development of firm skeletal structures, as the shell in the Mollusca.

In general, then, we may conclude that the modes of arrangement of the parts of the organization, which are known as radial and bilateral symmetry, the relation of dorsum to venter, etc., are characters of small degree of conservatism. But it is difficult to decide on the morphological value of metameric arrangement. For metamerism cannot be explained, as other modes of arrangement may be more or less satisfactorily, by the mode of life, but would rather appear to be referable to intrinsic growth methods; and it also does not become readily changed by variation in mode of life. Metamerism is also in no way a function of comparative size or length of the body, but would seem to be the consequence of primarily the mode of formation of the mesoderm (E. Meyer). Metamerism is more conservative than other body plans, and so must be given a greater value in classification. Thus the group of the Articulata is much better founded than the earlier postulated group of the Radiata, for it is based upon a more conservative mode of arrangement of the parts. And as generally held, metamerism of the inner parts is of much more morphological value than metamerism of the tegumentary structures, on account of the greater conservatism of the former.

The parts of the organization which furnish the best basis for classification are the organs, as this term is generally used. These parts may not reflect so fully the organization as a whole as do larger parts which they compose, such as antimere, metamere, right and left sides, head and trunk, etc.; but comparative anatomy has shown that they are, on the whole, more conservative, and on this account they are to be preferred. Their study, unlike study of cell or tissue components, gives a synthetic view of the whole organization.

The phylogenist has then to use what are generally called "organs" as the basis of his comparisons. And he has to determine by comparison which of the organs are the most conservative, and to grant them morphological value in direct proportion to their degree of conservatism. This must be done by a synthetic grouping of the facts, without any regard as to which organs are most convenient of study. He must also constantly bear in mind that an organ eminently conservative in one group may be variable in another. Degree of conservatism can be determined only by very broad and extended comparisons, and is to be gauged by the measure of change accompanying change of habit.

The great difficulty in putting this generally accepted principle in practice is the difficulty in determining whether the organs compared are homologous. Thus nephridia are organs of a certain function, but they are not of the same kind, not homologous, in all animal groups. Therefore they are not very conservative organs, even though they are present in many groups of animals. This is not, however, the place to discuss the organs in detail with regard to their relative morphological values: that would necessitate the reviewal of an enormous mass of facts. But it may be allowable to point out briefly those organs which seem of most importance in phylogeny. Omitting the intestinal organ, which is very readily modified by change of mode of life (as present in the female but absent in the male of Rotatoria), we find two organs of general occurrence in the Metazoa, the reproductive and the nervous systems. These are phyletically not as old as the body layers (ectoderm and entoderm), but both are found from the Cnidaria upward, and with fewer modifications than the body layers. Even extreme endoparasitism, the severest of all conditions, does not lead to the complete suppression of these organs. It cannot be stated that either of them is strictly homologous throughout in all Metazoa, for there is good evidence of substitution here, though to much less extent perhaps than in other organs. On the whole the nervous system, its central ganglionic portion, remains very conservative; and so does the central, gonadal portion of the reproductive system. These two are the most conservative of all organs, and their structure should receive first consideration in phyletic classification. The muscular system is as old as the nervous system, muscle and nerve are synchronous, but it is well known that the muscular system is very easily modified by change of habit. In the third rank would fall the organs known as nephridia or kidneys. The vascular, respiratory, locomotory, special sensory, intestinal, tegumentary and skeletal organs are all of less morphological value than these three for the determination of far-reaching relationships.

(*d*) *The Mode of Treatment of the Parts.*

The parts of the organization that should furnish the basis for morphological study leading to classification, we have seen, are those generally termed organs, and not larger complexes of these organs nor yet smaller parts of them. Broadly speaking, the organ is an anatomical unit in the consideration of the organism. And we have seen that it is necessary to fix upon certain parts for primary treatment, on account of the impossibility of mentally grasping the organization in its entirety. By examining in succession these components a synthetic concept of the whole organization may be gained. And all the parts must be studied—that is, the organization as a whole must be understood—before we can determine which of these parts are of most value for determining the phyletic affinities of that particular organization.

The mode of treatment of these organs is to compare those of different organisms, comparing together only those which evidently correspond anatomically. The more conservative organs would be the basis for defining larger groups, the successively less conservative for defining successively smaller groups (" small " being used in the sense of " closely related "). This is a well-recognized principle.

But great divergence of opinion is found in regard to the point of the mode of considering the organ, that is, which of its characteristics should be employed; and unless there be some logical basis in this treatment, the classification will be inconsequent and erroneous.

An organ may be considered with regard to any of the following characteristics: color, consistency, volume, shape, structure, differentiation of its parts, position with regard to other organs, and number. The guiding principles in determining which should be employed as the basis of treatment are two, the degree of conservatism of the characteristic and the degree in which the characteristic represents the organ as a whole. Judged in this way, the characteristics of *color* and *consistency* are found to be of small value. *Number* is in strict sense not a characteristic of an organ, but duplication of organs is a characteristic of the general plan, as in bilaterally symmetrical forms where certain organs are paired, in metameric forms where they are serially duplicated, in radiate forms where they are antimerically duplicated. Sometimes an organ is excessively duplicated without any corresponding duplication of the body plan (*e. g.*, testes within one proglottid of a Cestode). The relation that the number bears to the larger divisions of the organization must be determined, in order for us to conclude whether the two correspond; for when number of organs and number of larger body parts correspond, the number would have more significance for the comprehension of the whole organization than if there were no such correspondence. Number is a characteristic which must always be carefully considered, for the relative degrees of duplication of organs and of their concentration or concrescence are of great importance in estimating the affinity of the organism to its allies.

The *position* of an organ with regard to the other organs is also a characteristic to be carefully considered, though perhaps it has not the same value as number; thus whether the central nervous system lies above or below the intestine or heart, and whether the skeleton is external or internal. For if variations in the position of an organ cannot be readily explained by change in mode of life, it is probably the case that more conservative intrinsic growth energies are the occasion, and the latter should be ascribed great importance until the contrary be proved. It is just these phenomena, which seem most inexplicable, that should serve as warning signals not to proceed further until many explanations for them have been tested. Why the genital orifices in certain Rhabdocœlida are near the anterior end, in others near the posterior end of the body, we do not yet understand, and it is very difficult to give a good reason for the shifting of such important structures. But until it is proved that the shifting is due to some trivial cause, we have no right to disregard in classification such differences of position. Again, such an apparently trivial characteristic as the position of the anus: in most freely motile Metazoa it is ventral, in the Entomostraca and the Rotatoria it is dorsal. The dorsal position in these two groups has been given no particular morphological importance, as far as I can recall; but without wishing to prejudice the question it may be asked, is this dorsal position to be explained simply as due to peculiarities in the external skeleton? If it cannot be so explained, then it is a characteristic which should receive more attention than it has heretofore. The proboscis of an *Echinorhynchus* is morphologically a part of the body wall, that of a Turbellarian a fold of the pharynx alone; this difference of position is sufficient to disassociate these structures, even though they should agree closely in anatomical details, and here, then, relative position would be of more value than structural detail of the organ itself. The relative position of internal organs, which are not immediately exposed to change in external environment, is a characteristic which must receive careful consideration.

The other characteristics of an organ, form and differentiation of its parts, are especially important. The general form is of more importance for phylogeny than its minute histological structure, and its grosser than its finer structure. This point has been well expressed by E. B. Wilson:[18] "The nephrostome is a nephrostome all the same whether it consist of one cell, two cells, or many cells. Its form and function are both independent of the number of component cells. Cells multiply, but the organ remains the same throughout. So far as homologies are concerned, the existence of cells may be ignored." And to consider the nephridia of Turbellaria, Nemertini and Annelida. The nephridia of the first two mentioned groups are rightly considered to be of essentially the same type and different from the nephridia of Annelida, since they consist of continuous longitudinal ducts with numerous lateral branches, while a nephridium of an Annelid is essentially a single, unbranched tube; we cannot say there is a sharp distinction between the nemertean and the turbellarian type, because the terminal end of a branch in the former is multicellular, in the latter unicellular. Similarly, in certain Nematoda the intestinal lumen is intercellular, in others intracellular; but this histological difference should not lead us to doubt the correspondence of these intestines. In regard to the nephridia of Nematoda, there is still reasonable doubt whether they should be considered comparable to the protonephridia of Turbellaria; but this doubt is based upon

---

[18] *The Embryological Criterion of Homology*, Woods Holl Lectures, 1896.

their general anatomy (lack of lateral branches), not upon the fact that in the one case they are unicellular and in the other multicellular. In other words, in considering the homologies of organs one should not look for cell nuclei. The grosser differentiations of an organ are of the first importance in phyletic classification. A compound eye of an Arachnid is essentially a single lens in conjunction with retinal cells arranged in retinulæ; and we characterize it so in comparison with the compound eyes of insects or crustaceans, and need not define it further in terms of finer structure of rhabdomes of nerve endings. The fingers on the hand of a urodele may be compared with those of a mammal, because of their essential similarity and corresponding relations to the fore-limb, though in the one the skeletal rays are cartilaginous and in the other osseous. The method should be in general exactly that by which an anatomist examines any part—first, a careful examination of the whole with the naked eye, then of a part with a low degree of magnification, then of smaller parts with greater magnification—but with this difference, that the more minute the examination becomes the less general value the parts have for the purposes of phylogeny.

To summarize, all characteristics of an organ have value for the phylogenist, except the more superficial ones of color and consistency. Those characteristics which most completely represent the organ as a whole are the ones of most importance, and minute details of structure may lead to erroneous conclusions with regard to homologies. Degree of conservatism is also a criterion of the value of a characteristic. Broader homologies must be based upon the relations to the rest of the organization, and upon the grosser differentiations.

VII. Comparison of the Methods of Embryology and Comparative Anatomy in Determining Homologies.

The organism is to be classified at the end of its development, for reasons given in section III. But so far there has been no discussion as to whether for determining homologies the organism should be considered at this stage alone, or whether in previous stages also. The question is, is the determination of homologies to be made on the data of comparative anatomy or of comparative embryology, or upon both? In other words, are homologies to be drawn from essential similarity of adult structure, or of development? As to which of these methods is the more correct, has been and probably will continue to be a question of dispute. The comparative anatomists maintain one side, the embryologists another; and probably because the former are less conversant with the facts of embryology, and the latter with the facts of adult structure. Those who are at the same time comparative anatomists and embryologists have in general taken more of a middle course.

The argument for the embryological method is mainly based upon the hypothesis that the ontogeny is a more or less true parallel to or repetition of the phylogeny. The strength of the embryological method depends mainly upon the strength of this hypothesis, so that we have first to examine its correctness. This is the basis of the embryological method in the study of phylogeny, and therefore in the search for homologies, using the term "homology" in the sense of "homophyly." Certain writers have been more cautious, considering homology to depend upon corresponding ontogenetic mode of development, whether the ontogenetic correspond to the phylogenetic or not. But in assuming that the ontogenetic development may not correspond to the phylogenetic, they have no basis for assuming that essential ontogenetic agreement denotes homology, if homology be used in the sense of homophyly.

(*a*) *Hypothesis of the Correspondence of Ontogeny and Phylogeny.*

It is not my purpose to give a historical sketch of this hypothesis and of the many opinions which have been expressed with regard to it, but merely to state briefly the tenets, and then to examine them critically for our present purpose.

This hypothesis is an old one, going back to the eighteenth century, if not indeed to the seventeenth, and as von Baer expresses it, is "mehr eine Entwickelungsstufe der Wissenschaft als das Eigenthum eines einzelnen Mannes." It was held in the early statement of it, that a higher form in its development passes successively through lower animal forms—*i. e.*, that the ontogeny is a relatively exact repetition of the phylogeny. The first logical criticism of the hypothesis thus stated was made by von Baer,[19] who postulated the following laws of the development of the individ-

---

[19] *Entwickslungsgeschichte der Thiere*, 1828.

ual: "(1) Dass das Gemeinsame einer grössern Thiergruppe sich früher im Embryo bildet, als das Besondere. (2) Aus dem Allgemeinsten der Formverhältnisse bildet sich das weniger Allgemeine und so fort, bis endlich das Specialiste auftritt. (3) Jeder Embryo einer bestimmten Thierform, anstatt die anderen bestimmten Formen zu durchlaufen, scheidet sich vielmehr von ihnen. (4) Im Grunde ist also nie der Embryo einer höhern Thierform einer anderen Thierform gleich, sondern nur seinem Embryo." He objects to the hypothesis that no adult animal has a yolk sack; that none is surrounded by embryonic fluids; that it is not the case that an embryo of a higher animal in each ontogenetic stage corresponds in every point with an adult individual of a lower species; that it is not the case that in the ontogeny of a lower form structural relations do not occur which are found in the adult of a higher form; and that parts which are characteristic of only the highest forms do not appear latest in the ontogeny. He recognizes that there are indeed many correspondences between ontogenetic stages of higher and adult stages of lower forms, but contends that it is "noch nicht erweisen, dass jeder Embryo einer höhern Thierform allmählig die niederen Thierformen durchläufe, vielmehr scheint sich der Typus jedes Thiers gleich anfangs im Embryo zu fixiren und die ganze Entwickelung zu beherrschen." Any one who reads carefully this classic work will find there stated, very acutely and logically, most of the objections, generally supposed to be of much more modern date, to the theory.

Fritz Müller[20] held that the theory is in the main correct, but pointed out that phylogenetic traces may become more or less obliterated in the ontogeny; he held, accordingly, that the lack of exact correspondence is due to embryos adapting themselves to new modes of life. Haeckel has developed the theory most thoroughly; and has consequently used it most in the determination of phylogenies. He terms the theory the "biogenetisches Grundgesetz," and states it: "Die Ontogenie (Keimesgeschichte) ist eine kurze Wiederholung der Phylogenie (Stammesgeschichte)." He also introduced the terms "palingenesis" and "cenogenesis," and states: "Die Phylogenesis ist die mechanische Ursache der Ontogenesis." Thus Haeckel's position in regard to this hypothesis is in some

---

[20] *Für Darwin*, 1864.

respects a return to the opinion that was dominant before the time of von Baer.

Hatschek[21] gives a brief but able consideration of this hypothesis: "Die Ergebnisse der vergleichenden Ontogenie haben stets nur den Werth von Wahrscheinlichkeitsschlüssen, genau in demselben Grade wie die der vergleichenden Anatomie. Die relative Sicherheit hängt in beiden Fällen nur von der Menge der Praemissen und von der Schärfe des Schliessens ab. . . . . Die Methode der vergleichenden Ontogenie ist eine Erweiterung der vergleichend anatomischen Methode (Festellung von Homologie und Analogie) durch Anwendung derselben auf Formenreihen. . . . . Da der individuelle Organismus nicht durch einen einzigen Formzustand, sondern durch eine Formenreihe repräsentirt ist, die er während seines individuellen Lebens durchläuft, so kann es auch nicht genügen, allein die Endformen zu vergleichen, sondern es muss die ganze Formenreihe berücksichtigt werden." He concludes also that when a larval or embryonic form is characteristic for a large group, we are only justified in concluding that the ancestor of such a group possessed also this larval or embryonic form; and only when the latter shows great correspondence with the adult stages of lower forms can it be said with great probability to correspond to a similar ancestral form.

As the biogenetic law is generally held to-day, it assumes that the stages of the individual do not repeat but only to greater or lesser degree parallel the stages of the race: the correspondence is not one of repetition but of parallelism. And in each particular case the palingenesis must be distinguished from the cenogenesis. The possibility of error is in proportion to the difficulty of making this distinction.

(*b*) *On the Application of this Hypothesis.*

On the principle that the organization should be considered as a whole, there is no *à priori* reason for disregarding the various stages of the organization. With von Baer we may say that the individual development consists in a progress from the more general to the more special, and the further the individual of one race develops the more it diverges accordingly from individuals of other races. The biogenetic law is an assumption, and put into practice

---

[21] *Lehrbuch der Zoologie*, 1888.

it may become a *circulus vitiosus;* but at the same time the main principle of comparative anatomy is also a postulate, namely, that essential agreement of adult structure denotes phyletic relationship. When the conclusions from the embryological basis do not agree with those from the anatomical, how is the decision to be made ?

In the first place, it is evident that the adult stages of organisms do represent phyletic stages, while in many cases ontogentic stages certainly do not. There can also be no doubt that the characters of the adult become "segregated" (Lankester) or "accelerated" (Cope) gradually further back into the ontogeny, as the racial progress continues, and so in the course of time would modify more and more the ontogeny as a record of the phylogeny. Also the sequence in the formation of the organs of the individual need not be the same as their sequence in the racial development; a point already made by von Baer, and to-day particularly insisted upon by Keibel and others.

In the second place, the individual must be classified at its mature stage in order to show its full degree of racial development. This principle, therefore, demands that the organization should be primarily considered at that stage. Judged from this point of view, any classification based entirely upon the mode of cleavage of the ovum or upon the occurrence of a certain kind of larva is incorrect, because it would represent the organism before it had reached its full specialization. Here come such classifications as that given by Friedrich Brauer for the Diptera (according to the position of the split in the shell of the pupa), and that which has led to the formation of the group of the Trochozoa.

Thirdly, we have to consider on what the correspondence of the ontogeny to the phylogeny rests. The facts of comparative anatomy show that the groups of the Annelida and Mollusca are phyletically connected. The careful studies of the cell lineage of types of these two groups have shown a surprising and wholly unexpected degree of correspondence in their mode of cleavage, up to the time of the appearance of the larval organs; while from another standpoint the larval types of both show close structural similarity. This is sufficient as a case for examination, though a number of others would suffice equally well. Now, does this correspondence of the ontogeny to the phylogeny depend upon the individual inheriting the successive preceding stages of the race, or upon the growth-energies of the race being essentially the sum total of the growth-energies of the individuals which compose it? Evidently the latter, with the reservation that growth-energies are directed to the development of structure immediately in view, and with change of habit become correspondingly modified. If at a certain stage the individual is pelagic and later sessile, the growth-energies are first directed to the formation of the structures necessary for the habits of the pelagic period, later to the formation of those for the sessile condition. If the pelagic habit became lost, the growth-energies from the first become directed toward the development of structures essential for the sessile state.[22] There is here a continual adaptation to new conditions of life, restricted by the line of direction held by these energies in preceding ontogenies, the restriction more or less directly diminishing according as the preceding ontogeny is far removed, and according to the degree of plasticity of the organization.

Obviously, in regard to the Annelida and Mollusca, we may conclude either that their cell lineage is so closely correspondent because of their close genetic affinity (there not having been time for a great difference to arise), or because the cell lineage in both is followed by a more or less similar larval stage. In the former view genetic affinity is postulated, in the latter convergence of cleavage on account of the similarity in the larvæ. As to the larvæ, these may be alike because of the genetic affinity of the two groups, or because they lead a corresponding mode of life and are formed at an equally early period. At every point in this discussion of embryonic and larval homologies we find the possibility of two divergent opinions. The *pros* and *cons* of the two positions have been more or less fully discussed by the cell lineagists, and it is not for me to enter into questions concerning the homologies of blastomeres. It is sufficient to state here that the cell lineagists have more or less divided opinions on these points, as can be seen by an examination of the papers of E. B. Wilson (different opinions expressed in successive studies), Conklin, Mead, Treadwell, Lillie, Eisig, Heath, and others.

One point may be made here. If the biogenetic hypothesis is

---

[22] This is necessarily not an exact statement of the facts. Exactly stated, the growth-energies are *immediately* directed to the establishment of the next following stage. Yet, certainly all the energies are directed toward the establishment of the ultimate structural condition.

true, then in general the earlier the stage of the ontogeny the broader should be the homologies to be determined from it. But this not only does not accord with the facts (as in the case of embryonic structures which could not have been represented in any adult form), but would lead to the absurdity of homologizing all ova —an absurdity because the egg of a mammal is as much a mammal as the adult, and the egg of an arachnid equally well an arachnid. Ova of different organisms are more or less alike, because they all represent single cells with generalized potentialities, and hence usually not great structural differentiations; and not because they represent a repetition of a protozoan ancestor. Sexual reproduction, as clearly shown by Richard Hertwig, is characterized as reproduction by means of germ cells, whether the germ cell be fertilized or not (parthenogenesis); and since sexual reproduction is found in all Metazoa, the beginning of each metazoan individual is a single cell (or a union of two cells).[23] And the gradual ontogenetic differentiation of the organism being accompanied by cell division, each metazoan must have a two-cell, a four-cell stage, etc.; in the course of the further differentiation these must become arranged into layers, and there must be folding of these layers. Thus agreement in the early ontogeny at least is directly referable to reproduction by means of germ cells, and to the development of these cells proceeding by division; this is the immediate explanation, and much more circuitous is the theory that in the phylogeny there followed upon the unicellular condition a parvicellular, and upon that a multicellular. Thus the earliest of the processes of the ontogeny, which on the assumption of the biogenetic theory should show the broadest homologies, are the very ones which show homologies least clearly. The ovum of a mammal is a mammal and not a protozoan; and there is no adult protozoan known which is structurally similar to the ovum of any known metazoan. In most cases the cytoplasmic differentiation of a protozoan is much greater than that of an ovum of a metazoan, yet the metazoan is higher in the phyletic scale.

Thus the organism represents in its ontogeny merely conditions preparatory and subservient to the perfected, terminal stage. The

---

[23] Of course in the case of a protozoan the single cell is at once soma and germ plasm, and is not to be compared to the germ cell alone of Metazoa.

structural conditions of this stage control, more especially where the ontogeny is without metamorphosis, the nature of the conditions that precede it. Metamorphosis and larval conditions have probably been secondarily acquired, and direct development is the more primitive; for metamorphosis is a result of change of habit at different periods, and such change of habit is not as primitive as a habit continuous through the life of the individual, since it is more complex. It will, of course, be understood that in the case of certain phyla, such as the Annelida, I grant that the larval type of development may be primitive, and that forms which do not show it have lost it; but that it could not have been primitive for the ancestors of the Annelida. There is also good reason to conclude that the larvæ of different phyla of organisms may be alike, because they are ontogenetic forms of essentially the same mode of life, and because their organs are comparatively few in number and at an early stage of specialization. The earlier the stage of the ontogeny, the greater in general should be the agreements in structure, not because the homologies are more comprehensive at that time, but because there are fewer structural parts to show differences.

Thus far we have criticised the application of the biogenetic theory to the determination of homology. These criticisms might be multiplied and examined more in detail; and they are objections which have been made before, though not from the standpoint of the necessity of classifying the organism at its terminal stage.

Now we have to consider in what respects the study of ontogenetic conditions is necessary in the search for homologies. Homology is a likeness of descent, is homophyly, whether it be based upon adult or embryonic structure, provided that there is a good basis employed in its determination. It is an erroneous position to hold that the adult anatomy alone is sufficient for determining all homologies; it is equally erroneous to hold that homologies can be determined on the basis of similarity in ontogenetic formation alone. Whenever a structure is greatly degenerate in the adult condition, a study of its preceding ontogenetic stages is often the only guide we have as to its homologies.[24] Then in organ-

---

[24] Often, however, a highly degenerate structure can be explained by comparative anatomy as well as by embryology. Thus the pineal gland of a bird and the pineal eye of certain reptiles.

isms which are isolated at the present time, whose more immediate relatives have become extinct, it is particularly necessary to know the organization at all its periods.

In conclusion, we have to bear in mind that of first importance in classification is the terminal, perfected stage of the organism, since this ontogenetic stage is also an actual phylogenetic stage. The further removed from this stage the further from actual phyletic conditions, and therefore the greater chance of error in interpretation. The correspondences between the ontogeny and the phylogeny are not repetitions but parallels, and in many cases parallels that are so imperfect that it is always necessary to decide what is palingenetic and what cenogenetic. The decision in regard to this point is necessarily more arbitrary and subjective than a decision upon similarities of adult structure; for the embryological method, in addition to assuming in common with comparative anatomy that essential similarity of structure and position denotes homology, has also to assume as correct that the course of the ontogeny is more or less similar to that of the phylogeny. Comparative anatomy is not obliged to make this assumption, and so has one premise less. In this conclusion we do not diminish the value of comparative embryology, but only restrict the application of its facts. Comparative embryology has been fully as productive as comparative anatomy in establishing working hypotheses, the value of which for research is indisputable. But it is, in the main, from comparative anatomy that the phylogeny is to be determined; and from comparative embryology an understanding of the growth-energies, and therefore a more complete comprehension of the adult structures. And it is the logical method to investigate all the series of forms of the organism, so as to reach the most comprehensive concept of the organization as a whole.

ON THE LOCALITIES OF A. ADAMS' JAPANESE HELICIDÆ.

BY HENRY A. PILSBRY.

The paper by Dr. Arthur Adams on the species of Helicidæ found in Japan,[1] published in 1868, would have formed a foundation for subsequent faunistic work if the species had been recognizably defined. As it is, that production has been the chief difficulty with which recent investigators have had to contend.

The numerous new species described by Adams are so inadequately defined that it is well-nigh impossible to recognize them without specimens from the original localities to compare with his descriptions. And here another obstacle is met, for a part of his localities are out-of-the-way places, not indicated on ordinary maps, some of them even nameless in Hassenstein's magnificent folio atlas of Japan.

Some little assistance is afforded by Adams' *Travels*,[2] an innocuous book written in a bread-and-butter-miss style and singularly free from information, useful or otherwise. My colleague, Mr. Benjamin Smith Lyman, has rendered indispensable assistance by translating names from Japanese maps and various kind suggestions. Finally, I am indebted to the Hydrographic Department of H. M. Admiralty for information from the log of the "Actæon," fixing the location of certain places.

From these and other sources of information I have traced all of the localities where Adams collected land snails. In the account

---

[1] *Annals and Magazine of Natural History* (ser. 4), I, pp. 459–472 (June, 1868).

[2] *Travels of a Naturalist in Japan and Manchuria*, by Arthur Adams, F.L.S., Staff-Surgeon R. N. London: Hurst and Blackett, 1870.

Adams was surgeon of H. M. S. "Actæon," of the Hydrographic Survey. The "Actæon" after passing through Corea Strait skirted the shores of the mainland, landing at various places, as far north as Saghalin Island; thence down the coasts of Yesso and Nippon, through the Strait of Simonoseki and the Inland Sea, and up the Pacific coast of Nippon from Tanabe to Yeddo Gulf where some time was spent in Tateyama Bay (lat. 35° N., lon. 139° 48′ E.) in August, 1861. Years before, Adams as surgeon of H. M. S. "Samarang" had visited the southwestern islands of the Riukiu Curve, and collected some land shells.

following these type localities are located, and a list of species from each of them compiled from Adams' paper, is given. In square brackets some critical notes find place. For greater convenience I have dealt with all of Adams' localities, those well known with the others.

It may be as well to say that A. Adams' identifications of land shells are often open to doubt.

RIFUNSIRI.

Rebun-shiri is a small, rugged island, west of the north end of Yesso, near and southeast of Rishiri. The "Actæon" was there September 15, 1859. So far as I know no naturalist has visited the island since.

Limax varians A. Ad.

Helix (*Camæna*) *miranda* A. Ad.

RISIRI.

A snow-capped volcanic peak.

Limax varians A. Ad.

Helix (*Camæna*) *editha* A. Ad.

HAKODADI.

Hakodate, Prov. Ojima, Yesso.

Limax varians A. Ad.

Succinea lauta Gld.

Helix (*Acusta*) *læta* Gld. [= *Eulota* (*Mastigeulota*) *gainesi* var. *hakodatensis* Pils.].

Helix (*Camæna*) *pyrrhozona* Ph. [= *Eulota* (*Cathaica*) *fasciola* Drap., sole record of the species from Japan, and requiring confirmatory evidence].

Helix (*Patula*) *paupera* Gld. [= *Pyramidula pauper* Gld.].

Hyalina (*Conulus*) *labilis* Gld.

MATSUMAI.

At the southern point of Yesso, Province Ojima; otherwise known as Fukuyama.

Helix (*Acusta*) *læta* Gld. [see above].

Helix (*Fruticicola*) *japonica* Pfr. [only record extant of *Ganesella japonica* from Yesso].

Helix (*Patula*) *paupera* Gld.

Hyalina (*Conulus*) *tenera* A. Ad.

Also, *Blanfordia bensoni* A. Ad.

TABU-SIMA.

Tabu-shima or Tobi-shima is a small island off Ugo Province, lying near the west coast of Nippon, about eighty miles northeast of Sado Island. In his *Travels*, p. 257, Adams writes of it as "a small island about thirty miles from Niegata in Nippon"; but it is nearer eighty miles from Niigata. The name appears on some maps as Tobi-shima or Tabo-shima. It is nearly opposite the peak Tshiō-kai-san, on the mainland of Nippon. The following species are recorded:

Philomycus bilineatus Bs.

Helix (*Camæna*) *quæsita* Dh. [*Eulota* (*Euhadra*) *quæsita*].

Helix (*Fruticicola*) *japonica* Pfr. [*Ganesella*].

Helix (*Fruticicola*) *patruelis* A. Ad. [=*Ganesella tabuensis* Ancey].

Helix (*Plectotropis*) *ciliosa* Pfr. [probably an error].

Helix (*Plectotropis*) *conella* A. Ad.

Hyalina (*Conulus*) *incerta* A. Ad.

Clausilia martensi Herkl.

This place is also type locality of *Helicina japonica* A. Ad.

AWA-SIMA.

Awo-shima on Hassenstein's map. An islet northeast of Sado. It is not mentioned in Adams' *Travels*. It is off the north end of Echigo Province.

Helix (*Plectotropis*) *ciliosa* Pfr. [probably an error].

Helix (*Plectotropis*) *setocincta* A. Ad.

Helix (*Plectotropis*) *scabricula* A. Ad.

Clausilia pluviatilis Bs. [doubtless an error].

Clausilia valida Pfr. [doubtless an error].

Clausilia stimpsoni A. Ad.

SADO.

The largest island on the west coast of Nippon, in 38° N. lat., mentioned in *Travels*, p. 259.

Helix (*Acusta*) *sieboldiana* Pfr.

Helix (*Camæna*) *quæsita* Desh.

Helix (*Plectotropis*) *setocincta* A. Ad.

Also type locality of *Blanfordia japonica* A. Ad.

DAGALET ISLAND.

Now known as Matsu-shima. A small and little-known island in the Sea of Japan, east of Corea. See *Travels*, p. 174. Adams visited the island, which is inhabited or at least used as a *Haliotis*-fishing station by Coreans, on the 28th of June, 1859. It is densely wooded, with a central peak 4,000 feet high. In the *Travels*, p. 178, a slug " with the mantle covering the whole of its back " (probably *Philomycus*) and a *Zua* (*Cochlicopa*) are mentioned. In the paper on Japanese Helicidæ only two species are given:

Helix (*Camæna*) *luchuana* Sowb. [?].

Helix (*Patula*) *elatior* A. Ad.

It is the only locality for the latter species. The identification of *H. luhuana* is doubtful.

TSU-SIMA.

Tsushima, in the Corean Strait, is a locality prolific in land snails. Adams reports the following:

Helix (*Acusta*) *sieboldiana* Pfr.

Helix (*Camæna*) *orientalis* A. and R. [The specimens recorded were probably *E. luhuana tsushimana* Mlldff.].

Helix (*Plectotropis*) *ciliosa* Pfr. [?].

Helix (*Plectotropis*) *squarrosa* Gld. [??].

Helix (*Plectotropis*) *trochula* A. Ad.

Hyalina? *nitida* Mill. [only record from Japan. Probably wrong].

Hyalina (*Microcystis*) *rejecta* Pfr. [only record from Japan. Probably wrong].

Hyalina (*Conulus*) *stenogyra* A. Ad. [*Kaliella*].

Clausilia sieboldi Pfr.

Clausilia stimpsoni A. Ad.

NANGASAKI (NAGASAKI).

In addition to the species given below, Adams states in his *Travels* that he got *Hadra peliomphala*, *Satsuma japonica* and *Acusta sieboldiana* at Nagasaki (p. 268). The first two are improbable.

Helix (*Acusta*) *conispira* Pfr.

Helix (*Camæna*) *orientalis* A. and R. [What he found was probably *E. luhuana*].

Helix (*Fruticicola*) *genulabris* Mart. [= *E. similaris* var.].

SIMONOSEKI.

A town of Nagato Province, on the strait of the same name. Hassenstein prefers the name Akamagasheki.

Helix (*Fruticicola*) *stimpsoni* Pfr. [= *Eulota similaris* var.].

MOSOSEKI.

A village at the northern point of the Province Buzen, Kyūshū, on the Strait of Simonoseki, and spelled "Mosi" on some maps. It is the "Moji" of Hassenstein's folio map of 1885.

Helix (*Acusta*) *sieboldiana* Pfr.

Helix (*Camæna*) *peliomphala* Pfr. [probably *E. callizona maritima* G. and P.].

Helix (*Camæna*) *orientalis* A. and R. [probably *E. luhuana* Sowb.].

Helix (*Fruticicola*) *commoda* A. Ad.

Helix (*Fruticicola*) *despecta* A. Ad.

Hyalina (*Conulus*) *phyllophila* A. Ad.

Clausilia lirulata A. Ad.

TANABE.

On the southern coast of Province Kii, near the entrance of Kii channel. Only the last species has been recognized by later authors. The first two belong to *Ganesella*.

Helix (*Fruticicola*) *peculiaris* A. Ad.

Helix (*Fruticicola*) *gibbosa* A. Ad.

Clausilia plicilabris A. Ad. [= *C. aurantiaca* var.]

TAGO.

The location of this place caused me some trouble, from the conflicting data given by Adams. In one place he speaks of Tago, on the shores of the Inland Sea, while again he writes,[3] "not far from Tatiyama is a snug little harbour called Tago."

On application to the Hydrographic Department of the British Admiralty, I learned that "The 'Actæon' spent some time in

---

[3] *Travels of a Naturalist in Japan and Manchuria*, p. 311.

Tago Bay, Suruga Gulf, in September, 1861, and there is no doubt that this is the place referred to, lat. 34° 48′ N., long. 138° 45′ E.''

The following species were obtained; only the first two have been recognized with certainty by subsequent authors:

Helix (*Camæna*) *peliomphala* Pfr.
Helix (*Camæna*) *myomphala* Mart. [*Gancsella m.*].
Helix (*Fruticicola*) *textrina* Bens. [certainly an error].
Helix (*Fruticicola*) *sphinctostoma* A. Ad. [*Ganesella*].
Helix (*Fruticicola*) *collinsoni* A. Ad.
Helix (*Fruticicola*) *concinna* A. Ad.
Hyalina (*Conulus*) *acutangula* A. Ad.
Clausilia gouldi A. Ad.
Clausilia spreta A. Ad.

In the *Travels* Adams mentions finding "thousands of *Realia*" (p. 312).

SIMODA.

At the southern end of the peninsula formed by the Province Izu, and notable as being the place first set apart for the use of Americans, at the time of Commodore Perry's visit to Japan.

Helix (*Camæna*) *quæsita* Dh.
Helix (*Camæna*) *simodæ* Jay.[4]
Helix (*Fruticicola*) *similaris* Fér.

TAKANO-SIMA AND OKINO-SIMA.

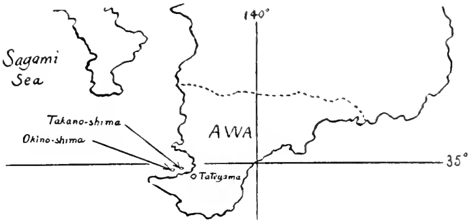
Takano-shima and Okino-shima have been two of the most problematic of Adams' localities, as the places to be found under these names on Occidental maps are not those visited by the "Actæon." The first clue I had to their true location was from the *Travels*, p. 309, where Adams states that "on the east coast of Nippon and not far from Tatiyama are two small islets named Takano-Sima and Okino-Sima''

On ordinary maps these islets are not even indicated. Hassenstein, on sheet IV of the folio atlas, maps them minutely, but without names. Referring to a large-scale Japanese atlas in 47 sheets, I found the islets were duly indicated, and the names when

---

[4] Adams gives *H. herklotsi* Martens as a synonym of *simodæ*, which is far from being the case.

translated[5] proved them to be the islands of Adams. Under the circumstances I have thought it not superfluous to give a sketch-map of so much of the southern end of Awa Province[6] as is necessary to show the location of these type localities. At Taka-no-shima (" Island of Taka ") only one terrestrial species was taken, *Philomycus bilineatus* Bens., probably = *P. confusus* Ckll.



Oki-no-shima, or as A. Adams, from some erroneous notion, transposes it in some places, " Kino-O-Sima," lies west of Taka-no-shima. The following species are recorded, only the first one having been recognized by recent students of Japanese snails:

Helix (*Fruticicola*) *similaris* Fér.

Helix (*Fruticicola*) *craspedocheila* A. Ad.

Helix (*Fruticicola*) *proba* A. Ad.

Helix (*Plectotropis*) *squarrosa* Gld. [probably *Plectotropis vulgivaga*].

Hyalina ? *electrina* Gld. [probably an error].

Clausilia stenospira A. Ad.

Clausilia proba A. Ad.

Clausilia pinguis A. Ad.

In the *Travels*, p. 310, Adams mentions taking *Helix simodæ* and a little *Bulimulus*, and on the next page records *Peronia tongana* from this place.

---

[5] Mr. Benjamin Smith Lyman, formerly of the Pennsylvanian and Japanese Geological Surveys, was so good as to translate these as well as many other Japanese place-names.

[6] It may be needless to mention that there are two provinces called Awa:—that intended here, lying east of the entrance to Tokyo Bay, and another in the eastern part of Shikoku Island.

APPENDIX.

Although not properly coming within the scope of this writing, it may be useful to list A. Adams' species from the Russian Maritime Province and Saghalin Island; the latter especially, from being adjacent to Yesso, is of interest to Japanese zoologists. In the *Travels* Adams mentions finding *Acusta læta* at Sio-wu-hu Bay, on the Manchurian coast. I am disposed to think what he found was some allied form, not the Yesso species.

OLGA BAY.

On the mainland of Asia, west from Yesso.

Succinea putris L. [?].

Helix (*Camæna*) *pyrrhozona* Ph. [= *Eulota* (*Cathaica*) *fasciola* Drap.].

Helix (*Camæna*) *simodæ* Jay. [no doubt an erroneous identification].

Helix (*Patula*) *paupera* Gld.

VLADIMIR BAY.

Near Olga Bay, also in the Maritime Province, on the mainland.

Succinea lauta Gld.

Succinea putris L. [?].

Helix (*Camæna*) *simodæ* Jay. [?].

Helix (*Camæna*) *pyrrhozona* Ph. [= *E. fasciola* Drap.].

Helix (*Camæna*) *editha* A. Ad.

Helix (*Patula*) *depressa* A. Ad.

Hyalina (*Pseudohyalina*) *minuscula* Binn.

Hyalina (*Conulus*) *pupula* Gld.

NEAR CAPE NOTORO.

The southern cape of Saghalin Island.

Helix (*Camæna*) *serotina* A. Ad.

OBSERVATIONS UPON GALEOPITHECUS VOLANS.

BY HENRY C. CHAPMAN, M.D.

Scattered through the works of Cuvier, Meckel, Owen, Schreber, Wagner, Huxley, and other anatomists, are to be found here and there more or less brief notices upon the anatomy of *Galeopithecus*. So far, however, as known to the author, the only account of this interesting animal approaching the character of a monograph is the admirable work of Leche,[1] which leaves subsequent anatomists but little more to do than confirm, or at best extend, his observations.

The opportunity having been recently afforded the author of acquiring a specimen of *Galeopithecus*, it is hoped, in view of the scant literature of the subject and the conflicting opinions still held by zoologists as to the nature of this animal, that the results of its dissection as well as some reflections upon its natural affinities may prove acceptable.

The specimen, a male measuring 6.4 cent. (16 inches) from the snout to the root of the ,tail, was obtained from Sarawak, in the Baram district, Borneo. The specimen had been preserved in spirit for a long time, but unfortunately was not in a sufficiently good state of preservation to admit of thorough dissection. It is hoped, however, that the disposition of the parts was sufficiently made out to permit of comparison with the results obtained by Leche and other anatomists. The author has also had the opportunity more recently of examining the viscera of a male *Galeopithecus* obtained in Sumatra by the distinguished travelers, Mr. Alfred C. Harrison, Jr., and Dr. H. N. Hiller, and presented by them to the Academy, which did not differ essentially, however, from those of the Borneo specimen.

SKELETON.

As the skeleton of *Galeopithecus* has often been described, attention will be directed only to those peculiarities which serve to show its

---

[1] *Ueber die Säugethiergattung Galeopithecus*, Kongliga Svenska Vetenskaps-Akademiens Handlingar, 1884–1885.

relation to the other forms of mammalian life with which it has been affiliated, and the same plan will be pursued in the account of the remaining organs.

Among such peculiarities, as regards the skull, may be mentioned the presence in *Galeopithecus* of the foramen transmitting the supra-orbital nerve and artery, the division of the lachrymal bone into facial and orbital portions, and the interorbital situation of the lachrymal canal. In these respects *Galeopithecus* agrees closely with the insectivorous *Tupaia*. On the other hand, in the formation of the tympanic bulla and in the condyle of the jaw being situated at nearly the same level as the teeth, *Galeopithecus* agrees with bats, *Chiromys*, as well as certain insectivores. In regard to the vertebral column, *Galeopithecus* differs from both Insectivora and Chiroptera in the presence of spinous processes and a pubic symphisis, and in the absence of a ridge on the sacrum and a keel on the sternum. It is an interesting fact that the sacrum, according to Leche,[2] develops caudad—that is to say, ossifies at the expense of the tail, the reverse of which obtains in other mammals. In the presence of an epicoracoid cartilage lying between the clavicle and first rib, and in the epicoracoid element being united with the clavicle, and in the elongated character of the scapula, *Galeopithecus* and *Pteropus* agree. In the splitting of the coracoid into two distinct processes, dorsal and ventral, the latter the homologue of the coracoid in other mammals, *Galeopithecus* presents, however, a peculiarity not found in lemurs, insectivores or bats, except in *Pipestrellus*, in which bat the coracoid, according to Flower,[3] is sometimes forked. It is worthy of mention that in both *Galeopithecus* and *Pteropus* the humerus and radius are of the same length in the young animal, the radius becoming the larger of the two bones only as development advances.

PATAGIUM AND MUSCULAR SYSTEM.

One of the most striking features in the organization of *Galeopithecus* is its patagium, or the duplicature of the skin that extends from the upper extremity to the head (propatagium), from the trunk to both extremities (palatopatagium), and from the lower extremity to the tail (uropatagium), covering the whole animal

---

[2] *Op. cit.*, p. 9.

[3] *Osteology of the Mammalia*, 1870, p. 227.

like a cloak. While asleep, which is usually diurnal, *Galeopithecus*, so enveloped, hangs head downward, suspended by its hind claws from the branches of a tree, and in that position strikingly resembles *Pteropus* when in the same condition. The patagium of *Galeopithecus* is not a mere cutaneous expansion or parachute which serves to break the fall when the animal descends from higher to lower levels, but being supplied with muscles and nerves it enables the animal (to some extent at least) to fly and to guide itself. That most competent observer, Wallace, writes: "Once, in a bright twilight, I saw one of these animals run up a trunk in a rather open place, and then glide obliquely through the air to another tree, on which it alighted near its base, and immediately began to ascend. I paced the distance from the one tree to the other, and found it to be seventy yards; and the amount of descent I estimated at not more than thirty-five or forty feet, or less than one in five."[4]

While *Propithecus* among lemurs, *Petaurus* among marsupials, and *Pteromys* and *Anomalurus* among rodents, are also provided with a patagium, the latter differs in all these animals from that of *Galeopithecus* in being much less developed, supplied with a different set of muscles and nerves, and is more hairy. The patagium of the above-mentioned animals is therefore not homologous with that of *Galeopithecus*, but rather analogous. On the other hand, the patagium of the Chiroptera in being as extensively developed and supplied by the same muscles and nerves is homologous with that of *Galeopithecus*, even though the calcar or elongated bone or cartilage attached to the inner side of the ankle-joint, which supports the patagium in the Chiroptera, is absent in *Galeopithecus*.

While the scope of this communication does not admit of a detailed account of the muscles and nerves of the patagium of *Galeopithecus* and allied forms, the following may be cited as illustrations, among others, of how closely the patagium of *Galeopithecus* resembles that of bats and differs from that of marsupials, lemurs and rodents. It has been shown by Leche[5] that while the disposition and nerve supply of the *Platysma myoides* is the same in *Galeopithecus* and Chiroptera, in *Pteromys* the muscle is absent. Further, it appears that the occipito-pollicaris or the muscle extending in Chiroptera from the occipital bone to the termi-

---

[4] *Malay Archipelago*, 1869, p. 145.
[5] *Op. cit.*, pp. 14–18.

nal phalanx of the pollex,[6] and the jugalis propatagii extending in *Galeopithecus* from the external auditory meatus and malar bone to the finger and palatopatagium are homologous and are supplied by the same nerve, the facial. The coraco and humero-cutaneous muscles, among others, agree essentially in their disposition in *Galeopithecus* and Chiroptera. Further, the striking fold in the palatopatagium of *Galeopithecus,* extending to the ventral surface of the elbow, is an equally characteristic feature in the patagium of the Chiroptera. It was absent, however, in the two specimens of *Pteropus frugivorous* dissected by the author. It should be mentioned, however, that in the uropatagium of the Chiroptera muscles are present that are absent in that of *Galeopithecus,* such as the cutaneo, pubic, ischio and femoro-cutaneous. On the other hand, in *Petaurus,* the muscular fibres of the patagium are so little differentiated that they cannot be homologized with those of *Galeopithecus* or Chiroptera, while in *Pteromys* muscles are present in its patagium that have no homology in *Galeopithecus* or Chiroptera.[7]

Such being the relation of the patagium of lemurs, marsupials and rodents to that of *Galeopithecus* and bats, it is readily conceivable how, on the theory of descent, the patagium of *Pteropus* might be derived from that of *Galeopithecus* by the simple extension of the upper extremity, supposing that such extension was of advantage in the struggle for life, and that the variation, however acquired, was intensified in successive generations. While it does not necessarily follow that because two animals found in the same part of the world and provided with the same kind of patagium and having similar habits should be genetically related, it seems more probable that *Pteropus,* the more specialized animal, should have descended from *Galeopithecus,* the more generalized one, than that the two animals should have acquired such characteristic structures and habits independently of each other.

In regard to the muscles of the head and neck, it may be mentioned that the part of the trapezius arising from the head and neck in lemurs and insectivores is absent in *Galeopithecus* and bats. The insertion of the teres major is quite distinct from that of the latissimus dorsi in *Galeopithecus* and Chiroptera, the action of the former muscle being to reinforce that of the subscapu-

---

[6] Macalester, *Myology of the Cheiroptera.* Phil. Trans., 1872, p. 128.
[7] Macalister, *op. cit.,* pp. 14-21.

laris which is very large. The flexor sublimus digitorum and palmaris longus act together in *Galeopithecus* and Chiroptera, as is also the case in the hedgehog. The phalanges supporting the claws in *Galeopithecus* are supplied by the extensor digitorum communis and extensor pollicis longus, the middle and first phalanges by the extensor digiti secundus, indicis, and pollicis brevis. The origin of the psoas major is shorter in *Galeopithecus* and *Pteropus* than in insectivores and lemurs. The disposition of the tensor fasciæ latæ, glutæus maximus, and femoro-coccygus muscles are the same in *Galeopithecus*, Chiroptera and *Chrysochloris* among the Insectivora. The sartorius, though present in *Galeopithecus, Tupaia* and lemurs, is absent in Chiroptera, and the gracilis, while double in *Galeopithecus* and some Insectivora, is single in Chiroptera. The biceps is rudimentary in *Galeopithecus* and absent altogether in Chiroptera. The soleus and plantaris are absent in *Galeopithecus* and Chiroptera, though both these muscles are present in Lemuroidea. The plantaris is, however, absent in *Tupaia.* An extensor brevis digiti quinti appears to be present in *Galeopithecus*, as is also the case in the Chiroptera, and *Loris gracilis* among the Lemuroidea.

NERVOUS SYSTEM.

The brain of *Galeopithecus* having been described and figured by Gervais[8] and Leche,[9] the author has but little to add to their descriptions. The most striking feature externally in the brain of the specimen examined by the author, as also noticed by the observers just mentioned, is the almost complete absence of the occipital and temporal lobes, they being so little developed that only the anterior part of the nates are covered by the hemispheres. The olfactory lobes are well developed, and but slightly covered by the cerebral hemispheres; their slender tracts expand posteriorily into the hippocampal uncinated gyrus. On the lateral surface of the brain the hippocampal gyrus is separated from the rest of the brain by a deep sulcus, from the anterior end of which proceeds upward a fissure, the so-called principal fissure (Pansch). The dorsal surface of the brain is furrowed by two parallel sulci, the external one very deep, corresponding, probably, to the interparietal sulcus, the internal much more superficial.

---

[8] *Journal de Zoologie*, T. 1, 1872, p. 445, Pl. 31, fig. 5.

[9] *Op. cit.*, p. 48, fig. 29–32.

On the mesial surface a well-marked calloso-marginal sulcus is present, which comes to the surface and furrows the hemisphere as the cross sulcus between its anterior and middle thirds. A small corpus callosum with its genu, the septum lucidum and fornix, a ventricle containing a thalamus opticus and corpus striatum, an anterior and middle commissure were present, the latter being very much developed. The nates are larger than the testes. The pons varolii is small. The vermis is large, but little separated from the lateral lobes. The floculi are large and lodged in fossæ of the periotic bones. The brain of *Galeopithecus* differs from that of all other mammals in its hemispheres being so small, and yet at the same time being so deeply furrowed. In comparison with that of affiliated animals, the brain of *Galeopithecus* is less developed than that of lemurs, but more so than that of insectivores. There are, for example, sulci present in the brain of the lemurs that are entirely absent in that of *Galeopithecus* and *vice versa.* The corpus callosum is much more developed in the brain of the former than in that of the latter. On the other hand, the number and depth of the sulci in the brain of *Galeopithecus* are far greater than in the brain of any insectivore. Indeed, sulci are absent in even large insectivorous brains like those of *Tupaia, Rhyncocyon,* while the corpora quadrigemina are uncovered in the latter. Of the mammals with which *Galeopithecus* has been affiliated it resembles, as regard cerebral characters at least, the Chiroptera most, the number and disposition of the sulci being the same in the brain of the latter as in that of *Galeopithecus,* though not so deep. On the other hand, the olfactory lobes and corpora quadrigemina are completely covered by the hemispheres in the brain of *Pteropus,* for example, and the corpus callosum is much more developed than in the brain of *Galeopithecus.* The brain of *Galeopithecus* is neither that of a lemur, insectivore nor bat, resembling, however, that of the latter more closely than that of either the other two, standing, indeed, somewhat midway between the Insectivora on the one hand and Chiroptera on the other.

The distribution of the nerves having been thoroughly described by Leche,[10] the author will not dwell upon this part of the economy, but will merely call attention to one or two points of special interest. The facial and third cervical nerves supply the muscles of the

---

[10] *Op. cit.,* pp. 52–55.

propatagium; the spinal accessory supplies the sterno cleido mastoid, levator claviculæ and trapezius muscles; the axillary branch of the brachial plexus, muscular fibres of the plagiopatagium; the internal cutaneous nerve, the humero and coraco-cutaneous muscles; a branch of the brachial plexus gives off at the distal insertion of the latissimus dorsi muscle the radial nerve, and below divides into the median and ulnar nerves. The median nerve perforates the supracondyloid foramen and supplies thumb, index, middle and inner side of ring finger; the ulnar nerve, the outer side of the ring and little fingers and the muscular fibres of the plagiopatagium. The lumbo sacral plexus is situated nearer the tail than in most mammals, the last lumbar nerve supplying the obturator cruralis and ischiadus muscles instead of the nerve emerging in front of the last two lumbar vertebræ as is usual. The cruralis nerve supplies the plagiopatagium; the ischiadic supplies the uropatagium.

Alimentary Canal, etc.

The palatal gum is ridged, as in the lemurs. Parotid and submaxillary glands were present, but so small as to readily escape notice. The ducts are, however, proportionally large; that of the parotid gland crossed the masseter muscle and was more than 25 mm. (1 inch) long; that of the submaxillary gland opened into the mouth far forward, and was almost as long as the duct of sterno.

The teeth of *Galeopithecus* have been described by Owen,[11] De Blainville,[12] and others, and the relation of the deciduous to the permanent teeth more particularly by Leche.[13] One of the most interesting facts established by the latter observer is that the teeth erupt late, so that the deciduous teeth and all the molar teeth (except, perhaps, the upper third) are in use at the same time. The most remarkable feature, however, in the dentition of *Galeopithecus* is the well-known comb-like form presented by the crown of the first two incisors of the lower jaw, due to the deep extension of the marginal notches upon the crown, and in respect to the extent to which this furrowing of the crown is carried unique in mammals.

---

[11] *Odontography*, 1840–1845, p. 433.

[12] *Ostéographie*, 1841, p. 42.

[13] *Op. cit.*, pp. 56–61.

Each of these broad comb-like teeth is implanted by a single conical fang excavated by a pulp cavity which divides into as many canals as there are divisions of the crown, each canal passing up the latter to its extremity. What particular purpose these comblike incisors subserve in *Galeopithecus* is difficult even to imagine. It is very unlikely that, as has been suggested, the animal uses them to clean its skin. It is far more probable that the peculiar form of these teeth depend in some way upon the nature of the food, which consists of leaves, remains of the latter being found between the teeth, on the tongue and in the œsophagus, and that they have been gradually developed from the tooth of some ancestor in which a slight furrowing of the crown existed and which, being of advantage, was gradually intensified in its posterity. In support of such a view it may be mentioned that there is a slight indication of furrowing of the crown in the incisors of the lower jaw in *Hyrax, Indri, Tupaia, Rhyncocyon, Desmodus* and *Diphylla* among Chiroptera. Another interesting peculiarity in regard to the dentition of *Galeopithecus* is the fact of the outer incisor of the upper jaw having two roots, which is also the case not unfrequently in *Petrodromus* and in certain species of *Erinaceus*. The canine of the upper jaw in *Galeopithecus* are likewise provided with two roots, as was the case in the extinct Jurassic mammals, *Pantotheria*,[14] another illustration of the affiliation of *Galeopithecus* with extinct mammalian forms.

The tongue is dented at the end, the dents supporting round papillæ. This pectinated condition of the end of the tongue may possibly be correlated in some way with that of the lower incisor teeth. The under surface of the tongue is deeply grooved. Two large circumvallate papellæ and foliate papillæ at the sides of the tongue are also present. There is only a slight indication of the under tongue, so prominent a feature in lemurs, which is present also in *Tupaia*, but entirely absent in Chiroptera.

The stomach (Plate XII) is very much elongated and drawn out, resembling that of *Pteropus*. The mucous membrane of the cardiac part is smooth. That of the pyloric part lying toward the cardia is thrown into deep folds, which run parallel with the long axis of the stomach, while the remaining part of the pyloric mucous membrane is smooth again. The small intestine preserves about the

---

[14] Marsh, *Amer. Journal Arts and Sciences*, Vol. 20, p. 239, 1880.

same diameter throughout its whole extent. Villi are present and there is an ileo cæcal valve. A tapeworm was found in the small intestine, but in such a disorganized condition as not to admit of identification. The cæcum is long and capacious and puckered up, the muscular fibres being gathered together into three well-marked wide bands. A long and capacious cæcum is found as well known in lemurs, and though less well developed in certain insectivores as *Macroscelides* and *Rhyncocyon*. A cæcum is also present in some species of *Tupaia* and absent in others. While usually absent in Chiroptera, it is nevertheless found in a rudimentary condition in certain species of *Rhinopoma* and *Megaderma*. The cæcum of *Galeopithecus* agrees with that of the lemur more than with that of either Insectivora or Chiroptera in being constricted into pockets or cells. The large intestine, larger than the small one as obtains in certain Herbivora, may be divided somewhat arbitrarily into three parts, distinguished by the disposition of the muscular fibres and the character of the mucous membrane, the first part consisting of about one-seventh, the second of two-sevenths, and the third part of four-sevenths of the entire length of the gut. Peyer's patches are found throughout the long intestine, as is also the case in Edentata, Rodentia and Insectivora. The length of the alimentary canal (including the œsophagus) and parts of the same appear to vary considerably as shown by the following *résumé*, the difference being due possibly to the age of the animal examined:

	Leche[15] specimen.	Borneo specimen.	Sumatra specimen.	Owen[16] specimen.
	mm. in.	mm. in.	mm. in.	mm. in.
Length of animal	400 = 16	375 = 15	350 = 14	400 = 16
Length of stomach	58 = 2.3	100 = 4	75 = 3	
S. int.	450 = 18	650 = 26	550 = 22	1,300 = 52
L. int.	470 = 18.8	1,000 = 40	800 = 32	2,275 = 91
Cæcum	74 = 2.8	225 = 9	175 = 7	25 = 1
Ratio of length of animal to length of alimentary canal .	1 to 2.9	1 to 5.5	1 to 4.8	1 to 9.2

According to Cuvier,[17] the length of the alimentary canal is about three times the length of the animal. This estimate agrees more closely with the results obtained by Leche and the author than those of Huxley,[18] who states that the alimentary canal is six

---

[15] *Op. cit.*, p. 63.

[16] *Anat. of Vertebrates*, 1868, Vol. III, p. 430.

[17] *Anatomie Comparée*, 2d Ed., 1835, Tome 4, 2d Partie, p. 185.

[18] *Anatomy of Vertebrated Animals*, 1872, p. 383.

times the length of the animal, which is not the case in any of the first three animals examined. The total length of the alimentary canal in Owen's specimen, not counting the œsophagus and stomach, exceeds so much that of the other three as to give the impression that possibly Owen's figures are erroneous, due, possibly, to a typographical error or otherwise. The difference in the length of the cæcum in the four specimens is very noticeable, that of Leche's specimen being nearly three times as long as that of Owen's, and those of the Sumatra and Borneo specimens seven and nine times as long respectively. The capacity of the cæcum has been stated as being equal to that of the stomach. While such was no doubt the case in Leche's specimen, in both the Sumatra and Borneo specimens the capacity of the cæcum was greater than that of the stomach. In the case of two lemurs recently dissected by the author, with the view of comparing the structure of the lemur with that of *Galeopithecus*, in one, *Lemur albifrons*, measuring from the snout to the root of the tail 38.7 cent. (15.5 in.), the cæcum measured 17.5 mm. (7 in.) and in the other, *Loris tardigradus*, 37.5 cent. (15 in.) long, the cæcum measured 5 cent. (2 in.). The liver is divided into two halves, the right half being the largest, and subdivided into three lobes. The gall-bladder is small and elongated. The ductus choledochus enters the small intestine 50 mm. (2 in.) from the pyloric orifice. The pancreas lying in the mesentery is flattened and much branched. Its duct enters the intestine 20 mm. ($\frac{4}{5}$ in.) from the orifice of the choledochus. The spleen attached to the cardiac part of the stomach by the gastro-splenic ligament is triangular in form and presents at the anterior part of its median surface a small but well-defined process.

RESPIRATORY AND CIRCULATORY ORGANS.

PLATE X.

The posterior nares are narrow. The larynx does not present anything of especial interest. The trachea was 100 mm. (4 in.) long, and its rings were complete. The lungs are undivided ; the right lung is slightly larger than the left. There are three vena cavæ, two superior and one inferior. The left superior cava passing behind the heart to empty into the right auricle. A similar disposition obtains also in certain Insectivora and Chiroptera, but not in Lemuroidea there being but one superior vena cava in the latter. There are three arteries given off from the arch of the aorta, a left subclavian, left carotid and an mnominate, the latter dividing into right carotid and right subclavian, the disposition of the great blood vessels being the same, therefore, as in man. In lemurs, the innominate gives off the right subclavian and both carotids ; in the hedgehog among the insectivores the arch of the aorta gives off two vessels, each of which subdivides into subclavian and carotid, while in the bats the vessel subdividing into the two carotids arises from the arch separately from the subclavians.

Genito-Urinary Organs.

PLATE XI.

The right kidney lies higher, that is nearer head than the left; only one Malpighian pyramid is present. There was nothing exceptional in the ureters and bladder. The scrotum is well developed and contained the testicle and epidydimis. There was nothing peculiar about the vas deferentia. The spermatic vesicles, perfectly distinct, were large, extending beyond the base of the bladder. The prostate gland was also much developed, and embraced the dorsal surface of the urethra. The Cowper's glands were also large. The penis is pendent, and there appeared to be two suspensory ligaments. The gland is surrounded by a circular hump consisting of connective tissue, and apparently not connected in any way with the corpora cavernosa.

The author not having had the opportunity of dissecting a female *Galeopithecus* cannot give any account of the female generative apparatus, and must therefore limit himself to offering a *résumé* of the observations made by Leche upon that part of its economy. According to that author,[19] there is nothing especially noticeable about the ovaries, except that they are enclosed like the hedgehog in wide-mouth peritoneal sacs, their diaphragmatic ligament extending to the posterior surface of the diaphragm. The uterus, however, is bifid, and the two uteri open by distinct openings into the vagina, in which respect *Galeopithecus* agrees with Chiroptera and differs from Insectivora. Among the latter it is said that in *Tupaia nana* there is a slight indication of a double uterus. The external generative organs resemble, however, those of the lemurs,

---

[19] *Op. cit.*, p. 68.

the clitoris being concealed by a circular fold of integument, as obtains also in *Chiromys.*[20] The teats are pectoral in position, and there are two pairs. One young only is born at birth, as obtains also in Chiroptera. The placenta is said by Gervais[21] to be discoid. If such is the case, then *Galeopithecus* agrees in the character of its placentation with the Chiroptera and Insectivora, and not with the Lemuroidea, the placenta in the latter (*Propithecus diadema*, *Lemur rufipes*) being diffuse.[22]

From the above observations it appears that *Galeopithecus* agrees as regards its organization in some respects with the Lemuroidea, in others with the Insectivora and in others with the Chiroptera, and yet again differing in many respects from all three.[23] Considerable difference of opinion has, therefore, prevailed in the past and still prevails among systematists as to which of these three orders of mammals *Galeopithecus* should be referred to, or whether it should be regarded as the sole representative of a fourth distinct order of mammals, Galeopithecidæ. The species of *Galeopithecus* upon the study of which this communication was based was called by Linnæus[24] *Lemur volans,* a name indicating perfectly the view of the great naturalist as to its natural affinities. Pallas,[25] who was among the first to describe *Galeopithecus,* while admitting that it resembled in some respects the Lemuroidea, considered it as being equally closely related to the Chiroptera. To the latter order of mammals it was referred by Cuvier.[26] In modern times *Galeopithecus* has been usually regarded as being an aberrant form of Insectivora, that view being held more particularly by the English anatomists, such as Huxley,[27] Flower and Lyddeker.[28] Notwithstanding the difference of opinion as to the nature of *Galeopithecus* held by the above anatomists and others, all agree

---

[20] H. C. Chapman, *Proc. Acad. Nat. Sciences*, 1900, p. 423.

[21] *Op. cit.*, p. 448.

[22] Wm. Turner, *Comparative Anatomy of the Placenta*, 1876, p. 57; A Milne-Edwards et Grandidier, *Madagascar Mammifères*, T. 1, 1875, p. 282.

[23] For a *résumé* of these agreements and disagreements, see Leche, *op. cit.*, pp. 72–74.

[24] *Systema Naturæ*, 1758, Tomus 1, p. 30.

[25] *Galeopithecus Volans Camellii Descriptus*, Acta Acad. Scient. Imperialis Petropolitanæ, 1780, p. 208.

[26] *Règne Animal*, 1817, Tome I, p. 30,

[27] *Anatomy of Vertebrated Animals*, 1872, p. 383.

[28] *Mammals Living and Extinct*, 1891, p. 615.

that while *Galeopithecus* may resemble or differ from Lemuroidea, Rodentia, Insectivora or Chiroptera, nevertheless it presents so many peculiarities in its organization that it stands by itself. No one doubts that a *Petauris* is a marsupial, a *Pteromys* a rodent, a *Propithecus* a lemur, a *Pteropus* a bat, even though they all are provided with a patagium resembling more or less that of *Galeopithecus*, by means of which they fly or dart through the air. *Galeopithecus*, however, stands alone; it is *sui generis*. To no order can it be referred unless to some hypothetical extinct one, fossil remains of which have not yet been discovered. The most plausible view as yet advanced as to the affinities of *Galeopithecus* with the mammals with which it has been usually associated is to suppose with Leche[29] that there once existed, in remote Mesozoic times, an order of mammals of ungulate character from which have descended *Galeopithecus*, the Chiroptera, Lemuroidea and Insectivora. Certain facts otherwise difficult to explain become then intelligible. For example, if the lemurs of the present day have descended from Eocene lemurs like *Adapis*, *Anaptomorphoris*, *Tomitherum*, *Hyopsodus*, *Notharctus*,[30], generalized forms combining ungulate with quadrumanous characters, certain peculiarities of their alimentary canal and their non-deciduous diffuse placenta may be explained as being due to inheritance from remote ungulate ancestors. Further, the fact that the condyle of the jaw is situated nearly on a line with the teeth in *Galeopithecus*, *Chiromys*, in certain Insectivora and Chiroptera, as in the *Diplocynodon* and kindred mammals, the *Pantotheria* of Jurassic times[31] points to the same conclusion. Accepting the above hypotheses as provisionally correct, it follows that the herbivorous character of the alimentary canal of *Galeopithecus* is due to inheritance from an ungulate ancestor, whereas its patagium has been acquired in some unknown way through adaptation. Were it not for the combination of the above characters, *Galeopithecus* would have become long since extinct in the struggle for life with its contemporaries, the lemurs, insectivores and bats.

It appears, at least in the judgment of the author, that *Galeopi-*

---

[29] *Op. cit.*, p. 78.

[30] Cuvier, *Ossemens Fossiles*, 1835, T. 5, p. 460; Leidy, *Report U. S. Geol. Survey*, 1873, pp. 75, 86; Cope, *U. S. Geol. Survey*, Vol. III, 1884, pp. 233–235.

[31] Marsh, *Op. cit.*, p. 235.

thecus cannot be regarded as being either a lemur, insectivore or bat, but that it stands alone, the sole representative of an ancient order, Galeopithecidæ, as *Hyrax* does of Hyraeoidea. While *Galeopithecus* is but remotely related to the Lemuroidea and Insectivora, it is so closely related to Chiroptera, more particularly in regard to the structure of its patagium, brain, alimentary canal, genito-urinary apparatus, placenta, etc., that there can be but little doubt that the Chiroptera are the descendants of *Galeopithecus*, or more probably that both are the descendants of a *Galeopithecus*-like ancestor.

MAY 6.

Mr. ARTHUR ERWIN BROWN, Vice-President, in the Chair.

Seventeen persons present.

Papers under the following titles were presented for publication:

"Absorption and Secretion in the Digestive System of the Land Isopods," by John Raymond Murlin.

"Additions to the Japanese Land Snail Fauna, VI," by Henry A. Pilsbry.

The Chair having announced the death, on the 2d inst., of Uselma C. Smith, the following minute was unanimously adopted:

The Academy has heard with profound regret of the sudden death of its member, USELMA C. SMITH, whose devotion to the welfare of the society was manifested for more than ten years by an intelligent and accurate attention to its financial interests as member of the Council, the Finance Committee and the Committee on Accounts, while his generous encouragement of and coöperation in the scientific work of his associates caused him to be held in affectionate esteem. The Academy tenders its heartfelt sympathy to his widow and children in their irreparable bereavement.

MAY 13.

Mr. ARTHUR ERWIN BROWN, Vice-President, in the Chair.

Eleven persons present.

A paper entitled "Descriptions of Two Species of Extinct Tortoises, one New," by O. P. Hay, was presented for publication.

MAY 20.

Mr. ARTHUR ERWIN BROWN, Vice-President, in the Chair.

Ten persons present.

A paper entitled "Twenty New American Bats," by Gerrit S. Miller, Jr., was presented for publication.

MAY 27.

MR. ARTHUR ERWIN BROWN, Vice-President, in the Chair.

Seventeen persons present.

Papers under the following titles were presented for publication :

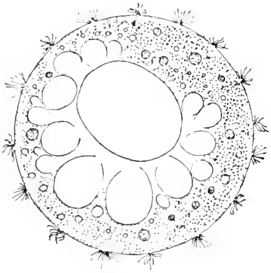
"The Mollusca of the Mount Mitchell Region," by Henry A. Pilsbry and Bryant Walker.

"Synopsis of the American Martens," by Samuel N. Rhoads.

The deaths of Ferdinand J. Dreer, a member, on the 25th inst., and of Henri Filhol, a correspondent, were announced.

A Peculiar Heliozoan.—MR. HOWARD CRAWLEY remarked that the heliozoan here figured was found on August 8, 1900, in water taken from a stagnant, spring-fed pool, near Wyncote, Pa.

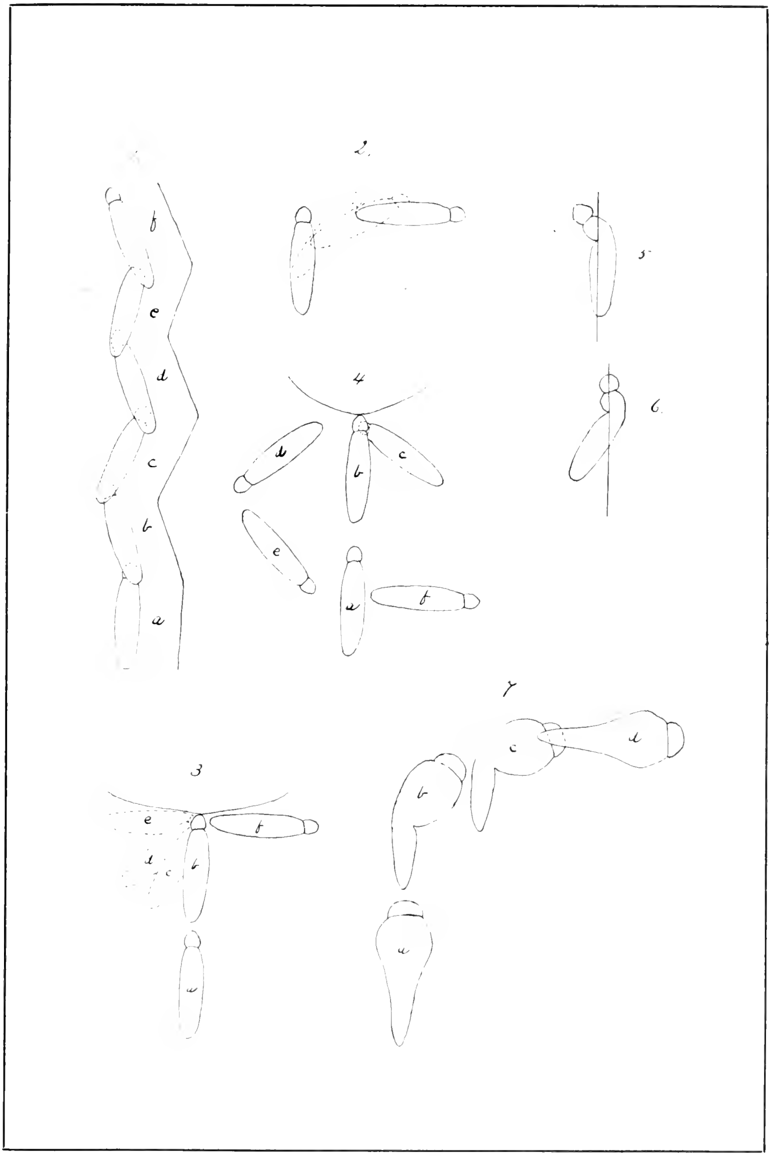
The animal was almost perfectly spherical and showed no alteration in form while under observation. Its diameter was about 90 microns. Around the central part of the body there was an irregular whorl of large alveoli, and, in addition, a number of elements which may have been either small alveoli or large colorless granules. There was no distinction between cortex and medulla, the whorl of alveoli lying in a cytoplasmic matrix, uniform throughout. This matrix was colorless and granular, and closely resembled the endosarc of an *Amœba.* Within it was a diatom which still showed a little colored substance, and a number of more or less completely digested plant spores.



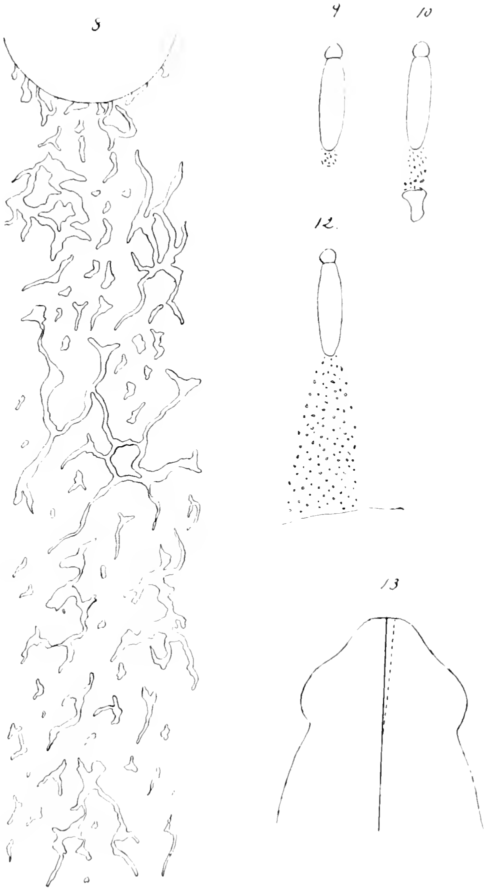
Occupying a slightly excentric position was a large vesicle, having the form of an ellipsoid. The contents of this vesicle were perfectly homogeneous under a magnification of 370 diameters, and of a very pale-green color. It was probably a food-ball.

From the surface of the animal arose a number of minute protoplasmic processes. These occurred in clusters, which were separated from each other by approximately the same distance as that which ordinarily separates the typical heliozoan pseudopodia. It was further to be observed that at the points from which these clusters arose there were breaks in the continuity of the animal's contour, such as those which are seen at the point where a pseudopodium arises.

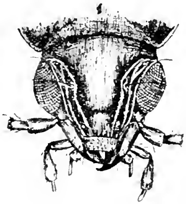
Two conditions which these clusters presented are illustrated in



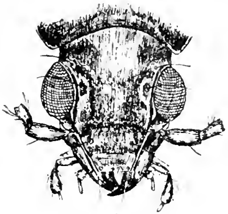
CRAWLEY. MOVEMENT OF GREGARINES.



CRAWLEY. MOVEMENT OF GREGARINES.



1

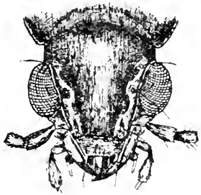


2

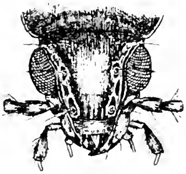
3

4

5



6

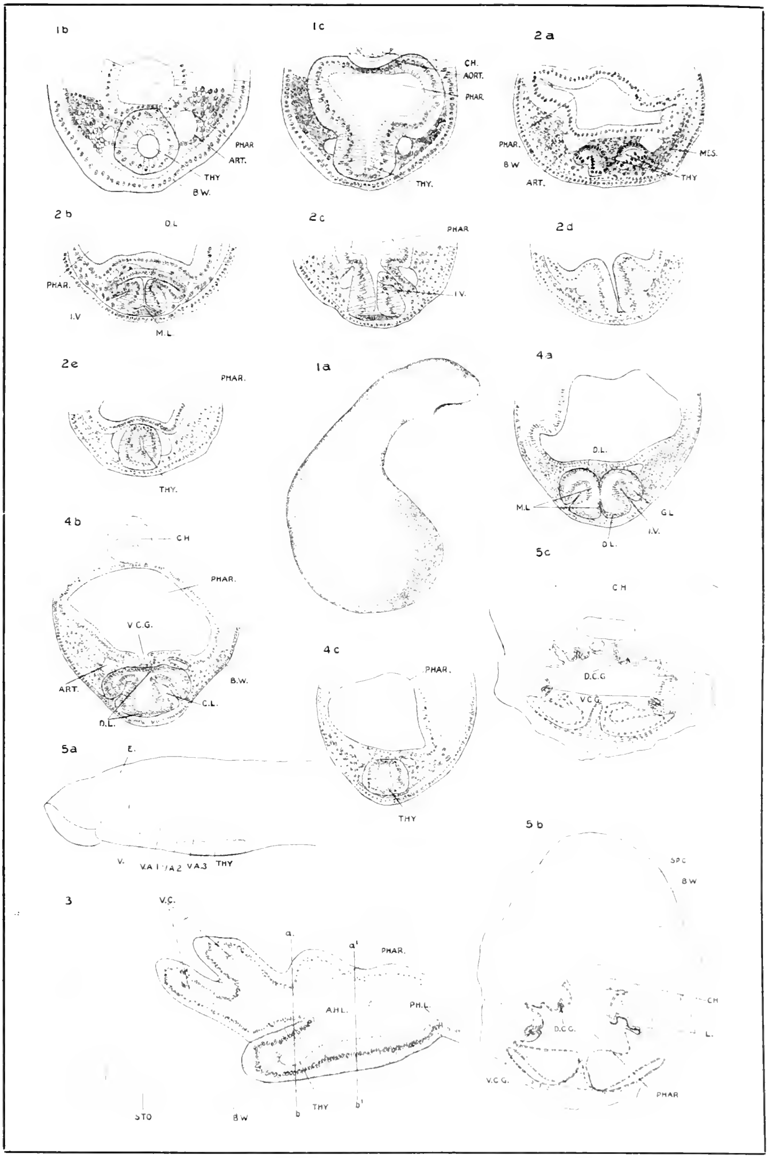


7

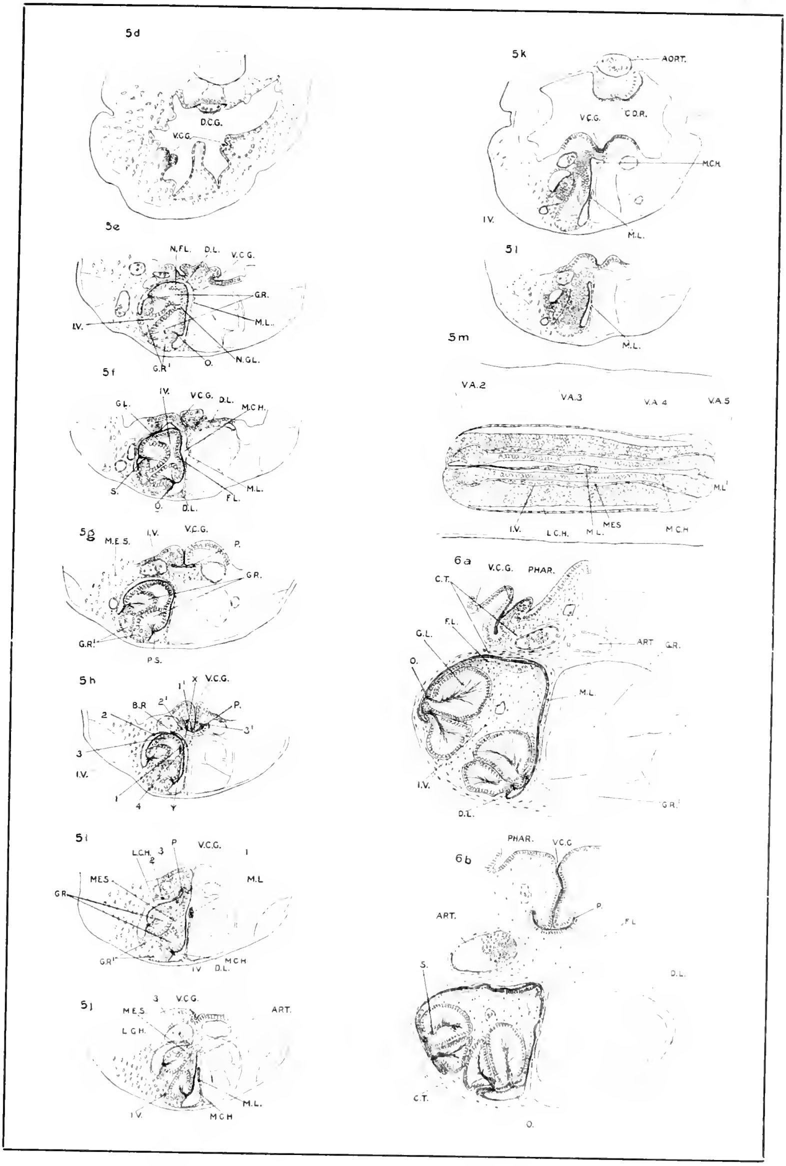
8

9

BLAISDELL. FRONS IN BEMBIDIUM

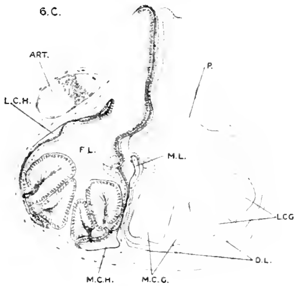


REESE. THYROID GLAND IN PETROMYZON.

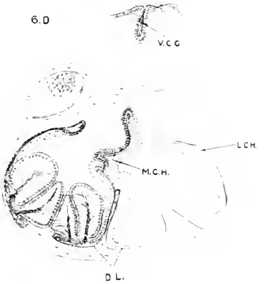


REESE. THYROID GLAND IN PETROMYZON

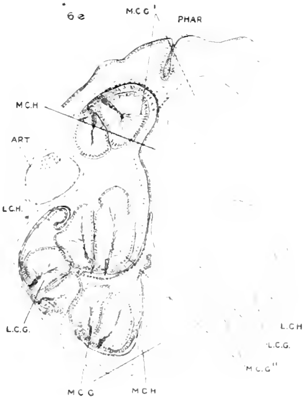
6.C.



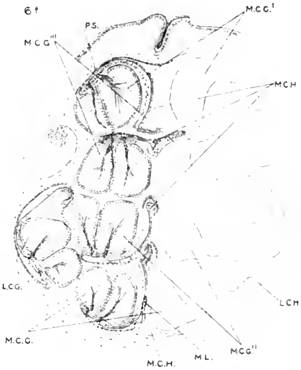
6.D



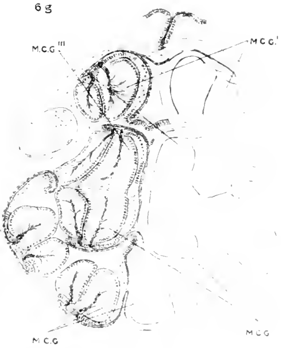
6e



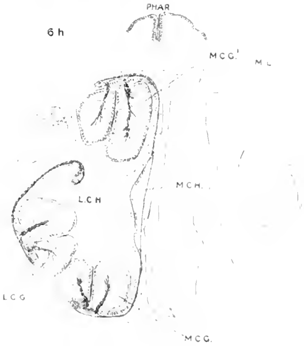
6f



6g

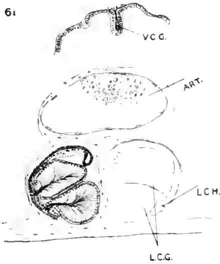


6h

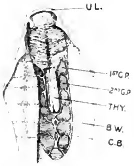


REESE. THYROID GLAND IN PETROMYZON.

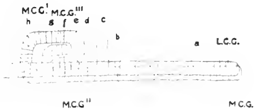
6i



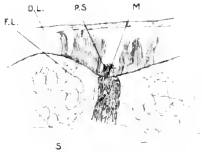
6j



6k

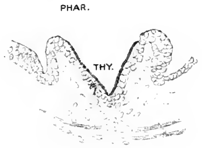


6l

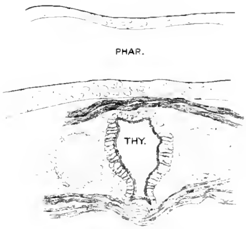


7

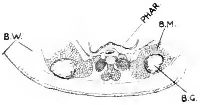
8a



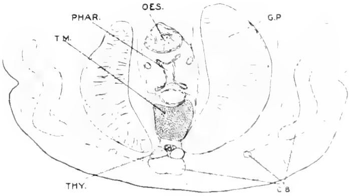
8b



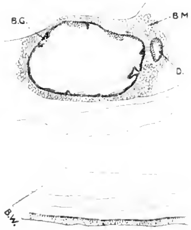
9a



10a

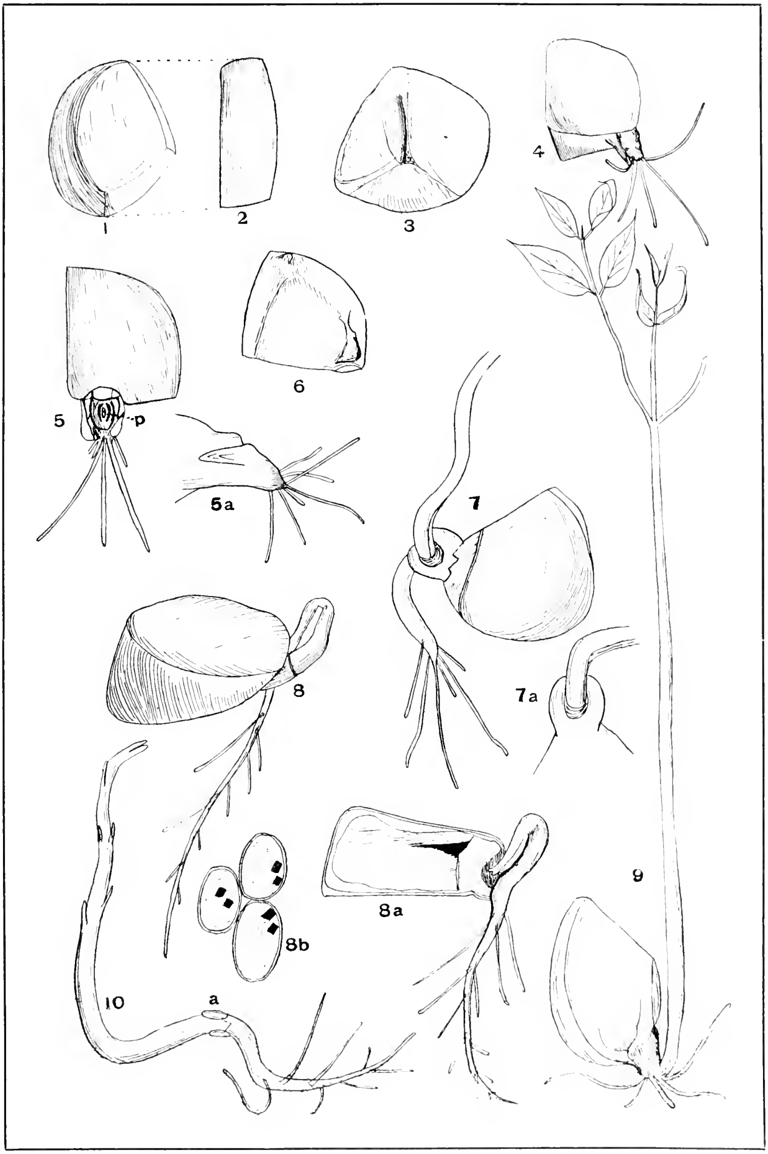


9b



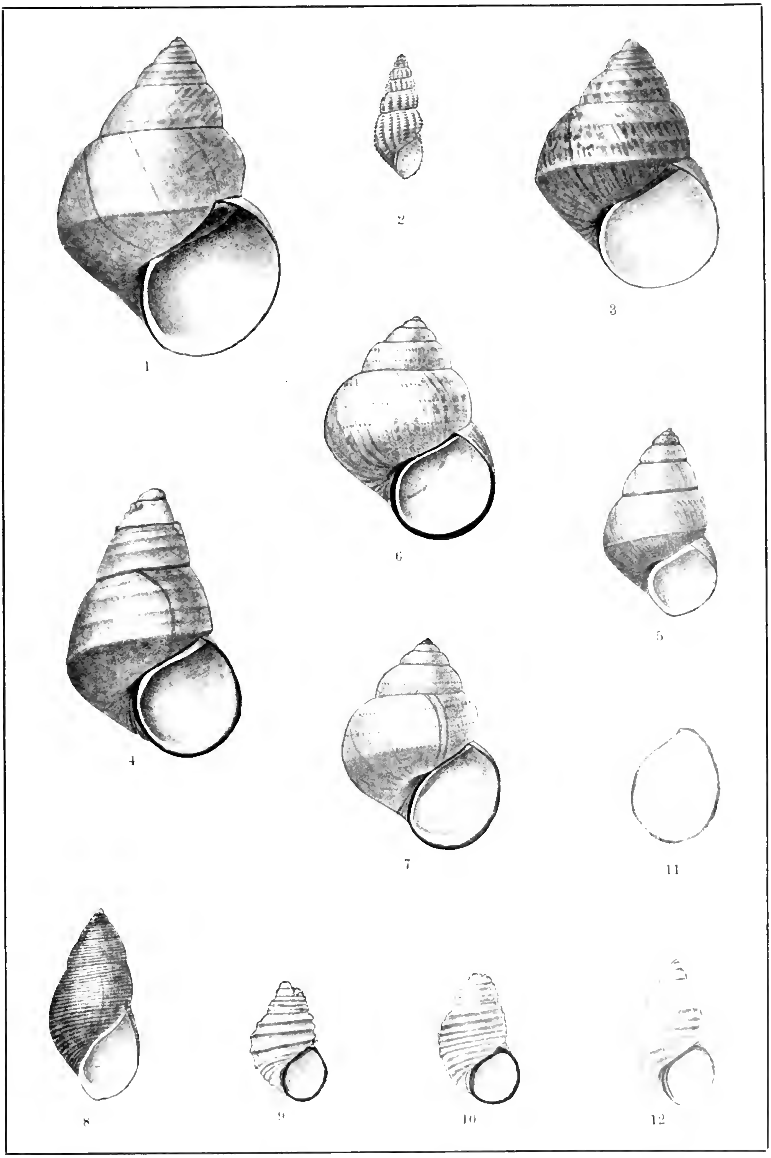
10b

REESE. THYROID GLAND IN PETROMYZON.

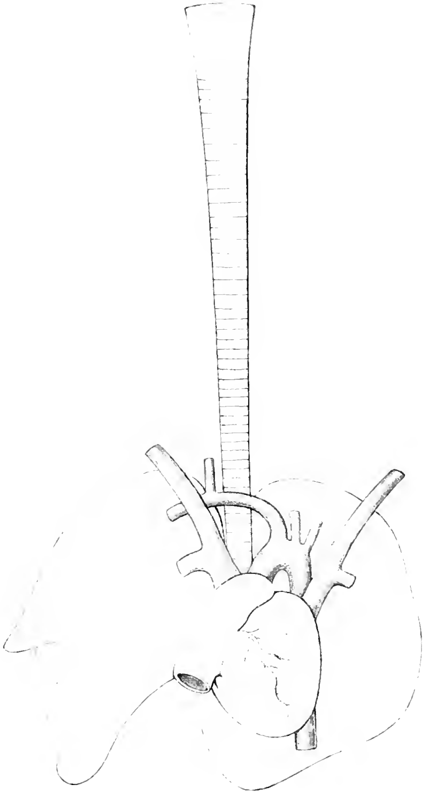


HARSHBERGER. GERMINATION OF CARAPA.

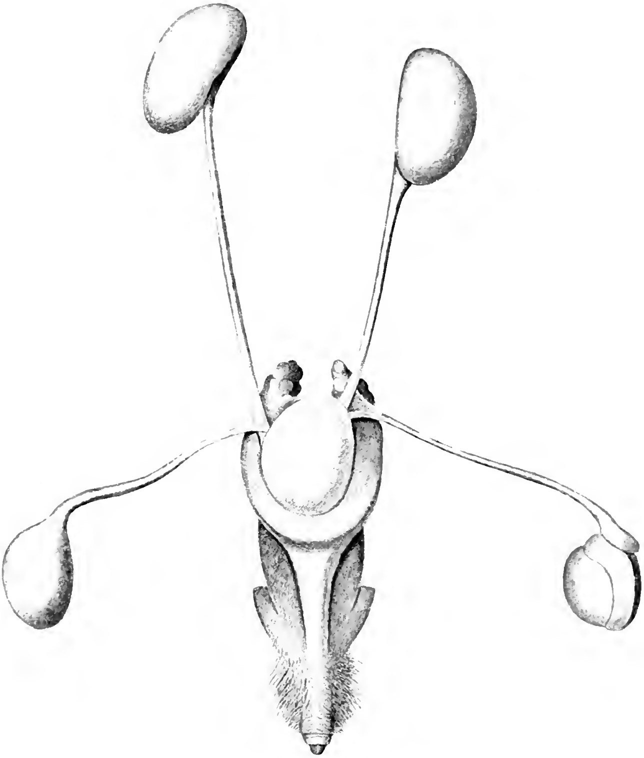
PLATE IX.



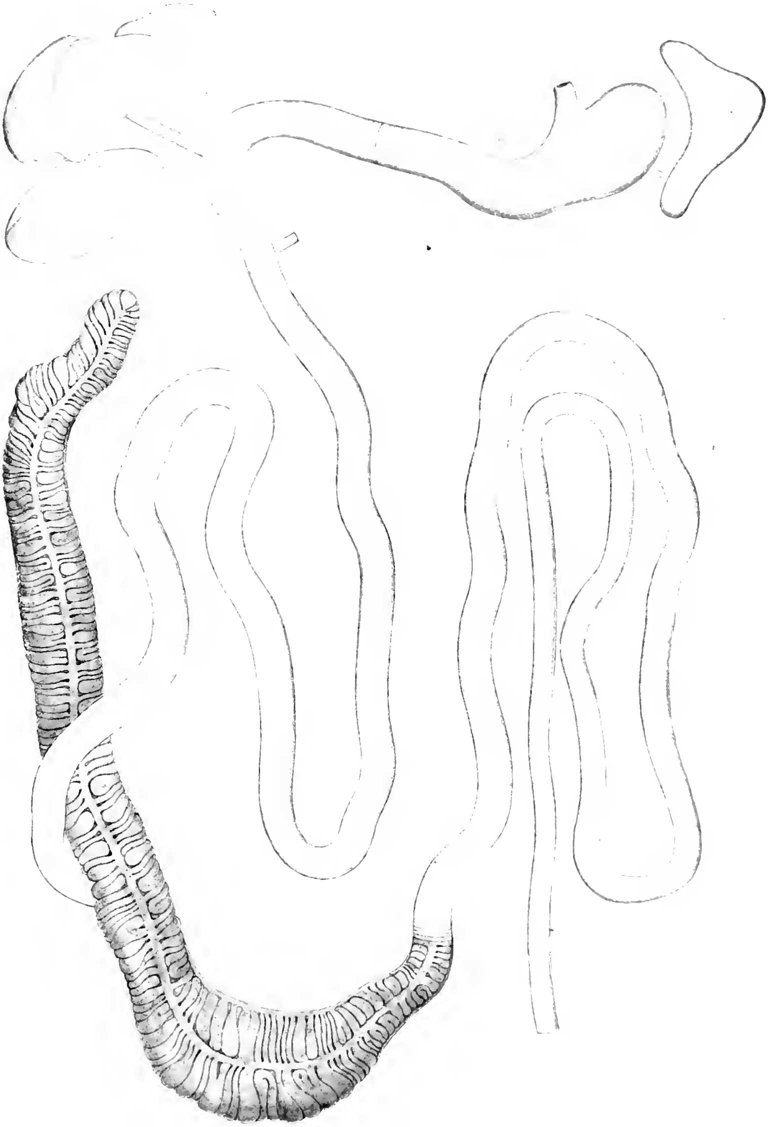
PILSBRY. MOLLUSKS OF JAPAN AND THE BONIN ISLANDS.



CHAPMAN ON GALEOPITHECUS.



CHAPMAN ON GALEOPITHECUS.



CHAPMAN ON GALEOPITHECUS.

the figure. In the one case, the processes were stiff, straight and motionless; in the other, they exhibited lashing movements, each separate process acting independently of the others of the same cluster. These two conditions passed readily the one into the other, the processes of a given cluster being at one moment motionless and the next in motion. In the figure, these two conditions are shown as occurring alternately, but this division is purely arbitrary.

In addition to these two, a third condition was observed. At frequent intervals the processes of a number of clusters became animated by a common impulse and exhibited a ciliary movement. All the processes of perhaps one hemisphere of the protozoan lashed or beat vigorously in the same direction, causing a rapid rotation of the body and a progression from one place to another. This phenomenon was seen a number of times, and in each case the activity appeared to involve the processes of only one side of the body at once. It was impossible, however, to determine whether or not this was always the same side.

The presence within this animal of a partly digested diatom seems to warrant regarding it as belonging to the Rhizopoda (Sarcodina). The spherical form and alveolar protoplasm furnish reasons for considering it a heliozoan. Of the several genera of fresh-water Heliozoa, it comes closest to *Actinophrys.* The signification of the curious phenomena observed is problematical, but the observation appears to be worthy of record in that it shows the readiness with which pseudopodia and flagella may change into each other.

Mr. G. B. Boulenger, of London, was elected a correspondent.

The following were ordered to be printed:

DESCRIPTIONS OF SOME NEW POLYNOIDÆ, WITH A LIST OF OTHER POLYCHÆTA FROM NORTH GREENLAND WATERS.

BY J. PERCY MOORE.

The Polychæta of the Arctic regions have been so thoroughly studied and described by a host of able Scandinavian, Dutch, German, English and other European zoologists that the fauna ranks as one of the best known in the world. Although the shores of Greenland have been repeatedly ransacked, especially by the zoologists attached to various exploring expeditions, the waters washing the north and northwest borders of that island have been searched much less thoroughly than those to the south and east.

From the standpoint of geographical distribution it has, therefore, seemed desirable to publish a list of the species contained in three small collections from this region which I have recently had the opportunity of studying. The first consists mainly of well-known species of Polynoidæ collected by Dr. Benjamin Sharp, in the shallow waters of McCormick Bay, in July, 1891, while a member of the party accompanying Lieutenant Peary to Greenland. The second embodies the results of a few dredge hauls, also in McCormick Bay, made by the Peary Relief Expedition, under the command of Prof. Angelo Heilprin, in August of the following year. This collection is remarkable from the circumstance that, while it contains but twelve species, eleven of which are Polynoidæ, four are well characterized new forms. It indicates the richness of the polynoid fauna at this particular spot, and recalls the results of Hensen's study of the annelids of the Norwegian North Atlantic Expedition to the regions about Spitzbergen and Nova Zembla. In the following list this collection is indicated by the letters P. R. E. These two collections belong to the Academy of Natural Sciences of Philadelphia. The third collection was made under the direction of Prof. Ortmann of the Princeton University Expedition to North Greenland in July and August, 1899. It is more extensive, both in the number of species represented and in the extent of territory covered, which overlaps McCormick Bay, both north and south, and extends from Godhavn to Cape Sabine, though few collecting stations were made south of Cape York. Some thirty species are comprised in this collection, mostly of forms well known from more southern waters; but several of them have not been previously recorded from North Greenland. None of the species are new, but it is noteworthy that several of the polynoids differ materially from the more typical representatives of their species which occur on the coasts of North America, of Norway, Scotland, etc. Although one cannot safely draw general conclusions from the small amount of material at hand, there seems to be a tendency for the elytra to become rougher and more spinous. In the list of localities, the numerals preceded by the letter O. indicate the dredging stations of this expedition. The collections of the Academy also include the few Polychæta remaining of those brought back from southern Greenland by Dr. Hayes in 1860–61, a list of which was published by Stimpson in the *Proceedings of the Academy of Natural Sciences of Philadelphia* for 1863. These also are enumerated in the following list.

Gattyana cirrosa (Pallas) McIntosh.

The elytra are rougher than those figured by Malmgren and McIntosh, the numerous papillæ being rough, horny, and spinous at the tip. The specimens from Cape York are covered with the "ochreous deposit" mentioned by McIntosh, which appears to be derived from the bottom soil. McCormick Bay, P. R. E.; Barden Bay, O. 45, 10–40 fath.; Cape York, O. 34, 10 fath.

Gattyana amondseni (Malmg.) McIntosh.

McCormick Bay, Dr. Benjamin Sharp; Payer Harbor, O. 17, 16 fath.

Gattyana senta sp. nov.

This species has the broad, thick-set form of *Harmothoë imbricata*, but is more depressed. Owing to the very spiny elytra and the dense bundles of dorsal bristles it presents a remarkably shaggy aspect. The type specimen is 22 mm. long, exclusive of the cephalic and caudal appendages, and has a maximum width between the tips of the longest setæ of 8.5 mm., of which the body itself forms about two-fifths. There are thirty-six setigerous somites. As viewed from below the body, exclusive of the parapodia, increases in breadth to X, from which it decreases very gradually to

XXX, and more rapidly to the anal somite. The fifteen pairs of elytra are borne on the same somites as in *Harmothoë imbricata* and allied forms.

The head (prostomium) is about two-thirds as long as broad, with the greatest width at about the middle. Anteriorly it is divided into two broadly rounded lobes by a median fissure which reaches as far as the posterior eyes; laterally it is strongly and posteriorly slightly convex, but normally the posterior margin is concealed by a median nuchal lobe of the succeeding somite. There are no anteriorly produced cephalic peaks.

Eyes, two pairs, conspicuous, black, circular, the posterior only visible from the dorsum. The anterior the larger, and situated on the ventro-lateral faces of the head about their own diameter from the anterior margin. The posterior dorsal close to the nuchal margin and separated by an interval of four times their diameter.

Exclusive of its base, which arises from the frontal fissure, the median tentacle has a length of about two and one-half times the width of the head, with a subterminal enlargement and a filamentous tip of about one-fifth its length. Except on the latter it bears rather long scattered cilia. The lateral tentacles arise from short and slender ceratophores from the anterior surface of the head at a lower level than the median tentacle, but, in the absence of anterior peaks, not very sharply demarcated from the cephalic lobes. Their diameter is about two-thirds, and length slightly more than one-half of the median tentacle. They are slender and taper continuously from base to apex, which is tipped by a delicate filament. A very few cilia similar to those on the median tentacle are present. Palps robust, with a basal diameter of rather more than one half the width of the head and a length about equal to the median tentacle. They taper rapidly, but not uniformly, to the acute tip, which bears a short filiform appendage. Numerous short, truncate cilia are borne on five longitudinal lines, of which two are nearer together on the medial aspect and the others respectively dorsal, external and ventral. Tentacular cirri similar to the notopodial cirri, ciliated like the median tentacle; the dorsal is slightly the longer.

Somite I is very narrow dorsally, but bears an unusually prominent median lobe which overlaps the head between the posterior eyes. The nephridial papillæ become distinct on IX, and continue to the posterior end. They are short and directed dorsad. Anal cirri, one pair, similar to dorsal cirri, but more slender.

In the typical parapodium (Pl. XIII, fig. 1) the neuropodium and notopodium are distinctly separated; the former is much the larger and angular in outline, whereas the latter is rounded. Both terminate in acicular lobes, of which the neuropodial is the longer. The acicula are remarkable for the unusual length of the free, projecting end, which in the case of the neuropodial equals one-third of the length of the longest setæ, and is slender and curved.

The dorsal cirri spring from conspicuous cylindrical bases. They are larger than the median tentacle, with less of a subterminal enlargement and shorter filamentous tip. The numerous cilia are of two kinds; the largest have a length of two to three times the diameter of the cirrus, have a uniform diameter and are confined to the distal half, excluding the filamentous tip which bears no cilia; the smaller ones are enlarged at the end and are more widely distributed proximally. The ventral cirri are about one-fourth of the length of the dorsal, slender, awl-shaped, and bear a very few short clavate cilia.

The first elytra are circular and fixed nearly at the middle; the next succeeding ones ovoid, with a slight anterior emargination at the point of contact with the preceding peduncle; at the middle of the body they are reniform, while posteriorly they again approach the circular form. They are loosely attached and easily displaced and are of a soft membranous texture, with very hard horny spines (Pl. XIII, fig. 2). Around the entire uncovered margin is a fringe of rather widely separated cilia which become elongated externally. With the exception of a small antero-internal margin the entire surface is spinose, the spines as usual increasing in size and complexity and decreasing in number from the anterior and internal toward the posterior and external border. The first are merely low cones. They are succeeded by others with bifid summits which soon become larger. Passing obliquely across the middle of the scale in its longest direction is a broad band of prominent bifid spines, the apices of many of which are again divided. Most of the spines on the posterior half have, on the other hand, a quite distinct character. Here they are more remotely distributed and are mostly trifid, with broad bases and each limb usually bifid at the tip. Numerous other forms occur. Some have a central spine arising from the middle of the three diverging ones, others expand into an irregular disk, from which project from four to seven points of different sizes and shapes. But the most remarkable spines are those which protect the extreme posterior and external border of the scale. These are very large and tree-like in form, and most frequently branch in a fundamentally trifid, ternate plan, though some of the branches may be bifid or even simple. The final divisions are always acutely pointed.

Setæ of the dorsal and ventral fascicles are of approximately equal length and thickness. The former are somewhat stouter basally, but the latter are terminally, and their apices form a nearly regular outline, beyond which only one or two of the dorsalmost neuropodial setæ project. The very numerous notopodial setæ are arranged in many rows and radiate in all directions, but chiefly laterad and caudad, overlapping the following parapodium. Their form is characteristic. The anterior dorsalmost ones (Pl. XIII, fig. 3) are short, stout and strongly curved. They are about two-thirds free, with the inserted part suddenly contracted and narrow, and the thickest region at about the middle of the free portion. There is a very extensive spinous region, in which the rows of capillary spines are rather close and long. The short, smooth end, which is equal in length to the space of three or four of the terminal rows of spines, is peculiar in having an abruptly recurved or hooked tip (Pl. XIII, fig. 6). Toward the ventral end of the anterior row the setæ become less curved, more slender and the terminal hook less abrupt.

Posteriorly the setæ of succeeding rows become much longer, relatively more slender, and almost straight. A typical one is exhibited in Pl. XIII, fig. 4. Such setæ, which are very numerous, have the following characteristics: They are slender and taper regularly from the thickest point in the proximal third to the acute tip, which is slightly curved and sometimes suggests the hook of the dorsal setæ by the faintest indication of a recurvature. The spinous region is less extensive than on the dorsalmost setæ, and the spines are excessively fine, except toward the free end, where the elsewhere very close long rows become broken up into short detached plates, which alternate on the opposite sides of the seta. Proximally they again become irregular. In some cases these spinous rows actually encircle the setæ, but usually there are two intervals on opposite margins, that on the concave side being occupied by a distinct longitudinal groove in which short transverse ctenoid plates are situated. The non-spinous basal portions of these setæ and the smooth interval on the convex border are covered with numerous minute granulations (Pl. XIII, fig. 8) which become less numerous and finally disappear distally.

The neuropodial setæ (Pl. XIII, figs. 9–13) are less characteristic. They are arranged in eight or nine horizontal rows and are less numerous and rather stouter than the notopodials, notably at the distal end, where their enlarged spinous portions contrast conspicuously with the attenuate tips of the former. From ventral to dorsal the spinous tips increase in length much more rapidly than the entire free portion of the setæ, these regions being as one to five or six in the ventral, and as one to three in the dorsal. The number of spinous rows is large, but varies only from twenty-three in the ventral to twenty-seven in the most dorsal. Distally the teeth are coarse and the rows rather widely separated, proximally they are fine and the rows crowded. The smooth tips are rather long, without accessory processes and on typical setæ strongly hooked and sharp-pointed. Probably as a result of wear, the tips of the prominent dorsal neuropodial setæ are blunt. On the second and third parapodia the neuropodial setæ are intermediate in form between the typical neuropodial and notopodial setæ just described; their tips are straight and slender, and the spines very long and few in number. The first foot bears a tuft of four or five of the notopodial type. At the posterior end the setæ show modifications from the type similar to the anterior.

Pigment, if originally present, has almost entirely disappeared. A general pale-yellow hue results from the dull yellow of the spines on the elytra, the hay color of the notopodial, and the rich amber of the neuropodial setæ.

Two specimens. McCormick Bay, P. R. E.

Gattyana ciliata sp. nov.

In ventral aspect the body is rather slender and nearly linear, and tapers very gently from about X to the posterior end. Dorsally it is strongly convex. The type consists of two imperfect individuals, one consisting of twenty-one anterior somites, the other of thirteen posterior somites, together constituting nearly the total number. These measure respectively 30 and 12 mm. long, so that length of a complete example of this size would probably be about 45 mm. The width of the body alone at X is 4.8 mm., to the ends of the parapodia 11 mm., and to the tips of the setæ 16.5 mm. Apparently the elytra number fifteen pairs, borne on the usual somites. Segmental papillæ begin on V and soon become long and slender, but instead of pointing freely caudad, as in *Harmothoë imbricata* and allied forms, they are directed dorsad between the bases of the parapodia.

The head is broad, its length being about three-fourths of its greatest width, which is about one-third of its length from the anterior end. Its lateral margin is almost angulated; the anterior fissure is deep and wide, and the ceratophore of the median tentacle occupies it in such a way as to give the impression of having pushed apart the two lobes of the head. These lobes are rounded anteriorly and have no distinctly produced peaks.

The eyes are black, circular and widely separated. Those of the posterior pair are less than their own diameter from the posterior margin of the head and so far apart as to be partly laterad in position. The anterior are slightly larger, separated from the extreme anterior margin by less than their own diameter, and latero-ventral in position.

Median tentacle absent, its ceratophore of large size and marked by a conspicuous chocolate-colored band. Lateral tentacles arise at a level quite below the dorsal surface of the head lobes and partly overlapped by the ceratophore of the median tentacle. They have a length of about one and two-thirds the width of the head, are slender and tapering, with a brown pigmented subterminal enlargement and a rather long filiform tip. The single palpus remaining on the type specimen is an elongated, almost whip-like structure eight times as long as the head. It bears a single line of cilia on the medial side, while much shorter clavate cilia are scattered over the general surface. Its cuticle is remarkably iridescent, a condition not found elsewhere in this worm. Frontal ridge broad and low. The tentacular cirri are missing.

Typical parapodia are long and slender, the neuropodium prominent and bearing near its base the small lobe-like notopodium. The dorsal border of the former is straight and slopes gently downward, to pass without angulation into the dorsal edge of the acicular lobe, the base of which is met abruptly by the sharply upturned ventral margin. The aciculum projects but slightly.

The notopodium is merely a dorso-anterior lobe supported by a slender aciculum, which lies close to the neuropodial aciculum, but terminates far short of it. The large base of the dorsal cirrus, with its double wing-like lobes, further overshadows the notopodium. The cirrus itself has the usual form and bears numerous slender cilia, which, on the dorsal side, have a length nearly equal to the diameter of the cirrus and about four times that length ventrally. The ventral cirrus is about one-fifth the length of the dorsal. The first ventral cirrus (somite II) is, however, as usual larger and formed like the dorsal cirri; moreover, its ventral surface bears numerous truncate cilia as long as one-half its diameter.

Although few in number and arranged in only eight very definite rows, the neuropodial setæ, because of their large size and rich golden color, are very conspicuous. They increase in length to the sixth row, but their spinous ends continue to elongate to the most dorsal (8th) row. All are stout and have abruptly enlarged ends (Pl. XIII, figs. 17–19) with long, slightly curved, and rather blunt-pointed, smooth tips. The spinous region is remarkably short, particularly on the most ventral setæ, which bear only four pairs of coarse teeth and seldom a trace of lateral fringes. The middle setæ have six or seven pairs of such spines with short lateral fringes, and the dorsal setæ as many as fifteen or twenty rows of spines, of which the basal ones are very fine. The smooth tips of these dorsal setæ are relatively and absolutely shorter as well as more slender.

The notopodial setæ (Pl. XIII, figs. 14–16) are of a pale hay color and rather lustreless. They are extremely numerous and arranged in many nearly horizontal ranks, from which they spread fan-like in a nearly horizontal plane outward and slightly backward, so that these worms present none of that shaggy appearance which characterizes some Polynoidæ. These setæ are so long, so numerous and keep so well together, that the parapodia are scarcely visible from above. This species is distinguished from other species of the genus by the fact that all of the notopodial setæ, without exception, bear long capillary tips. The longer middle and ventral setæ are spinous for about one-third of their exposed length and become excessively slender toward the gently curved tip, which bears a smooth, tapering and flexible filament about one-fourth of the length of the spinous portion. The very numerous rows of fine spines are about equidistant for the entire length, but increase in height to near the tip where they again diminish. The bristles present a very strongly serrated profile, especially at the point where the tapering shaft has a diameter less than the height of the projecting spines. The dorsalmost and ventralmost setæ are shorter and bear much shorter capillary tips; the former are also strongly curved and the latter straight and very slender.

Somite I has the parapodium supported by a single stout aciculum which passes between the bases of the dorsal and ventral tentacular cirri. It bears a tuft of four or five notopodial cirri of the extreme dorsal pattern. II bears a nearly normal tuft of notopodial and a small group of long-spined and slender neuropodial setæ.

A single elytron (the right one of somite VII) was found *in situ* on the type specimen, and is represented on Pl. XIV, fig. 20. It is narrow and strongly reniform, with the external half broader than the internal. Close to the anterior emargination, but rather to its external side, is the area of attachment. Closely placed cilia extend all around the posterior and external margin and increase in size and frequency from within outward, while here and there one or two of the larger cilia are replaced by much smaller ones. Coarser cilia are scattered sparingly over the greater part of the postero-external region, and, like the marginal ones, are longer externally.

With the exception of a very narrow antero-internal marginal area the entire surface bears numerous horny papillæ which, as usual, increase in size slightly, but decrease in number toward the posterior margin. In this case the papillæ or spines are of largest size and most numerous in a narrow area along the middle of the scale. Along this area their summits are distinctly thickened and bispinose. A line of tall, slender cylindrical ones with prominent bifid tips runs from the point of attachment of the scale to the outer margin, and a few similar ones are scattered elsewhere. Just in front of the posterior margin is a row of seven prominent conical papillæ with broad bases and truncate roughened summits. These are also covered with a horny cuticle, but appear to be softer than the small spines and papillæ, like which they are of a pale-brown color.

Three specimens. McCormick Bay, P. R. E.

Lagisca multisetosa sp. nov.

Like other species of *Lagisca* this is slender, with the widest part of the body far forward at somite VI, behind which it diminishes gently, while the anterior end is broadly rounded. The type specimen consists of the twenty anterior somites and measures 11 mm. in length, 3.2 mm. in width of body at VI, 5.3 mm. to tips of feet, and 8 mm. to tips of the setæ at the same place. It will be observed that the parapodia are here relatively short.

The head is three-fourths as long as wide, with a gently convex posterior border, lateral margins prominently bulged at the middle, and the anterior fissure deep, with a narrow furrow continuing it back to about the middle of the head. The two halves of the head are produced forward around the base of the middle tentacle, and the prominent peaks in which their outer sides end are widely separated from the latter. The frontal ridge is strong and high.

The posterior eyes are situated close to the posterior margin of the head and separated by four times their diameter. They are black, circular and look upward and slightly outward. The anterior eyes are of the same shape and color, but about twice the size of the posterior. They are situated relatively far back, not more than their own diameter in advance of the posterior pair, but on the ventro-lateral surface, though they may be seen through the tissue of the head from above.

Of the cephalic appendages the median tentacle is absent, but its deep chocolate-colored base remains. The lateral tentacles have a length about equal to the width of the head, and are slender and tapering, the distal half being filiform. They arise entirely below the level of the median tentacle and their bases are almost in contact in the median line. The palps are about two and one-half times the length of the lateral tentacles, taper to a very acute tip, and bear two dorsal lines of very small cilia, with a few of the same kind scattered over the surface. The dorsal tentacular cirrus about equals the palp in length; the ventral is slightly shorter. Both taper from the base to a very slight subterminal enlargement bearing a short terminal filament. Short truncate cilia are sparingly scattered over the surface, being rather more numerous just below the subterminal enlargement.

Although the setæ are long the parapodia themselves are short, the tenth, for example, being somewhat less than one-half the width of the body. In shape the foot is easily distinguished from that of *Lagisca rarispina* by the much smaller notopodium. The neuropodium is broad, with a prominent acicular lobe, from the end of which, above the projecting aciculum, is produced a long, slender, tentacle-like process, quite as long as the lobe itself. The notopodial acicular lobe bears no such process, and is much shorter. The dorsal cirri resemble the tentacular cirri, except for the longer filiform tips and longer, more numerous and clavate cilia. Ventral cirri slender, reaching nearly to the end of the neuropodial acicular lobe and bearing a few very short, nearly globoid cilia.

Only the anterior elytra are present, and these have the normal arrangement as far as the tenth pair on somite XIX. The first is circular, five or six succeeding pairs (Pl. XIV, fig. 29) reniform, and the others ovate-reniform. They are thin, membranous, translucent and fairly adherent. The area of attachment is small, elliptical and very much nearer to the anterior and external borders than to the posterior and internal. A rather wide and clearly defined area internal to the hilum and along the anterior border is entirely free from spines. Anteriorly and internally the spines are low and nipple-shaped, but over most of the surface are sharply conical, becoming elevated and acute in certain regions, notably in a broad irregular band which passes across the middle of the scale in its long direction. Enlarged spines are also scattered singly or in groups here and there over the surface toward the posterior and external borders. Twelve or fifteen prominent soft papillæ (Pl. XIV, fig. 31) of various heights and with rounded summits appear just in advance of the posterior margin, and a few similar ones on other parts of the surface. Marginal cilia appear to be absent, but a few large ones are scattered over the surface in the external third. On the first scale soft papillæ extend more than half-way around the margin, and an area of particularly strong spines occurs above the area of attachment.

The neuropodial setæ (Pl. XIV, figs. 32–34) are long and slender, with very long and but slightly enlarged spinous regions. The smooth tips are very short; the principal point rather strongly curved, but not hooked; the accessory process far out, running first parallel to the principal point and then diverging from it, very slender, sharp-pointed and long. These setæ are very fragile and but few are found with the tips intact. The spines are long and fine, except at the base. The number of rows varies from nineteen on the most ventral setæ to twenty-four or twenty-five on the middle and thirty-one on the most dorsal. The neuropodial setæ are arranged in numerous rows, there being at least twelve subacicular and six supraacicular series.

The notopodial setæ (Pl. XIV, figs. 35, 36) are also rather long and slender, gently and regularly curved and tapering to the rather acute points. As usual in *Lagisca*, the rows of spines are long, numerous and close, the spines themselves being fine and a few in the middle of each row enlarged.

The neuropodial setæ of II differ very little from the normal types in typical parapodia, except for their smaller size and longer spines. I bears no neuropodials, and in the specimen examined only two notopodials, which have the characteristic form.

The elytra are pale mottled brown, the setæ all a pale but glistening hay color. The dorsum of the body is light brown, with a yellowish line across the anterior end of each somite and the anterior somites each with a median spot of dark brown. The bases of the parapodia are pale yellowish, the cirri white with dark rings above and below the enlargement. The head is light-colored and iridescent with brown cloudings, the base of the tentacles chocolate color, and the palps buff. The under surface of the body is pale and iridescent.

One specimen. McCormick Bay, P. R. E.

Lagisca rarispina (Sars) Malmg.

The anterior pair of eyes is borne on the anterior face of prominently outstanding lobes, which give to the head a very characteristic form not shown in any of the published figures. These ocular lobes are situated slightly posterior to the middle of the head, which is very much narrower anterior than posterior of them. A specimen 12 mm. long has only seven somites posterior to the last elytraphore, whereas one of 43 mm. has fifteen.

McCormick Bay, Dr. Benjamin Sharp; Northumberland Island, O. 11, 10–15 fath.; Olridir Bay, O. 29 and 49, 7–25 fath.

Actinoë sarsi Kinb.

McCormick Bay, P. R. E.; Granville Bay, O. 39, 30–40 fath.; Olridir Bay, O. 49, 15–20 fath.

Harmothoë imbricata (Linn.) Malmg.

This species occurs in considerable numbers and from many localities, most abundantly in material gathered in shallow water. The examples from McCormick Bay are of large size, and the setæ are nearly black instead of the usual rich amber color; the elytra also are marked with nearly black spots. Many varieties, both in color and structural features, are represented. The elytra vary from those without any trace either of horny papillæ or soft marginal papillæ, to very rough ones with numerous hard prominences easily visible under a magnification of five diameters and soft papillæ so close together that they crowd one another in the marginal rank.

McCormick Bay, Dr. Sharp; Godhavn, Dr. Hayes, Godhavn, O. 2, 8 fath.; Saunders Island, O. 9, 5–10 fath.; Barden Bay, O. 45, 10–40 fath.; Orlidir Bay, O. 49, 15–20 fath.; Robertson Bay, O. 52, 5–15 fath.; Foulke Fjord, O. 54, 5 fath.; Sarkak, O. 57, 9 fath.

Harmothoë (Lænilla) glabra (Malmg.).

McCormick Bay, P. R. E. and Dr. Sharp; Northumberland Island, O. 11, 10–15 fath.; Barden Bay, O. 45, 10–40 fath.

Harmothoë (Evane) impar (Johnston).

The single specimen from McCormick Bay is typical. In this the soft marginal papillæ have the rounded form shown by Malmgren, not the truncate and lobulated appearance of McIntosh's figures. The hard papillæ are mostly elevated and divided at the summit into two short, blunt divergent processes. The other specimens are referred doubtfully to this species, from typical examples of which they differ in the following details: The median and lateral tentacles and the tentacular cirri have the tapering and filamentous portion relatively longer than in McIntosh's figure; the scales are rougher, with spinous-tipped horny papillæ and few cilia, of which the longer ones have bulbous ends; four examples lack the large, soft papillæ altogether, while the fifth one bears a single minute one on one scale only; the neuropodial setæ have the spinous tip longer and the accessory process nearer to the extreme end.

McCormick Bay, Dr. Sharp; Saunders Island, O. 9, 5–10 fath.; Olridir Bay, O. 49, 15–20 fath.

Harmothoë (Eunoa) nodosa (Sars) Malmg.

Two examples approach nearer to *Eunoa œrstedi* in many respects. The distinctness of these two species has been already called in question, but is generally upheld by the highest authorities. The scales exhibit the dense external ciliation of *E. nodosa*, but are rougher even than *œrstedi*. The large papillæ are spinous at the apex, and many even of the smaller ones, especially toward the outer margin, bear a number of conical or bifid divergent spines. Around the posterior margin, and more or less elsewhere, many of the papillæ become low, rounded and mound-shaped, and bear numerous small spines in clusters. Anteriorly the roughness of the scales increases and a detached scale, which, being circular, is regarded as the first, bears around its entire margin a narrow band of large, irregularly globoid bosses, produced into numerous processes, each of which bears a tuft of spines at its summit. A smaller group occurs at the middle of the scale and papillæ of smaller size are scattered between. All of these papillæ are hard and horny and supported on horny basal plates of various and irregular shapes.

The ventral setæ have the form figured by McIntosh, and the dorsal also resemble his figure of *E. nodosa*, except that the short tips are sculptured in much the fashion of the smaller notopodial setæ of *Harmothoë truncata*. They resemble the apex of the green fruit of *Lireodendron* or a winter leaf-bud, but are less regular and the smaller ventral ones especially have fewer scales or ridges. The ventral setæ of II resemble McIntosh's figures of *œrstedi* rather than *nodosa*.

Several discrepancies appear in the published accounts of the species of *Eunoa*. Malmgren figures the smooth tips of the notopodial setæ of *nodosa* as the longer of the two species; McIntosh both describes and figures the reverse, but neither indicates the sculpturing. McIntosh in one place[1] (p. 292) describes segmental papillæ in *Eunoa*, in two other places (pp. 291 and 293) he states that they are absent. In these specimens they are nearly as well developed as in *Harmothoë imbricata*, for example.

The head and its appendages conform almost exactly to McIntosh's figure. The anterior eyes are quite dorsal in position, situ-

---

[1] *Monograph of British Annelida*, Part II.

ated well posterior and but little farther separated than the posterior pair.

In many respects these specimens resemble the figures of *Harmothoë scabra* (Oersted), especially those of the scales given by Wirén.[2] The anterior elytra of ***Polynoa*** (*Harmothoë*) ***islandica*** Hensen also approach the character of these, but the entire absence of those belonging to the posterior region renders it impossible to determine if they possess the peculiar ragged appendages present in Hensen's species, in which also the first elytron is reniform.

McCormick Bay, P. R. E.

Harmothoë (Eunoa) truncata sp. nov.

This well-marked species is known only from a single imperfect specimen, consisting of the head with twenty-four somites. The elytra, dorsal cirri, all but one tentacular cirrus and the tentacles are missing. Viewed from beneath the body is truncate anteriorly, widest at V or VI, and with nearly parallel sides, narrowing very gently posteriorly. The third and fourth somites together form a broad swollen area which bounds the mouth posteriorly. Rather prominent but short, projecting nephridial papillæ begin at VI, and continue to XXIV at least. Scars for the attachment of elytra are present on the usual somites back to XXIII.

The head is slightly broader than long, with a well-marked median anterior fissure and slightly produced, obtusely pointed peaks. A small posterior nuchal lobe is inseparably connected with the head, but by analogy probably belongs to the following somite. The two pairs of eyes are black, circular and of equal size. The posterior are close to the posterior margin, and are separated by a space of five times their diameter. The anterior are placed laterally on the widest region of the head, and distant about twice their diameter from the tips of the cephalic peaks. There is nothing peculiar in the place of origin of the tentacles. The palpi are about five times the length of the head, with a swollen basal half, a slender distal half and a short terminal filament.

In the typical foot the neuropodium has nearly straight outlines terminating at a nearly right angle, with a projecting acicular lobe. The aciculum projects but little and its end is suddeny contracted in a peculiar way. The notopodium lies a little to the anterior of

---

[2] *Vega-Expeditionens Vetenskapliga Iakttagelser*, II.

the plane of the neuropodium, but scarcely overlaps it. Its aciculum projects farther than the neuropodial, like which it is suddenly narrowed at the end.

The neuropodial setæ (Pl. XIV, figs. 21, 22) are grouped in eight rows, of which five are ventral, two dorsal and one opposite to the aciculum. They are of large size, the longest dorsal ones about equaling the longest notopodials in length. Like the latter they are stout. The spinous portion is relatively short, but there is the usual increase in length dorsad. On a typical seta from the middle of a bundle the five or six terminal pairs of spines are of large size, little or not at all divided and with no lateral fringes. They rapidly diminish in size and become finely ctenoid as the fringes appear, and soon become continuous with the latter. Proximally the spines become very fine and the rows crowded. On the dorsalmost setæ the number of fine rows increases and the transition from the coarse to fine is much more gradual. The number of spinous rows is about fourteen in the ventral, nineteen on the middle and thirty on the dorsal setæ. On all of the neuropodial setæ the smooth tip is long, simple, strongly hooked and sharp-pointed. On the ventral setæ it nearly equals in length the spinous region and even on the dorsal ones is about one-third as long.

The largest of the notopodial setæ (Pl. XIV, figs. 23 and 25) are remarkable for their size and truncate ends. They are long, stout, slightly curved and bear for fully one-half of their exposed portions numerous close and long rows of excessively fine teeth, which are frequently worn away over considerable areas. Except near the tip they extend nearly around the shaft. The tip has a peculiar frayed-out appearance, as though the fibres of the setæ had separated and spread apart. The peripheral layer is a whorl of elongated scales surrounding a fibrous bundle, from the midst of which a central point appears more prominently. Around the base of these scales is a very dense fringed whorl. The very large setæ are few in number, not more than eight or ten in a bundle.

The most usual form of the seta tip is shown in fig. 27. In such the outer scales embrace the central style more closely, so that a rough, blunt point is formed. Somewhat similar are the tips of the strongly curved antero-dorsal setæ (Pl. XIV, figs. 24 and 26), but these have very short scales. The slender, sharp-pointed anterior ventral setæ (Pl. XIV, fig. 28) approach more nearly the usual type of notopodial setæ found among the polynoids, but even these have the points somewhat divided. On the extreme anterior feet all of the dorsal setæ are blunt-pointed, having much the appearance of the conventional architectural pineapple. The first foot bears a group of five or six setæ of this type and no neuropodials. The neuropodials of the second foot are slender, tapering and provided with very long spines.

One specimen. McCormick Bay, P. R. E.

Melænis loveni Malmg.

McCormick Bay, Dr. Sharp; one specimen.

Pholoë minuta (Fabr.) Malmg.

Godhavn Harbor, O. 2, 8 fath.

Phyllodoce citrina Malmg.

Northumberland Island, O. 11, 10–15 fath.; one specimen.

Phyllodoce greenlandica Oersted.

Barden Bay, O. 45, 10–40 fath. Some fine examples, the largest measuring 390 mm.

Phyllodoce mucosa Oersted.

Foulke Fjord, O. 54, 5 fath. Three specimens, all of which exceed Oersted's original examples in length. The largest measures 94 mm.

Autolytus longisetosus Oersted.

Cape Chalon, O. 25, surface.

Nereis pelagica Linn.

Godhavn, Dr. Hayes.

Nereis zonata Malmg.

Granville Bay, O. 39, 30–40 fath.; one specimen.

Lumbriconereis sp.

McCormick Bay, P. R. E., 10 fath. A fragment of a large individual of an undetermined species.

Northia conchylega (Sars) Johnson.

This species must be extremely abundant at some points, as at Olridir and Granville Bays. The characteristic tubes are flattened and of an elongated rectangular form, measuring up to 80 mm. long, 10–12 mm. wide and 3 mm. thick. The lumen is about twice as wide as high, and is completely filled by the worm. Judging from the fact that attached tubes of *Spirorbis*, *Serpula*, together with bryozoans, tunicates and hydroids are confined chiefly to one side, it is probable that they are fixed to the bottom, resting on one of the flat surfaces. The material of which they are composed differs with the character of the bottom. Those from Olridir Bay are uniformly formed of coarse grains of red, black, yellow and colorless sand, with here and there a small lamellibranch shell or a fragment of a larger one. The Granville Bay examples, on the other hand, are composed of flattened pieces of black or occasionally gray shale, with numerous large pieces or even entire shells, bits of sea urchin tests, etc. Many of the bits of shell are very thin and translucent (like *Anomia*), permitting the form of the worm to be distinctly seen. In many cases the fragments of shale are as much as 15 mm. in diameter, and the pieces of shell are still larger.

Granville Bay, O. 39, 30–40 fath., and O. 40, 20–30 fath.; Olridir Bay, O. 49, 15–20 fath.

Scalibregma inflatum var. **corethura** Mich.

Whale Sound, O. 41, surface.

Flabelligera affinis Sars.

Cape York, O. 34, 10 fath.

Flabelligera infundibularum Johnson.

This species, recently described by H. P. Johnson from the Puget Sound region, is represented by one specimen which differs slightly from the Pacific coast examples. The capillary setæ have a greater number of cross nodes, the infundibular setæ appear to be somewhat shorter, and the stalked sense organs have a different form, which, however, is probably merely the result of a different state of preservation.

McCormick Bay, Dr. Sharp.

Axiothea catenata Malmg.

Barden Bay, O. 45, 10–40 fath.

Cistenides granulata (Linn.) Malmg.

Godhavn Harbor, O. 2, 8 fath., and O. 3, beach; Sarkak, O. 57, 9 fath.

Cistenides hyperborea Malmg.

Barden Bay, O. 45, 10–40 fath.

Amphitrite cirrata Müller.

Barden Bay, O. 45, 10–40 fath. A few tubes of an *Amphitrite* were also dredged at Foulke Fjord, O. 12, 35 fath.

Nicolea arctica Malmg.

Very abundantly represented in the collections from Northumberland Island. Melville Bay, O. 6; Northumberland Island, O. 11, 10–15 fath.

Scione lobata Malmg.

Granville Bay, O. 39, 30–40 fath.; Barden Bay, O. 45, 10–40 fath.

Axionice flexuosa (Grube) Malmg.

Saunders Island, O. 9, 5–10 fath.; Granville Bay, O. 39, 30–40 fath.

Thelepus circinnatus (Fabr.) Malmg.

Next to ***Harmothoë imbricata***, this species occurs most frequently in the collections of Dr. Ortmann. It is not represented in the material from McCormick Bay.

Godhavn, Dr. Hayes; Godhavn Harbor, O. 2, 8 fath.; off Cape Chalon, O. 27, 35 fath.; Foulke Fjord, O. 32, 14 fath.; Granville Bay, O. 39, 30–40 fath.; Olridir Bay, O. 49, 15–20 fath., Robertson Bay, O. 51, 35–40 fath.; Karnah, O. 50, 30–40 fath.

Chone infundibuliformis Kröyer.

Olridir Bay, O. 29, 7–25 fath.

Serpula sp.

Tubes of a small *Serpula* were found attached to the tubes of *Northia conchylega* from Olridir Bay and other places.

Spirorbis granulatus (Linn.) Mörch.

Found only attached to the tubes of *Northia conchylega* and *Thelepus circinnatus*, and especially abundant on the former in Olridir Bay. A number of examples were noticed in which the last turn of the tube was elevated and free. The thick tube is sometimes marked with one, sometimes with two, longitudinal angular ridges; these become quite evident in young individuals of .5 mm. diameter.

Foulke Fjord, O. 32, 14 fath.; Granville Bay, O. 39, 30–40 fath.; Olridir Bay, O. 49, 15–20 fath.

Spirorbis verruca (Fabr.) Mörch.

Found only with the last, than which it is less common, attached to the tubes of *Northia*. Specimens measuring 7 to 8 mm. across the spiral were found.

Spirorbis spirillum (Linn.) Mörch.

In addition to the typical open spiral form there have been referred to this species numerous examples which, while having, so far as could be determined, identical characters of setæ, operculum, etc., have the tube usually coiled in a flat spiral of smaller size and less pellucid character. This form occurs abundantly in comparatively shallow waters, attached in the manner of *Spirorbis borealis*, from which the tube is distinguished at once by the reverse direction of its coil, to *Laminaria* and other resistant thalloid algæ. When attached to a clean surface of the alga the plane of the spiral is always perfectly flat; when, however, as frequently occurs, the annelid is associated with an incrusting growth of bryozoans, the coil of the former immediately becomes elevated and open, approaching the typical form which is found in deeper waters associated with hydroids and branching bryozoans. As noted by Michaelsen, this species reaches a much larger size than has been recorded by Levinsen and other students of Arctic Polychæta. One of the largest examples, occurring in the collections from Olridir Bay, measures 8.5 mm. in height of the spiral. The typical form is represented from the following localities: South of Cape Alexander, O. 26, 27 fath.; Olridir Bay, O. 49, 15–20 fath.; Karnah, O. 50, 30–40 fath.; Robertson Bay, O. 51, 35–40 fath. The flat form occurs as follows: Upernavik, O. 4, 5–10 fath.; Saunders Island, O. 9, 5–10 fath.; Northumberland Island, O. 11, 10–15 fath.; Robertson Bay, O. 51, 5–15 fath.; Foulke Fjord, O. 54, 5 fath.

Spirorbis vitreus (Fabr.) Mörch.

A single example attached to the tube of a *Northia conchylega* from Foulke Fjord, O. 39, 14 fath.

EXPLANATION OF PLATES XIII AND XIV.

Plate XIII.—*Gattyana senta :*

Fig. 1.—Outline of the right parapodium, without setæ, of X ; posterior aspect. × 14.

Fig. 2.—Right elytron of XIII. × 14.

Figs. 3–5.—Dorsal, middle and ventral notopodial setæ, respectively, from the left parapodium of X. 12 mm. have been cut out of the drawing of the middle setæ to permit of its being shown entire on the same scale as the others. × 75.

Fig. 6.—Tip of dorsal notopodial ; left, X. × 335.

Figs. 7 and 8.—Tip and basal portion of middle notopodial, respectively ; left, X. × 335.

Figs. 9–11.—Tips of ventral, middle and dorsal neuropodial setæ, respectively, from the left parapodium of X. × 75.

Figs. 12 and 13.—Extreme tips of the ventral and middle setæ shown in figs. 9 and 10 respectively. × 335.

Gattyana ciliata :

Figs. 14 and 15.—A dorsal and a middle notopodial seta from X. × 75.

Fig. 16.—A portion of a typical notopodial seta. × 335.

Figs. 17–19.—Tips of ventral, middle and dorsal neuropodial setæ, respectively, from X. × 75.

Plate XIV, fig. 20.—A typical elytron of *Gattyana ciliata*. VII, right. × 14.

Harmothoë truncata.—All setæ are from the right foot of X :

Fig. 21.—Typical middle neuropodial. × 75.

Fig. 22.—A portion of the same seta. × 335.

Fig. 23.—A large middle notopodial. × 75.

Fig. 24.—A dorsal notopodial, entire. × 75.

Fig. 25.—Tip of a large middle notopodial. × 335.

Figs. 26–28.—Smaller dorsal, middle and ventral notopodials respectively. × 335.

Lagisca multisetosa.—All setæ are from the right parapodium of X :

Fig. 29.—A typical anterior elytron. × 14.

Fig. 30.—A small portion of the middle of the dorsal surface of the same. × 75.

Fig. 31.—A small portion of the posterior margin of the same. × 75.

Fig. 32, *a*, *b* and *c*.—Ventral, middle and dorsal neuropodials. × 75.

Figs. 33 and 34.—Tips of ventral and dorsal neuropodials. × 335.

Fig. 35.—A middle notopodial. × 75.

Fig. 36.—Tip of the same. × 335.

THE CLASSIFICATION OF THE ALEYRODIDÆ.

BY T. D. A. COCKERELL.

The American species of this homopterous family have been well treated by Quaintance (*Tech. Bull.*, 8, Div. Ent., Dep. Agric., 1900); in the following essay an attempt is made to classify and catalogue the species of the world.

ALEYRODIDÆ Westwood, 1840.

Adults of both sexes with two pairs of wings, which are rounded apically and appear more or less mealy; the edges of the wings are ornamented with a distinct sculpture or little bunches of bristles. Antennæ simple in form, seven-jointed; first two joints short and stout. Legs six, all well developed. Eyes often constricted in the middle, or even completely divided. Tarsi with two claws. Size always small.

Egg elliptical, with a short peduncle (fig. 9).

Larva oval, with short, stout legs.

Pupa quiescent, oval, often with a waxy fringe. Margin variously sculptured (figs. 4, 5, 6). Abdomen sometimes with large secretory pores (fig. 4). On the dorsal surface of the abdomen is an orifice, known as the vasiform orifice, provided with a more or less rounded flap, the operculum, and a usually elongate narrow two-jointed structure, the lingua (fig. 3).

Adult with the median vein of wings forked; pupa with the lingua large, ... ALEURODICUS.
Adult with the median vein of wings not forked; pupa with the lingua usually small, ... ALEYRODES.

ALEURODICUS Douglas.

Aleurodicus Douglas, Ent. Mo. Mag., Ser. II, Vol. 3 (1892), p. 32.

All the species belong to the warmer parts of America, except *A. holmesii* from Fiji, which was, I suspect, introduced from America with the *Psidium* on which it feeds. The adults are easily recognized by the venation of the wings (fig. 1), although *Aleyrodes* often has a fold which simulates a branch. The submedian vein has usually been considered a branch of the median, but it appears to have in every case a separate origin. The pupa of *Aleurodicus* is rather easily recognized by its large lingua, and the nearly universal possession of very large secretory pores along the sides of the abdomen. The margin of the pupa is often provided with hairs at rather distant intervals.

1. *cocois* (Curtis).
2. *anonæ* Morgan.
3. *dugesii* Ckll.
4. *iridescens* Ckll.
5. *mirabilis* (Ckll.), figs. 3, 4.
6. *minimus* Quaint.
7. *ornatus* Ckll., fig. 1.
8. *pulvinatus* (Mask.).
9. *altissimus* (Quaint.).
10. *perseæ* (Quaint.).
11. *holmesii* (Mask.).
12. *jamaicensis* n. sp., fig. 2.

Aleurodicus jamaicensis was collected by the writer at Kingston, Jamaica, in 1893. The pupa is small (hardly $1\frac{1}{2}$ mm. long), with vertical walls, margin resembling that of *pulvinatus;* color bright yellow, with a brownish dorsal cloud, and a diamond-shaped black patch just anterior to the vasiform orifice. Other characters are shown in fig. 2.

Subg. **DIALEURODICUS** n. subg.

Pupa without any profuse secretion or wax rods; no large secretory pores; adult with short spotted wings, the branch of the median vein more basal than usual. Type *Aleurodicus cockerelli* Quaintance, from Brazil.

ALEYRODES Latreille.

Aleyrodes Latreille, Hist. Nat. Crustacés et Insectes, Vol. XII (1804), p. 347.

Type *A. proletella* (L.).

The species average smaller than *Aleurodicus* and the median vein is not forked. The pupæ often have a lateral fringe of waxy rods or ribbons. As at present understood, the genus is cosmopolitan.

(1) Palæarctic Species.

1. *aceris* (Baer.).
2. *avellanæ* Sign.
3. *brassicæ* Walk.
4. *capreæ* Sign.
5. *carpini* Koch.
6. *dubia* Hegeer.
7. *fragariæ* Sign.
8. *fraxini* Sign.

9. *immaculata* Hegeer.
10. *jelinekii* Frauenf.
11. *loniceræ* Walk.
12. *phillyrea* Halid.
13. *prenanthis* (Schr.).
14. *proletella* (L.).
15. *quercûs* Sign.
16. *ribium* Dougl.
17. *rubi* Sign.
18. *rubicola* Dougl.
19. *spirææ* Dougl.
20. *vaccinii* Kūnow.
21. *xylostei* Westhoff.
22. *lauri* Sign.

(2) Ethiopian Species.

23. *asparagi* Lewis. (Natal.)
24. *bergii* Sign. (Mauritius.)

(3) Oriental Species.

25. *nubilans* Buckton.
26. *barodensis* Mask.
27. *cotesii* Mask.
28. *eugeniæ* Mask.
29. *aurantii* (Mask.).
30. *piperis* Mask.
31. *gossypii* (Fitch).
32. *lactea* Zehnt. (Java.)
33. *longicornis* Zehnt. (Java.)

(4) Australasian Species.

34. *sacchari* Mask. F.
35. *lecanioides* (Mask.). N.
    Syn. *papillifer* Mask.
36. *asplenii* Mask. N.
37. *aurea* (Mask.). N.
    Syn. *melicyti* Mask.
38. *fagi* Mask. N.
39. *simplex* Mask. N.
40. *banksiæ* Mask. A.
41. *cerata* Mask. N.
42. *comata* Mask. F.
43. *croceata* Mask. A.
44. *decipiens* Mask. A.
45. *fodiens* Mask. N.
46. *hirsuta* Mask. A.
47. *limbata* Mask. A.
48. *nigra* Mask. A.
49. *styphelicæ* Mask. A.
50. *T-signata* Mask. A.

Those marked A. are from Australia; N., from New Zealand, and F., from Fiji.

(5) Neotropical Species.

51. *phalænoides* Blanch.
52. *tinæoides* Blanch.
53. *aëpim* Goeldi. B.
54. *filicum* Goeldi. B.
55. *cockerelli* Von Ihr. B.
56. *floccosa* Mask. J.
57. *fumipennis* Hempel. B.
58. *goyabæ* Goeldi. B.

59. *horrida* Hempel. B.
60. *parva* Hempel. B.
61. *stellata* Mask. J.
62. *tracheifer* Quaint. M.
63. *vaporariorum* Westw.
64. *vinsonioides* Ckll. M. Fig. 6.
65. *lacerdæ* Sign.
66. *youngi* Hempel. B.
67. *struthanthi* Hempel. B.

A. vaporariorum occurs in hothouses in Europe and the United States, but is supposed to have originated in Brazil. In the above list, B. = Brazil, M. = Mexico, J. = Jamaica.

(6) NEARCTIC SPECIES.

68. *abnormis* Quaint.
69. *abutilonea* Hald.
70. *acaciæ* Quaint.
71. *asarumis* Shimer.
72. *aureocincta* Ckll.
73. *berbericola* Ckll. Fig. 8.
74. *citri* R. and H. (prob. introd. from China).
75. *corni* Hald.
76. *coronata* Quaint.
77. *perileuca* Ckll.
78. *melanops* Ckll.
79. *erigerontis* Mask.
80. *fitchi* Quaint.
81. *floridensis* Quaint.
82. *forbesii* Ashm.
    Syn. *aceris* Forbes.
83. *gelatinosa* Ckll. Figs. 5, 9.
84. *graminicola* Quaint.
85. *inconspicua* Quaint.
86. *mori* Quaint.
87. *mori arizonensis* Ckll.
88. *nephrolepidis* Quaint.
89. *nicotianæ* Mask.
90. *pergandei* Quaint.
91. *plumosa* Quaint.
92. *pyrolæ* G. and B.
93. *quercus-aquaticæ* Quaint.
94. *rolfsii* Quaint.
95. *ruborum* Ckll.
96. *spirœoides* Quaint.
97. *variabilis* Quaint. Fig. 7.
98. *vittata* Quaint.

A. mori arizonensis is the form on *Citrus* in Arizona, described in *Science Gossip*, 1900, p. 366.

Subg. **ASTEROCHITON** Maskell.

Asterochiton Maskell, Trans. New Zealand Inst. for 1878, Vol. XI, p. 214.

Type *A. aurea*. Adult with second joint of antennæ much longer than first; pupa broad, with four radiating bands of circular markings; vasiform orifice elongate. *A. lecanioides*, described also under *Asterochiton*, does not belong to the subgenus as here defined.

Subg. **DIALEURODES** n. subg.

Type *A. citri;* also includes *A. eugeniæ* and *A. aurantii.* Adult with second joint of antennæ much longer than first; eyes not completely divided; male abdomen with a large ventral waxy tuft on emerging from pupa. Pupa not fringed; vasiform orifice broad, lingua short; three radiating grooves, one posterior and two anterolateral, terminating peripherally in a star-shaped opening.

Subg. **TRIALEURODES** n. subg.

Type *A. pergandei.* This name is proposed for an American series (including *pergandei, variabilis, fitchi, ruborum, vittata, erigerontis,* etc.) in which the apical segment of the lingua is strongly crenulated. The posterior end of the vasiform orifice is often bifid.

Subg. **TETRALEURODES** n. subg.

Type *A. perileuca.* Pupa extremely dense, black, with a fringe of radiating waxy ribbons. Vasiform orifice shovel-shaped. Margin of pupa very regularly and strongly beaded; dorsum keeled. Includes also *A. melanops.* Occurs on the upper side of leaves of *Quercus.* Southern California and Texas.

EXPLANATION OF PLATE XV.

Fig. 1.—*Aleurodicus ornatus* (imago).—*A.* Venation of upper wing. *B.* Claw. *C.* Margin of wing.

Fig. 2.—*Aleurodicus jamaicensis.*—*A.* Vasiform orifice, etc. *B.* margin of pupa. *C.* Side view of pupa. *D.* Abdominal pore.

Fig. 3.—*Aleurodicus mirabilis.*—Diagram of vasiform orifice, etc.

Fig. 4.—*Aleurodicus mirabilis.*—*A.* Pupa, showing involuted margin. *B.* Edge of pupa (involuted). *C.* Abdominal pore.

Fig. 5.—*Aleyrodes gelatinosa.*—Margin of pupa.

Fig. 6.—*Aleyrodes vinsonioides.*—Margin of pupa.

Fig. 7.—*Aleyrodes variabilis.*—Vasiform orifice, etc.

Fig. 8.—*Aleyrodes berbericola.*—*A.* Margin of pupa. *B.* Margin of wing.

Fig. 9.—*Aleyrodes gelatinosa.*—Egg from body of female.

ABSORPTION AND SECRETION IN THE DIGESTIVE SYSTEM OF THE LAND ISOPODS.[1]

BY JOHN RAYMOND MURLIN, PH.D.

I. INTRODUCTION.

While the tendency at this day is to approach physiological problems chiefly from the experimental and the chemical standpoints, there is yet need of many morphological observations to supplement these more *ultimate* researches. The chemical history of the transformation of foods into tissues has advanced considerably beyond the morphological history, because until recently no means has been at hand for identifying them by morphological methods. Such determination has been begun by Fischer (1)[2] in his studies on the effects of fixing fluids on various proteid bodies and their derivatives.

Proteid foods have often been traced to the intestinal absorbing cells, and have been identified in the blood of many animals after having traversed the cells; but their course in passing through the intestinal epithelium and their relation to the various cell constituents have been little known. With the hope of throwing some

---

[1] Contribution from the Zoological Laboratory of the University of Pennsylvania.

[2] Numerals in parenthesis refer to bibliographical list at the end of the paper.

light on these and kindred problems, the present study was undertaken at the suggestion of Prof. E. G. Conklin, in the Zoological Laboratory of the University of Pennsylvania.

It is a pleasure to express at the outset my gratitude to Prof. Conklin, both for turning over to me a subject on which he had made many observations and for rendering great assistance by suggestion and direction throughout the course of the work.

II. Material and Methods.

Several features combine to make the digestive organs of the land isopods especially favorable for a study of this kind. The digestive glands are simple tubes made up of a single-layered epithelium, which is bathed by the cœlomic fluid. From this the cells derive directly the substances elaborated into the ferments; and the secretion discharged at their luminal surface is poured into the anterior end of the intestine, where it is mixed with the food, partially at least, as it enters. That portion of the intestine which performs an absorptive function likewise possesses a single-layered epithelium composed of very large cells. Without going into details here, it is enough to say that the size of the cells is equaled, sof ar as is known to the writer, by those of a similar absorbing organ of only one other animal, the larva of *Ptychoptera contaminata* (2). In a word, the plan of organization which is shared by the digestive system of all Arthropoda, has here been carried out with diagrammatic simplicity.

Whether we regard the organization of the intestine as an adaptation to the mode of life or the feeding habits as an adaptation to the organization, there is plainly a very nice relation between the two. Microscopical examination of the intestinal contents shows that in proportion to the quantity of digestible matter a very large part is wholly indigestible. Bits of dead leaves, wood fibres and various other masses of thick-walled vegetable cells, some clearer, thin-walled cells, which I take for hyphal cells of fungi, are among the most commonly observed substances.[3] In addition there are in the intestine numerous crystalline bodies, doubtless of an inorganic nature, the skeletal remains of insects, and micro-organisms. But the

---

[3] I have frequently seen pill-bugs eating edible mushrooms and have observed that they shun poisonous species.

scanty proteid content of such food is compensated for by the very efficient absorbing surface.

Judged by the number of pellets of waste, the quantity of food eaten seems prodigious. An animal kept in a clean dish on a piece of moist bark will cast from twenty to fifty in twenty-four hours. The number is about the same for all the species. Brought fresh from the natural state and deprived of food the number cast in a single night (about fifteen hours) averages, for a large number of counts, between five and six; in the next twenty-four hours the average number decreases to three. (This decrease is explained by the fact that only the anterior half of the "mid-gut" is provided with strong musculature. In the absence of muscles strong enough to empty the posterior portion, and with no fresh food to crowd back the remainder, its progress is very much slower; some of it, indeed, may lodge just anterior to the sphincter for as long as two or three weeks, where it may be recognized as a little black mass in the region under the first abdominal segments.) The anterior portion is emptied, as can be seen by holding the animal up to the light, during the first night. Since then five or six pellets represent the contents of the anterior half of the "mid-gut," the animal must eat, in the course of twenty-four hours, an amount which fills the intestine from two to four times.

The several indigenous species of terrestrial isopods are equally favorable. Those which I have used are *Porcellio spinicornis*, *Porcellio scaber*, *Oniscus asellus*, *Philoscia vittata* and *Cilisticus convexus*.

A reserve stock of animals, renewed from time to time, has been kept in the University Vivarium surrounded by the natural objects among which they were found—bits of bark, dead leaves, etc. Placed in large glass evaporating dishes, covered with a glass plate, on the under side of which was kept moist filter-paper for preserving the proper humidity of the atmosphere, the animals behaved in every respect as in the natural state. In the feeding experiments, to be described later, it was necessary first to empty the intestine of all food. The method commonly employed for this was merely to isolate animals in dishes covered as above described and cleaned once or twice daily. No difficulty was experienced in keeping the animals alive in this way so long as starvation was not too prolonged, provided only the atmosphere was kept moist by daily renewal of water in the filter-paper, and care was taken to leave no large drops of water in the bottom of the dish.[4]

Several observers have remarked the prolonged starvation which the isopods can withstand (Ide (3), Conklin (4), McMurrich (5), Schönichen (6)). No attempt has been made here to determine the ultra-maximum time; but in the course of the study an isolated animal has frequently been starved for more than a month. When several are starved together in the same dish, the time of absolute deprivation seldom reaches a month; some are sure to moult, or to become greatly weakened, or to die from some cause, when the legs and soft parts are then eaten by the others. While this does not necessarily terminate the fast for all, it does make impossible that determination of the fasting period which is often desirable. The only way to obtain this datum with certainty is to isolate the animals. For this purpose small flat-bottomed vessels of various dimensions, preferably all of the same height, so that they could be covered with the same sheet of glass and filter-paper, have been employed.

Various methods of removing the intestine have been tried.

---

[4] The latter precaution was necessary to guard against drowning. When by chance the breathing appendages are covered with water, if the animal is in its natural habitat or on filter-paper or other object which will take up the water readily, it very rapidly frees itself by dipping the abdomen, just as one might remove an extra drop of ink from a fountain pen by touching it to an absorbing surface. Kept on clean glass, however, the drop is not always removed, and the animal may die from suffocation or over-exertion, or both.

A greater difficulty was experienced in cases of prolonged starvation from cannibalism. Although in the main vegetable feeders, or scavengers at most, and particularly inoffensive toward other species of animals, these Crustacea will eat one another, if driven by hunger to this extremity. While some signs of offensive attack have been seen, such as a vigorous nip by one animal at the dorsum of another, plainly sufficient to inflict considerable pain, it would be unsafe to regard an act of this kind as a deliberate attempt to kill. Moreover, very young animals have been kept alive in the same dishes with adults through a month or six weeks of starvation. Individuals isolated in small slender dishes have often been seen to moult and to survive the ordeal just as in the state of nature. But if one moult (Sec. iii, (4)) in a dish with other starving animals or is greatly weakened by its efforts to remove a drop of water, it may fall an easy victim to the hunger of its starving companions. The cannibalism to be guarded against is, therefore, of an accidental sort, and arises from an instinct to keep the intestine full. The same instinct prompts the animal in similar circumstances to eat anything it can swallow, although it is not intended by this to imply that no choice is exercised in the selection of its natural food. Mention will be made in a later section of the care necessary to induce animals which have been fasting a long time to eat the pure foods with which it is desirable to feed them.

Dissecting under fluids in the ordinary manner is not satisfactory because of the small size of the animals. McMurrich's (5) method of placing the animal in the killing fluid, and with a needle in each end pulling him asunder; or that employed by Conklin (4) of first removing the head, and then pulling out the intestine by catching the tail segment with a pair of forceps, is much more rapid. In either case the intestine breaks at the junction of the anterior portion, or stomach, with the middle portion, or "mid-gut." For obtaining the intestine and the glands with their connection preserved, the posterior one or two segments are cut off with scissors and the organs removed by pulling on the one or two anterior segments with forceps. The whole mass is easily handled, and the normal relation is preserved through all the fluids. I have usually dissected off the harder chitinous parts of the head in oil just before embedding.

It has been necessary to give special attention to the means and methods of fixation. As will appear more clearly later, the form and relation of the cellular constituents depend upon the direction of penetration of the killing fluid, as well as upon the strength of the fluid employed. By the usual method of plunging the organs directly into the killing fluid the penetration is, of course, from the cœlomic toward the luminal side of the cell. For the purpose of obtaining penetration from the luminal toward the cœlomic side of the intestinal cells an hypodermic syringe was filled with killing fluid, and the needle, made blunt by turning back the point, was inserted through the mouth into the anterior portion of the mid-gut. Then the posterior segment having been cut off as before to free the posterior attachment of the intestine, all the segments back of the second thoracic were slipped off together by holding the anterior end with one pair of forceps and pulling with another. In a few cases I was able to obtain a fairly good injection by inserting the needle after extracting the intestine; but since it always suffers more or less from handling, and it is always difficult to insert a needle into a collapsed intestine without tearing it, the former proved the safer if the more cruel method.

The following killing fluids have been used: *a*, ninety-five per cent. alcohol; *b*, saturated aqueous solution of corrosive sublimate; *c*, the same with addition of two per cent. acetic acid; *d*, picroacetic after Lee, and *e*, after Conklin; *f*, Zenker's fluid; *g*, picro-formalin; *h*, formo-alcohol; *i*, osmic acetic; *j* osmic-bichromate (Altmann's);

k, Flemming's; *l*, Hermann's, and *m*, Hermann's without acetic (one per cent. platinic-chloride 15 parts, one per cent. osmic acid 4 parts). For minute cytological details I have relied most on *a*, *k*, *l*, *m*, because these are most faithful to the structure in fresh cells. Further consideration of the effects of fixation on the different cell constituents and the metabolic contents will be taken up under the appropriate heads.

For studying the structure in fresh cells, the organs were mounted in the blood of other animals of the same species, as follows: Upon a slide a small rectangular fragment of cover-slip was supported by a fragment of glass of suitable thickness, the other end resting on the slide. The blood was now squeezed out of a decapitated animal in the form of a large drop, which, applied to the edge of the cover-glass, was drawn under by capillarity. From one to two dozen animals, according to the size, are required to furnish sufficient blood for a single intestine. The medium having been thus prepared, the organs were drawn out of the animal, placed on the slide, and arranged near the supporting glass parallel to the junction of the two fragments. The quantity of blood was then noted by a mark indicating its level on the cover-glass, and this level was maintained by adding distilled water as water was lost by evaporation. The chemical changes accompanying coagulation of the blood do not seem to affect the cells at all within the first half-hour. Post-mortem changes, however, do occur after an hour or two. Consequently no structure as seen by this method has been trusted beyond thirty minutes from the time of preparation.

Most of my observations have been made on serial sections prepared in the usual manner. Both "liver" and intestine were sectioned, stained and mounted on the same slide. The stains upon which most reliance has been placed are iron-hæmatoxylin, Biondi-Heidenhain, Flemming's triple, Hermann's triple and Altmann's acid-fuchsine-picric-alcohol. The effects of these on the various parts will be mentioned from time to time.

III. Description of the Digestive System.

1. *Gross Structure.*

It will be necessary to recall the gross structure of the digestive system, as this can be made out with the naked eye or a dissecting microscope.

1. *The intestine* takes the most direct course possible from the mouth to the anus. Three chief divisions are generally recognized: *the anterior*, consisting of the œsophagus and grinding stomach (*kaumagen*, *poche malaxatrice*); the *middle* ("mid-gut," *intestine moyen*), in which three divisions will be recognized, and

the *posterior* or rectum. Only the middle intestine concerns us in this paper. Its anterior portion is of slightly larger diameter than the posterior (fig. 1). The lateral walls are perfectly straight;

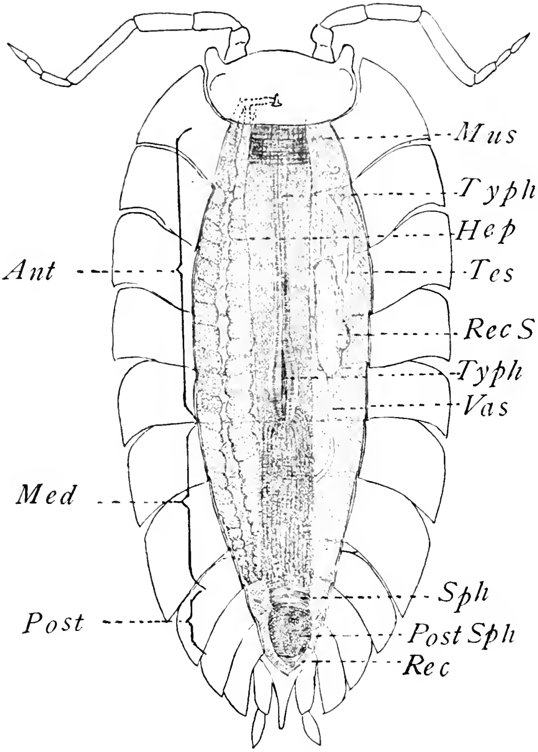


Fig. 1.—*Oniscus asellus* (male, 12 mm.) × 10.—(In this and following figures mm. refers to the length of the animal, measuring from the anterior margin of the head of the segment to the end of the uropods.) Slightly diagrammatic drawing to show relation of the digestive organs. *Ant.*, *Med.*, *Post.*, anterior, median and posterior portions of the "mid-gut"; *Mus.*, muscular coat of intestine, shown only at extreme anterior end of "mid-gut"; *Typh.*, typhlosole; *Hep.*, hepatopancreas; *Tes.*, testis; *Rec.S.*, receptacle of sperm; *Vas.*, vas deferens; *Sph.*, sphincter muscle; *Post Sph.*, post-sphincter; *Rec.*, rectum.

the transition from the anterior larger to the posterior smaller portion is very gradual. The only break in the uniformity of the wall back to the sphincter is a dorsal longitudinal furrow, bounded by two slightly projecting ridges, which extends from the extreme anterior end of the "mid-gut" to a point opposite the junction of the fifth and sixth thoracic segments. At the anterior end of its posterior third the structure thus presented widens out so that, as Ide (3) says, "it terminates like a spatula." The furrow is due to an infolding of the epithelium along the mid-dorsal line (fig. 3), which then spreads out laterally within the lumen, fitting into or covering the secondary grooves formed by the projecting ridges. Following Conklin (see Sec. vi), I shall call the entire structure, grooves and ridges, the *typhlosole.* The "mid-gut" is uniform in size from the posterior end of the typhlosole to the region of the fourth abdominal segment. Here it is considerably constricted by a strong sphincter muscle pinching off, so to speak, a small posterior portion of the "mid-gut," which has already been spoken of as the post-sphincter, and which moulds the pellets of waste before they are ejected. The typhlosole and sphincter mark off three convenient subdivisions of the "mid-gut": the *anterior,* containing the typhlosole and reaching to its posterior end; the *median,* from the end of the typhlosole to the sphincter muscle, and the *posterior,* including that portion covered by the sphincter, and the post-sphincter portion as far as the rectum.

2. *Glands.*—Huet (7) has described for *Ligia* a pair of salivary glands lying on the posterior ventral wall of the œsophagus and opening by an extremely narrow aperture into this portion of the canal. He has demonstrated that they are salivary glands by dissecting them out in alcohol (which does not destroy diastase) and placing potato starch in a watery extract. Dextrose was detected after twenty-four hours. Ide (3) considers these glands as cutaneous appendages, disputing their connection with the œsophagus, although admitting that they *may* be concerned in digestion. On account of their very small size and the uncertainty of their morphological nature, no attention has been given them in this study.

The only other digestive gland with which we have to do in the isopods is the *hepatopancreas.* It consists, in the forms studied, of two pairs of blind tubes, placed a pair on each side of the intestine, into which they open, at the anterior end, by a ⊥-shaped aperture. The two tubes on the same side unite into a transverse canal which joins that of the other side at the aperture. The tubes extend almost the entire length of the body cavity, their tapering blind ends reaching into the abdominal segments (fig. 1). It is to Weber (37) that we owe the recognition of the mixed nature of this gland and the application to it of the name *hepatopancreas,* introduced by Krukenburg (24) for the analogous organ of fishes.

2. *Microscopic Structure of Intestine.*

The wall of the "mid-gut," as of the other divisions of the intestine, is made up of four coats which have been recognized by all the later writers. Beginning with the outer or cœlomic side, these are the *muscular coat,* the *basement membrane,* the *epithelium* and the *intima* or chitinous lining. The muscular coat has been fully described by Ide (3) and Schönichen (6). It consists of two layers, an outer longitudinal and an inner circular. Over the anterior portion of the "mid-gut" (*i. e.,* as far back as the typhlosole extends) the outer is imposed upon the inner; posterior to this both layers thin out so that the fibres are quite widely separated from one another, each one running in the groove between adjacent rows of cells. They also fuse together and anastomose freely, so that a muscular network is formed, through the meshes of which the cells project. The sphincter, according to Ide, is an additional layer lying outside the longitudinal and constituting a second circular one. The inner circular layer is very much reduced at this place, so that only a few fibres appear.

The other coats, as McMurrich has indicated, properly belong to the epithelium. Both the basement membrane and the chitinous lining are formed by the epithelial cells. The former is a smooth membrane of uniform thickness which accommodates itself to all the irregularities of the outer surface, dipping into the dorsal furrow and keeping closely applied to the cells. We have already mentioned the very large size of the epithelial cells. As Ide observed, they are often to be seen with the naked eye. They are represented in fig. 1 for *Oniscus asellus,* 12 mm. long, magnified just ten diameters. Those in the median portion of the "mid-gut" are most easily seen, because only partly covered with muscle. Their ends, projecting freely into the cœlome, appear as little mounds on the contour line. Another striking feature of the epithelium is the rectangular arrangement of the cells in longitudinal and transverse rows. One exception occurs at the posterior end of the typhlosole, at which point the longitudinal rows converge, so as to form, as Schönichen says, " parallel parabolas, making a picture in optical section not unlike a longitudinal section through a vegetative point." While the rows elsewhere are rectilinear, they are not often continuous from one end of the " mid-gut " to the other. I have often seen longitudinal rows which terminate some distance from the end. Discontinuous transverse rows have also been seen. Ide's fig. 19 shows these features, which are supported further by his statement that only the median two ventral rows can be followed uninterruptedly from the anterior to the posterior end.

(1) *Growth of Intestine.*

At first sight the number of rows of cells appears definite and constant enough that one might name the cells as city blocks are named, and might even find cell homology between different individuals. This character has been mentioned by all the authors since Lereboullet (8) (Huet, Ide, Conklin, McMurrich, Schönichen), and McMurrich has attempted to show that the number is constant throughout the life of an individual. McMurrich's attempt is based on the non-occurrence of cell division. No observer except Lee (9), who regarded certain deformed nuclei stretching from one cell to another as remains of the spindle (*fuseau de regrèssion*), has seen any sign of mitosis, and McMurrich says: " I have never been able to satisfy myself that normal amitosis actually occurs." He seemed to be justified, therefore, in the attempt (which by his own confession is not wholly successful) to show that growth of the intestine takes place by enlargement of the cells *rather than* by multiplication.

Amitosis.—In young individuals amitosis is by no means rare. Fig. 2, *A*, *B* and *C*, show some of the stages which are easily found at this time. Fig. 2, *A*, is a longitudinal section exhibiting the relative sizes of cells whose nuclei have just divided, and of those recently constricted off. Conklin (*l. c.*) has rightly interpreted this constriction of the cells, and has figured what he regards as an amitotic division. It would appear from fig. *A* and fig. *B* (which is a horizontal section showing division in the transverse direction) that the nuclei may completely divide and move some distance apart before constriction of the cytoplasm takes place. From one or two observations made on very young porcellios in process of moulting, I am led to think that the constriction may even be postponed until the next moult of the intestinal lining. The old intima evidently would present considerable resistance to the formation of a furrow, which is always to be seen in the intima between

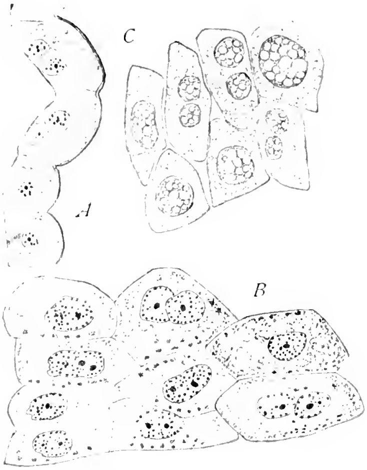


Fig. 2.—*A*, longitudinal section of intestine of a young *Porcellio* (3 mm.); *B*, transverse section of the same; *C*, optical section of intestinal cells of young *Porcellio* (1.8 mm.) immediately after moult of the posterior half. All these figures illustrate growth of the intestine by amitosis. *A* and *B* × 280, *C* × 600, nuclei in *C* show post-mortem changes.

cells. Moreover, there is nothing to indicate that the nuclei represented as already separate in these figures (*A* and *B*) have not been so for a considerable time, while the frequent occurrence of two nucleated cells, with no other sign of division, would speak strongly for this.

Several authors have reported cells with two or three nuclei, and Carnoy (10) finds as many as ten to thirty nuclei in the intestinal cells of *Cirolana*. So large a number is due, I have abundant reason to believe, to fragmentation of the nuclei, not to amitosis, as Carnoy states (*l. c.*). Schönichen discredits McMurrich's evidence (to the same effect as my own), holding that the fragmented nuclei resolve on focusing carefully into the nuclei of the muscle fibres. He evidently has not seen the phenomenon reported by McMurrich. Space does not permit an account of the unquestionable cases of fragmentation which I have seen. A whole plate of figures might be given of cells containing from a dozen to twenty-five fragments of the nucleus. No explanation of the phenomenon can be given at present further than to say that there are many reasons to regard it as pathological, or "degenerative" in Löwit's sense (see page 296).

I have found the intestine of a young *Porcellio*, 1.8 mm. in length, which had recently moulted the posterior half (Sec. iii, (4)), to be literally filled with amitotic division, both longitudinal and transverse, throughout its length (fig. 2, *C*). Many nuclei were in process of division; those already separated were approximately half the volume of others not yet beginning to constrict. There can be no doubt that the large number of divisions was correlated with the increase in size of the intestine immediately following the moult. It seems equally plain that two nucleated cells which are larger than adjacent ones, as in fig. 2, *A*, may represent precocious nuclear divisions, the constriction which will divide the cell being deferred to the next moult, when the luminal end of the cell will be free to cover the new furrow, as well as the old surface, with chitin.

It is evident that amitosis has been seen in the isopod intestine by a number of observers. Carnoy (10) claims to have seen "the constriction of the nucleus in the epithelium of the intestine of the Crustacea, *e. g.*, *Oniscus asellus*, *Ligia*, *Armadillo asellus*, *Idotea*, *Cirolana*, etc." He figures amitosis in the testicle cells of the isopod, and says these represent exactly what is to be seen in the nuclei of intestinal cells, so far as the phenomena of division are concerned. It is possible, however, that Carnoy, as McMurrich and Schönichen think, may have mistaken distortions of the nucleus for amitosis. Indeed, v. Bambeke (11) refers to one of the figures given by Carnoy as a deformed nucleus. Ziegler and vom Rath (12) say that the "mid-gut" of *Oniscus*, *Porcellio*, *Cymothoa* and *Anilocra* show amitotic nuclear divisions with special clearness and very abundantly ("besonders deutlich und recht häufig"); but as will be seen under the subject of *the nucleus* later, and as was recognized by Schönichen, it appears probable that they, too, confused with amitosis certain distortions of the nucleus. Conklin says, speaking of elongated nuclei extending into two cells, "some of these, I am convinced, are amitotic divisions of the nucleus." Since these observations have been called in question by McMurrich on the basis of the very frequent misjudgment of irregularly shaped nuclei, it has seemed worth while communicating my own observations. In conclusion, I may say there is no possible doubt that amitosis does actually occur in the growing intestine, nor any doubt that it has here the same significance which Frenzel (13) ascribes to the phenomenon in the mid-gut of *Astacus* and other decapods, namely, a true cell multiplication ("nicht einzig und allein eine Kernvermehrung, sondern ebensowohl auch eine wahre Zellvermehrung," p. 559).

In other words, it is a "regenerative" as distinguished from a degenerative process. Löwit (14) distinguishes between these two in the following: "Die erste führt nach meine Auffassung zur Neubildung von Kern und Zelle, die letztere kann mit sekretorischen und assimilatorischen Vorgangen im Zellleibe zusammenhängen und durfte wahrscheinlich in vielen Fallen der ausdruck eines bevorstehenden Kern und Zelltodes sein."

(2) *Origin of the Typhlosole.*—In specimens of *Porcellio spinicornis* 1.8–2 mm. long I have been able to follow the origin of the typhlosole. This structure, as we have seen, is but an infolding of the mid-dorsal wall of the "mid-gut," accompanied by a secondary outfolding on either side which appears as a ridge; but it is so definite in form as to be plainly a specialization as well, and my observations show that its development is a progressive one. Cross sections of the anterior portion of the "mid-gut" in animals just hatched show a perfectly uniform unfolded wall, the typhlosole not yet to be seen. In fig. 3, *A*, of a specimen 1.8 mm. long (taken in February and therefore probably several months old), the section is from the extreme anterior end; the next (fig. 3, *B*) is only six sections (about .04 mm.) farther back. The latter shows the earlier stage. The mid-dorsal portion of the wall is bulged out over a considerable extent of the circumference. The cells composing the bulged portion are very open in structure, like

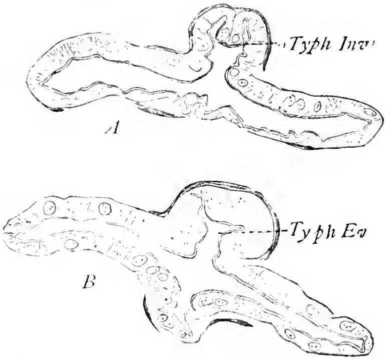


Fig. 3.—Transverse sections of empty intestine of a young *Porcellio* (1.8 mm.). × 180. *A*. At extreme anterior end of the "mid-gut"; *B*. Sixth section (.04 mm.) posterior to *A*.; *Typh.Ev.* Primary evagination in formation of the typhlosole; *Typh.Inv.* Secondary invagination of median two rows of cells which form the middle portion of the typhlosole.

those found in the extreme posterior end of the adult typhlosole. They are larger in all dimensions than those in the rest of the wall, so that the effect is such as would be produced by swelling. Since I have found the structure identically the same in five different individuals of the same age, killed in three different fluids, it seems certain that the swelling is normal and due to some intrinsic growth energy. Fig. 3, *A*, shows that the evaginated or bulged portion on the dorsal side is but preliminary to an invagination of the median two cells whereby the mature form of the typhlosole is approached. These cells have only to grow farther into the lumen and to expand laterally, so as to cover or fill the inner grooves formed at the sides, in order to attain the adult form. The invagination may involve more than these two cells; the stalks separate at their bases later, as shown in fig. 4, *A*, so that the division between these and the next cells must be purely arbitrary.

In the anterior portion the cells rapidly recover from the swelling which is so plain a feature at the first evagination (figs. 3 and 4), while in the posterior portion they retain this loose structure permanently (fig. 4). Here also the middle cells are not turned in so far, while the lateral extension at their luminal border is rather wider than it is farther anterior. The posterior portion of which we have been speaking is the spatula-like enlargement men-

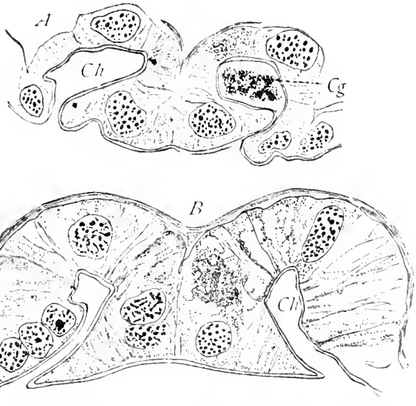


Fig. 4.—Transverse sections intestine of young *Oniscus* (4.4 mm) × 270: *A*, through anterior portion of the typhlosole; *B*, through posterior end of the typhlosole, same magnification; *Ch.*, channel for passage of secretion or liquid food; *Cg.*, coagulum of secretion of hepatopancreas. *B* shows the effects of killing fluids on the large cells of the typhlosole.

tioned on page 291). It will appear evident from figs. 4, *A* and *B*, that six rows of cells, counting by the nuclei, are involved in the typhlosole.

(3) *Syncytium.*

The very large cells which compose the adult "mid-gut" were recognized by Huet to be without distinct parietal walls, but to be bounded by rows of fibres. Ide figures cell walls for *Oniscus murarius*, and thinks Huet was in error or overlooked them. Almost simultaneously McMurrich and Schönichen put forward the view that the epithelium is in reality a syncytium, the walls being replaced by fibres which run from the intima to the basement membrane. Both authors show that what Ide saw is undoubtedly the chitinous lining, dipping in between the anterior cells on the luminal side and the basement membrane, which has a similar relation to the cœlomic side of the median cells. The syncytial nature they argue further from the facts that the cells cannot be separated by maceration in potash (a thing which Ide claims to have accomplished); that neither silver nitrate nor other stains differentiate cell walls; and finally, that the nuclei may be squeezed through from one cell into another. Ryder and Pennington (15), who described these movements of nuclei as a natural phenomenon (see page 304), figure cell walls, but do not state what becomes of them when the nuclei pass through. Conklin, in showing that the changes of position on the part of the nuclei are due entirely to rough treatment, says: "The parietal walls are so thin that they cannot be distinguished." My own observations confirm those of the later writers. In the majority of cases of adult intestines where I have looked for them, no sign of a wall is to be seen. Figs. 15 and 16 represent the cytoplasm as perfectly continuous from one cell to another.

We have already spoken of the grooves which separate the anterior cells on the luminal side. On account of these grooves the intercellular fibres are shorter than the cell axes. The same is true for the cells of the median portion and for those of the transitional region, but for a slightly different reason. While the intima does not dip in between the median cells, the latter project into the cœlome at their centres more than at the edges (fig. 12). The cells in the transition region immediately posterior to the typhlosole show an intermediate condition; the intima does not dip in so deeply between the cells as in the anterior (fig. 21), and the cells do not project so far into the cœlome as in the median portion. The intercellular fibres consequently are again shorter than the cell axis.

Inside the cells, as has often been described, occur other fibres taking the same course from the intima to the basement membrane. Their disposition is varied, sometimes in bundles, as in fig. 4, or singly, as in fig. 9. Again they may be strong throughout their length, as in fig. 4 (usually so in the typhlosole), or may thin out at one end, as in fig. 9. In sections they cannot often be followed continuously from intima to basement membrane because their course is not often straight. They are more frequently straight in the typhlosole where they are thicker than elsewhere (figs. 3 and 4). Where the fibres approach the intima or basement membrane they are parallel and nearly always straight. This gives the so-called "striated" border which has so often been described for the "mid-gut" of isopods (Lereboullet, Leydig (16), Huet, Ide, McMurrich, Conklin, Schönichen). The great regularity of the fibres along the intima is due to a thickening of them for a short distance in, thereby producing what Schönichen calls the "Bälkchenzone." Both McMurrich and Schönichen regard this thickening as due to a deposition of chitin on the fibres, basing their conclusion on a refractive index in the fresh condition, and on a staining reaction in the preserved material, similar to that of the inner border of the intima. Practically all authors agree that the thickened ends are continuous with the intra-cellular fibres. I shall designate this zone of thickened fibres by the term *palisade*, by which I would emphasize merely the parallel arrangement of the fibres at their ends. Very often the spaces between the thickened ends are empty of cytoplasm, which of course strengthens the impression of a separate zone. This zone does not have definite limits, as can be seen in starved cells, where it may extend into the cell as far as the nucleus. In such a case the only difference discernible in the course of the fibres is that they are slightly thicker at the luminal end. Again, as may be seen in figs. 9 and 11, the cytoplasm fills the intervals between the fibres all the way to the intima. Thus the width of the zone may vary from *nil* to more than half the thickness of the cell, according, as we shall see, to the physiological condition of the cell.

McMurrich speaks of the brittleness of the fibres, inferring this property from their cleavage in sections. Conklin calls attention also to the fact that they sometimes curl at the end when cut, and are therefore elastic. I have seen both of these effects, and would add merely that I have seen them in the intercellular fibres and those of the typhlosole more commonly than elsewhere.

Ide regarded the fibres as mere thickenings of the cytoplasmic reticulum, a view in perfect consistency with the reticular theory to which he holds. McMurrich does not agree that they are mere thickenings, and insists that they are entirely independent of the reticulum. McMurrich is quite right in affirming this independence, as many of my figures will show; nevertheless, it is true, as he discerns, that the fibres are cytoplasmic products. The only exception I would take to his view is with reference to their origin. He states that "in very young specimens of *Porcellio* and *Armadillidium* no trace of the fibres is to be discovered; and in a specimen of *Oniscus* measuring only 4 mm. in length they are but slightly developed, projecting into the cytoplasm from the basement membrane [from which they develop] but a short distance." Unfortunately McMurrich does not state how large his "very young specimens" were. In the youngest specimens of *Porcellio* which I have sectioned (less than 1.8 mm. in length) the fibres are already very evident, although as is to be expected not so strongly developed as in the larger specimens (figs. 2 and 3). I have also sectioned the intestine of an *Oniscus* measuring only 1.8 mm., and find the fibres stretching *all the way through* the cell. I cannot say how early the fibres arise, for these were the youngest individuals to be had in the fall of the year. Unquestionably McMurrich saw fibres which were cut obliquely and which *appeared* not to extend all the way through the cell. The figure to which he refers is evidently from a moulting animal (see fig. 8, page 309). There does not appear to be very good reason for inferring the origin of the fibres *from* the basement membrane merely because they can be traced *to* the membrane. My figs. 11, *B*, and 12 exhibit complete continuity between basement membrane and fibres. A safer conclusion from the facts would be that the fibres and membrane are both formed by the cytoplasm and *may* be formed in continuity. This would account for the appearance of a cell membrane in fig. 12.

a. Cytoplasm.

The earliest observers saw in these cells the fibrillar structure of the cytoplasm only. Leydig (17) states that what he described in former papers with lower powers as lines (" dicken granulären streifig erscheinenden Zone "), he now makes out to be a " fadiges Balkenwerk dessen einzelne Saulchen ausserdem nicht glattrandig sind sondern seitlichen Zacken haben, durch deren gegenseitige Verbindungen ein zartes netziges Wesen zwischen ihnen entsteht." Ide says, " The partisans of the fibrillar structure of protoplasm as opposed to the reticulated may see here an object very favorable to their thesis" (*l. c.*, p. 158). He recognized, however, as did Leydig, the falsity of such a view, and both authors commit themselves to the reticular structure.

Later writers also have described this structure more or less explicitly. McMurrich says: " The cytoplasm in young specimens has a uniform finely reticulated structure, but this is replaced in the adult by a much less uniform arrangement." Conklin says, in speaking of the disappearance of the nuclear membrane: " The cyto-reticulum is continued into the nucleus," etc. Schönichen finally accepts this structure also, and Hardy (18) figures a "net" structure for the fixed cells of *Oniscus*.

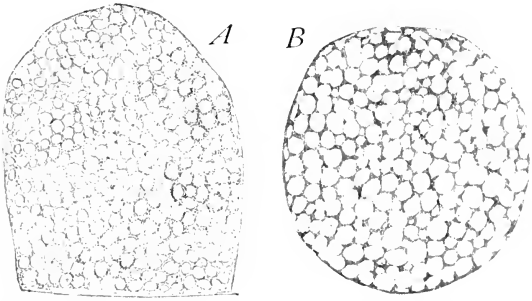


Fig. 5.—Optical sections of: *A*, cytoplasm; and *B*, nucleus of median absorbing cells of *Porcellio*, showing alveolar structure. Drawn with camera lucida from fresh cells, × 925.

None of the authors named seems to have studied the fresh cells. If a fresh intestine be mounted in blood (see page 289), and one attempts to draw the structure as it may then be seen with high powers, he will soon be convinced that the reticular is not the true structure. In all cases I have by this method found the structure to be alveolar (figs. 5, 6, 11).[5] This structure was observed in the fresh cell long before finding a fixation which preserves it. Subsequently, by examining very carefully with high powers sections from an in-

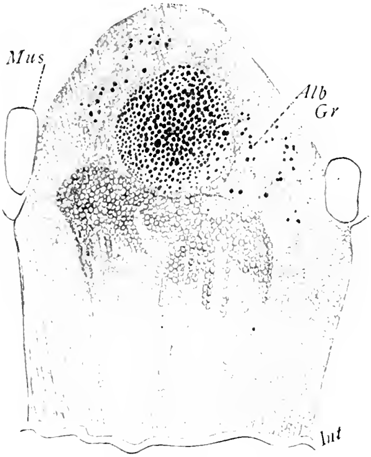


Fig. 6.—Cell from median portion of the "mid-gut" of *Oniscus asellus*, fixed in 1 per cent. platinic chloride 15 parts, 1 per cent. osmic acid 4 parts, sixteen hours after feeding, and stained in iron hæmatoxylin. Drawn with camera lucida, × 600. The alveolar structure of the cytoplasm is preserved. The shaded portion below the nucleus indicates an artifact produced by unilateral penetration of the killing fluid (see page 306). The alternation of fibres and alveoles is shown. *Alb. Gr.*, albumose granules; *Int.*, intima; *Mus.*, muscle.

---

[5] It is possible that even this structure is due to "sub-mortem" changes, as Hardy indicates. I have made many attempts to discover the alveolar structure in the gut of very young, transparent animals while still living; but without success. Nevertheless it would be premature to conclude from Hardy's studies on artificially prepared colloids alone that there is no formed structure in the living protoplasm. Should this be shown in time, we should then necessarily conclude that the coagulation incident to the "sub-mortem" changes is practically instantaneous, since the structure shown in Fig. 5, can be seen *as soon as* the preparation can be made (within one-half minute from the removal of the intestine). Pending further studies on this subject, I refrain from calling this alveolar structure, living.

It should be said that this paper was in press before Hardy's very suggestive one on "Structure of Cell Protoplasm" was seen.

testine fixed in Hermann's without acetic, I found the alveoles well preserved (figs. 11, *A*, 12, etc.).[6]

Two obstacles appear to stand in the way of recognizing the alveolar structure by ordinary methods. In the first place, the interalveolar substance, concerning which more will be said later, precipitates in the form of granules in the interstices between the alveoles, so as to look much like the nodes of a reticulum. In the second place, the contents of the alveoles precipitate also as fine granules on the alveolar walls. So that after sublimate-acetic fixation, for instance, the effect is precisely what one would expect from a reticular structure. The best conditions, therefore, for observing the true cytoplasmic structure would be where the interalveolar substance is less abundant, and the contents of the alveoles is slightly or not at all precipitated. Fig. 6 represents such a place; Fig. 7, *A*, is also favorable in places (*e. g.*, centre near the top). In the former figure the alveoles are represented by continuous lines as they should be; but for representing the combined effect of alveoles and granular substance, it has been necessary in the interest of simple drawings to adopt the conventional method seen in all the other figures. In fig. 6 it will be seen that the fibres have a very definite relation to the alveoles; often in this intestine, and in many others, the alveoles are plainly between fibres, and the fibres between alveoles as represented. This structure is easily seen in the free ends of the median cells of a fresh intestine mounted in blood. It is easy to understand how Ide and later writers should have mistaken this arrangement for the reticular, and should have supposed that the fibres are joined by trabeculæ. Ide seems to have recognized the independence of the fibres, where he says: "If it were shown that

---

[6] The fluid was suggested to me by Misses Foote and Strobel (19), who were able to preserve the alveolar structure (hyaline globules) of the eggs of *Allobophora fœtida* in it much better than in any other fluid. Their photographs of the living egg and of the structure as preserved by this fixation, which I have been permitted to see, are very convincing. Use had been made of this fluid to some extent early in the study, but as the nucleus appeared not to be so well preserved as with other fluids, it was set aside temporarily; more recently it was employed throughout a series of physiological stages, with results far more satisfactory for many purposes than were obtained with any other fluid. However, the alveolar structure has been met, occasionally very well preserved, after Hermann's, Flemming's, picro-formalin, and sublimate acetic (fig. 10, *B*). Ordinarily with these and all other fluids, except the platinic-chloride and osmic acid mixture, the structure appears to be reticular.

in certain cells strongly differentiated and old, such as those with which we are dealing, there exist fibres without connections, nothing would stand in the way of admitting that certain trabeculæ break their bonds and are isolated," etc. (*l. c.*, p. 158). The apparent connection of fibres with reticulum is due to bad fixation. Sublimate-acetic, Hermann's, usually Flemming's, and a number of other much trusted fluids produce a similar effect; but it is not the picture one gets in the fresh cell, the structure of which is not difficult to determine.

The alveoles measure on the averagee 2μ in diamter in all ages-Between them in the fresh cell is a substance in which I have not been able with a $\frac{1}{12}$ immersion to recognize granules or any other formed elements. Granules do appear at times about the nucleus, but these have no part in the ground structure. With nearly all fixations, except possibly alcohol and formo-alcohol, the homogeneous interalveolar substance precipitates in the form of fine granules visible with the immersion lens.

b. Nucleus.

aa. Form.—The nucleus of the "mid-gut" cells has been the object of several investigations within the period of modern technique. In 1885 Carnoy probably mistook some unnatural forms of the nucleus for stages of amitosis. In 1887 v. Bambeke described many of these unnatural forms in the "mid-gut" cells of *Oniscus* and other isopods, which may be produced artificially. His method was to examine the intestine in blood of the animals, either with or without the addition of methyl green. For permanent preparations he fixed in osmic acid, stained with methyl green, and mounted in glycerine. He recognized clearly that the irregular forms, frequently found in such preparations, were due to some mechanical disturbance.

Ziegler and vom Rath, like Carnoy, doubtless erred in supposing the elongated nuclei to be in process of division. Ryder and Pennington, overlooking v. Bambeke's paper, described elongated nuclei stretching from one cell to another as a form of non-sexual conjugation of nuclei. All subsequent writers have recognized that for the most part these deformations are due to mechanical causes incident to preparation of the intestine for study. Schimkewitsch (20), in calling attention to this error, says: "Bei Bearbeitung mit Perenyischer Flussigkeit erhielt ich mit Leichtigkeit alle jene Figuren, welche diese Autoren abbilden." Conklin showed that, by pressing a particular part of the intestinal wall with a pencil point, all the nuclei in this region were caused to stretch out in a radial manner from the place pressed. McMurrich distinguished between irregular forms found after rough treatment, and those which he regarded as natural. Schönichen declares that he never found any but spherical nuclei in well-preserved intestines.

McMurrich and Conklin thought the nucleus might be more or less amœboid in life, like those described by Korschelt (21) for the egg-cell of *Dytiscus*, and that not all the processes found in carefully mounted intestines were abnormal, but might be an index of the physiological condition. The processes stretching toward the lumen in fixed preparations were regarded as specializations for receiving food from that direction. For a time this seemed to me to be the state of affairs, and a number of sketches were made representing what seemed to be the escape of nuclear substance also from the processes toward the lumen. Processes of greater or less size were found on this side after all fixations, and it appeared that they must therefore be normal; yet I could not see them in fresh cells of any physiological condition. Finally, at Prof. Conklin's sug-

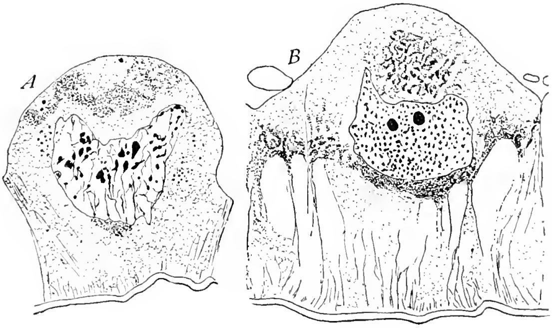


Fig. 7.—Cells × 600 from "mid-gut" of *Porcellio*, showing artifacts produced by injection of fixing fluids into the lumen of the intestine and consequent unilateral penetration by the fluid. *A*, injected with Hermann's fluid; *B*, with picro-acetic (after Bolles Lee). The nuclei exhibit "amœboid" processes.

gestion, several intestines were injected with killing fluid, to see if penetration of fluid from the lumen would cause processes toward the cœlome. The result is shown in fig. 7, *A* and *B*. Nothing could be more convincing. The processes of the nucleus, and in large measure all deviations from the spherical, or at least regularly curvilinear outline, are to be regarded as due to fixation. The latter are the forms found in the living cell, and they are the only ones considered in this paper to be perfectly normal.

bb. Structure.—Several authors have described more or less minutely the structure of the nucleus in fixed material. In adult cells after fixation it is filled with large granules of chromatin, between which are traces of linin. From one to many nucleoli are always more or less distinct. In young cells the chromatin is not so abundant, as McMurrich figures, and as may be seen from figs. 2 and 3. With neutral fixations like formo-alcohol, oxychromatin may be distinguished.

v. Bambeke seems to be the only author who has hitherto studied the nucleus in fresh material. From evidence furnished by the distorted nuclei, he says: " L'étude des noyeaux étrirés permet de conclure à une consistance visqueuse des parties constituantes du noyau, notammuent des filaments nucléolaire et de la substance intermèdiaire; les nucléoles (nucléoles plasmatique) présentent une consistance plus forte et resistent d'avantage aux causes de déformation;" and again, " La manière d'être des filaments dans les noyaux étrirés semble indiquer que dans le noyau intact ils sont pelotonnés et non disposés en reticulum." All other authors who have observed the deformed nuclei have drawn similar conclusions with reference to its consistency.

As may be observed from fig. 5, I have found the structure of the fresh nucleus plainly alveolar, like that of the cytoplasm, except that the alveoles are larger. The relative size may be seen in figs. 5, *A* and *B*. Both are drawn at the same magnification, the cell in *A* being much smaller than that from which the nucleus in *B* is taken. The alveolar structure may by chance be preserved by over-fixation, *e. g.*, " osmication," to use Bolles Lee's term. In neither the fresh nor this over-fixed condition are granules to be seen; but they are brought out sharply by nearly all fixations when the action is not so powerful. I see no way to account for the over-fixed alveoles on any other hypothesis than that of Fischer, who regards the chromatin as a more or less complete solution of nuclein bodies, which are precipitated ordinarily in the form of granules by fixing fluids. If the chromatin is already in the form of alveoles, over-fixation might result from too rapid action of the fluid on the periphery of the alveole, preventing a deeper penetration, and consequently preventing complete precipitation in the form of a granule. The "skein-like" arrangement (pelotonée) of the chromatin of v. Bambeke would thus be accounted for. Certainly the "osmicated" nuclei look as if such a partial precipitation had taken place. How to regard the strands which appear in distorted nuclei (Fig. 7, *A*), whether as the mere elongation of alveoles or as due to rupture with escape of chromatin contents, I am wholly undecided. I hope to make this and related subjects the object of a special study.

(4) *Moulting.*

We have now considered the normal cellular structure common to all physiological conditions, except those incident to the shedding and renewal of the lining. Early in the course of this study it became necessary to separate clearly the changes occurring in the cell during these processes from those connected with the phenomena of absorption of foods. It is well known that the land isopods moult frequently during the spring and summer. Kept in the Vivarium and Laboratory at temperatures corresponding to these seasons, the moults take place in a perfectly normal manner even in winter, and may easily be observed. It is well known, too, that the test of the isopod is cast in two pieces. The posterior piece, which comes off first, reaches to the anterior border of the fifth thoracic segment. One or two days may intervene before the anterior piece is shed.[7]

---

[7] In two cases observed in February, of which I kept careful account, the time was about forty-eight hours from the complete detachment and removal of the posterior half until the animal was freed from the anterior half; in several other cases observed in July the time was twenty-four hours. A number of animals kept in dishes were suspected of eating the posterior test while the mouth-parts were still hard. Quite recently I have obtained indubitable evidence that this occurs in the natural state. In a number of animals found with the anterior half still soft the intestine was filled with a chalky-looking substance, which proved on examination to be finely broken bits of the chitinous skeleton; no entire posterior test was found with these animals. The purpose of this habit is probably to utilize the calcareous matter.

It is said that the lining of the "mid-gut" comes out when the posterior half of the test is shed (Schönichen), and this I have seen in a number of cases. Sometimes, however, the lining is not to be found with the posterior half, but remains in the lumen attached, it may be, at some point. The habit of eating the posterior test (see note 7) may possibly be concerned with detaching the lining in such cases. The lining begins to break loose from the epithelial cells before there is any apparent sign of the external moult. Fig. 8, from an animal in the act of casting its intestinal lining, presents an appearance in striking contrast with that seen in other physiological conditions. The fibres are wholly wanting on the luminal side of the nucleus, and the cytoplasm has a uniformly granular aspect; the alveolar structure is almost entirely masked by the granules, so that only rarely does one get a glimpse of it even with high powers. The palisade at the luminal edge is not to be seen. Schönichen has observed this disappearance and concludes that the chitinized ends of the fibres (Bälkchen) function in breaking loose the intima, in the way the "little hairs" described by Braun (22) are said to do for *Astacus*. He has not, however, noticed the difference between the two cases, namely: that in *Astacus* the little hairs are to be seen in the test both during the shedding and after it has taken place, whereas in the isopods the fibres wholly disappear. The disappearance of the fibres is too complete to be accounted for by the mere masking of the alveolar structure by means of granules. This is in strong contrast with a case of masking which occurs when the end of the cell is filled with small granules, referable to the process of food absorption (fig. 11, *B*). The thickened portion of the fibres does not disappear in such masking; they may even appear more sharply defined than where such granules are not present (fig. 11, *A*). At a later stage in the process of moulting, fibres, very much finer than those which still exist unaffected by the moult in the cœlomic side, can be traced in the luminal side after the new intima has attained some thickness. The fine fibres do not possess the strong affinity for stains which they have later. From the foregoing facts it is only reasonable to suppose that the fibres in the luminal side of the cell contribute to the formation of the substance by whose transformation the new intima is formed; and that their disappearance at the time of moulting is due to some process of dissolution, the fluid thus formed precipitating in the form of granules which, as we have said, mask the true structure of the cytoplasm. On this hypothesis an explanation is readily afforded for the varying strength of the palisade in different individuals. When very strong—*i. e.*, composed of thick fibres from the intervals between which the cytoplasm has withdrawn—the very evident "striated border" described by so many authors is present. In such cases we may suppose the animal to be approaching a moult. When the palisade is scarcely visible (fig. 11, *A*) a moult has probably occurred shortly before feeding.

In the case of moulting figured (fig. 8) the intestine was taken forty-two hours after feeding. The quantity of food in granular form on the luminal side of the intestinal cell at this time is usually small, and when it does occur the granules can be distinguished from those of the chitinogenous substance. The latter are smaller, nearly uniform in size, equally distributed and very abundant. While I have not been able to trace all the steps in this process, it seems probable that there is here a dissolution of fibres in some points like that described by Mathews (23) for the zymogen of the pancreas of many vertebrates.[8] The new intima is laid down by some process of hardening of the chitinogenous substance.

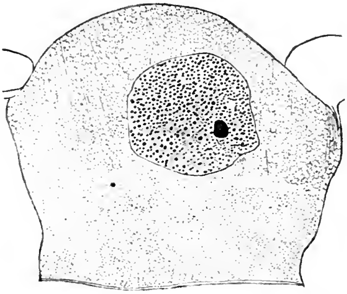


Fig. 8.—Median cell × 600 from intestine of *Oniscus asellus,* fixed in sublimate acetic immediately after moulting the chitinous intima. The lower part of the cell is filled with chitinogenous substance in granular form. All fibres have disappeared from this side of the cell. Intima is very thin.

---

[8] To any one familiar with Mathews' paper the difference will be obvious. The zymogen granules he derives directly from the fibres, which are traceable in some cases to the chromatin. Granules *may* occur here previous to precipitation by the killing fluids.

While McMurrich declares the intima to be impermeable, both Conklin and Schönichen speak for the existence of pores through which food may pass. These are best seen in the fresh intestine. When the intima is found with the posterior half of the test, one has only to mount it in water to demonstrate clearly the pores in all parts. They are a little more numerous per unit area of surface in the median than in the anterior portion. Owing to the relatively uniform structure of the chitin and its high refractive index, it is difficult to make out more than little pits at the surface, *i. e.*, the luminal end of the pores. In sections made from a fresh intestine with a freezing microtome and mounted in gum-arabic I chanced to get an oblique view of the pores, which supplied the direct evidence that they actually perforate the intima. One can in this way measure both their length and diameter. The former corresponds, of course, to the thickness of the intima, and avarages in the anterior portion for several individuals 1.6μ, in the median portion 2.4μ. The average diameter of the pores for a number of intestines was .5μ.

3. *Summary of Structure.*

We have now considered the complete structure concerned directly in the absorption of food, and have noted the changes in the cells due to the process of moulting. To recapitulate, the apparatus consists of an epithelium of large cells covered by a thin basement membrane, which alone intervenes between the cell body and the cœlome, and lined by a porous layer of chitin. On the mid-dorsal wall of the anterior portion of the epithelium six longitudinal rows of cells participate in the formation of a typhlosole. The cells have no parietal limiting membranes, but are separated quite distinctly from each other by intercellular supporting fibres. The cytoplasm is alveolar. Between the alveoles course the intracellular fibres from the intima to the basement membrane. Each cell contains a large spherical nucleus alveolar in structure in the fresh condition, filled with large granules of chromatin in the "perfectly" fixed condition. At the luminal side of the cell the intracellular fibres are parallel and are thickened so as to form a more or less rigid palisade, from the intervals of which cytoplasm may be excluded. The thickened ends of intracellular fibres serve, firstly, to preserve an open structure on the free margin of the cells, and, secondly, to furnish some substance essential to the formation of the intima.

IV. FEEDING EXPERIMENTS.

We come now to the main purpose of this paper, namely: to consider the cellular phenomena during the absorption of foods. We shall take up in order the changes to be observed in the cell during the process of absorbing (*a*) proteid and (*b*) fatty foods, reserving for later consideration the changes effected within the lumen by the digestive fluids under the subject of secretion in the hepatopancreas.

It will be necessary to mention briefly the methods of feeding. Animals were starved for various lengths of time, then allowed to eat fresh raw beef for ten minutes, after which they were isolated and killed at successive intervals. Table I (which appears at the end of the paper) is arranged with reference to the number of hours after feeding at which the intestines were fixed. Other foods containing proteid, such as raw and cooked oatmeal, bread, white of egg and other meats, were used for control and comparison, but by far the larger number were fed finely-chopped raw beef. For uniformity only those which were fed on beef are mentioned in the table.[9]

(1) *Effects of Starvation.*

In examining cells after feeding, two factors are to be carefully separated, namely: the effect of previous starvation, and the change produced by the food. It will be necessary now to make mention

---

[9] Some precautions had to be taken to induce the animals to feed contiuously. Thus, if they were brought from a dark room directly to a well-lighted one, none would eat unless protected from the light by an opaque object—a chip or bit of black paper. On the other hand, if kept in the light for several days the animal became accustomed to the greater intensity, and would usually eat at once. Even these would eat more contentedly if the food were spread on the under side of an object, as a box-lid, and this placed at an angle so that the animal's body was suspended. Again, if they were allowed to find the food in the course of their wanderings, the chances of eating continuously were improved. Even with these precautions the only way to be sure of the time was to watch the individual and keep note by some mark, such as a spot of asphalt-cement or India-ink on the dorsum. Ten minutes continuous eating was found to be a good average meal of beef. Mention has already been made of the dilute condition in which the land isopod obtains its food. If after long starvation one were allowed to fill the intestine entirely full, the result was sometimes fatal; although after a shorter period of starvation or taken fresh from the natural state, they could be kept alive indefinitely on a constant meat diet.

of the effects of the former. Inspection of fig. 7, *A*, shows that the fluid contents of the cell are free to move from one part of the cell to the other. Some of it is seen here coagulated on the cœlomic side of the nucleus. The alveoles in the lower part of this cell were uncommonly distinct. Comparison of this figure with 9 shows that the quantity of granular substance is considerably reduced in the former. The former is from an animal starved twenty-four days, the latter from one taken fresh from the natural environment. In the cœlomic end of the median intestinal cells of animals starved a considerable time (*e. g.*, three weeks), one often finds vacuoles. Again, great extension of the spaces which occur in the palisade next the lumen may be seen. These also are confined mainly to the median cells, and the effect is due merely to a withdrawal of cytoplasm from the luminal toward the cœlomic side (fig. 12).

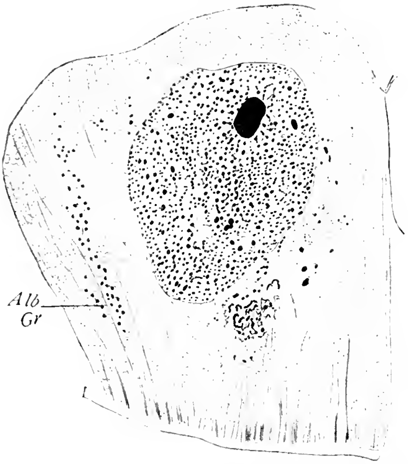


Fig. 9.—Median intestinal absorbing cell × 600 from *Porcellio scaber*, taken from natural environment. Intestine fixed in Hermann's fluid by simultaneous injection and immersion. *Alb. Gr.*, albumose granules.

V. ABSORPTION OF PROTEIDS.

Let us now examine some cells from intestines fixed at different intervals after eating. Fig. 10, *B*, shows several cells from the intestine of an animal which had been starved eleven days and then killed four hours after feeding (No. 7 of table). Besides the usual alveolar structure and the interalveolar substance, are to be seen definite aggregations of fine granules. These masses may be at almost any position in the cell, though rarely at an extreme distance from the nucleus. The cell on the extreme right of Fig. 10, *B*, is cut just to one side of the nucleus and in a plane in which the granular substance is specially aggregated—a very common arrangement. Often the masses are in actual contact with the nucleus. When the nuclei are broken or shrunken, granules indistinguishable from these are found about the nucleus or opposite the break. There seems good reason, therefore, to state that this substance is being given out by the nucleus. I cannot satisfy myself, however, that the nuclear membrane disappears or that the nucleus suffers any visible change in the process. Fig. 10, *A* (No. 20 of table), shows aggregations which are decidedly more definite. Figs. 11, *A* and *B* (Nos. 8 and 21 of table),[10] exhibit some variations in the form of these masses. All the figures thus far referred to are

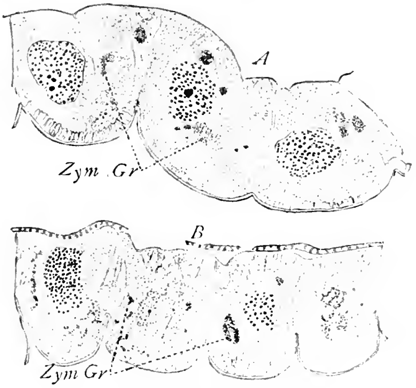


Fig. 10.—Sections × 270 from "mid-gut" of: *A*, *Oniscus asellus*, 16 hours after feeding with raw beef, fixed in Flemming's fluid; *B*, *Porcellio scaber*, 4 hours after feeding with raw beef, fixed in 1 per cent. platinic chloride 15 parts., 1 per cent. osmic acid 4 parts; *Zym. Gr.*, zymogen granules appearing about the nucleus.

---

[10] Tables I and II follow at end of paper.

of the anterior cells. In the column of the table devoted to these cells, wherever "small granules in masses" are mentioned, reference is made to the substance here spoken of. It will be observed from this column also that in all fixations, except those which blacken the cell contents, the granules are yellowish or brownish even after staining. With the osmic fixations they are always black. After such fixations they take the stains used. The median cells have not, up to sixteen hours after feeding, undergone visible change.

Fig. 11.—Cells × 600 from anterior portion of "mid-gut" of *Porcellio scaber: A*, 8 hours after feeding; *B*, 18 hours after feeding, both fixed in 1 per cent. platinic chloride 15 parts, 1 per cent. osmic acid 4 parts. *Alb. Gr.*, albumose granules; *Zym. Gr.*, zymogen granules.

In figs. 11, *A* and *B*, are seen numerous other larger and deeper staining granules scattered in the finely granular substance of which we have just been speaking. In fig. *A* particularly they seem to be quite definitely aggregated with reference to this substance. The small granules come from the nucleus, and there can be no doubt as to the origin of the large ones. Fig. *B* contains the same kind of granules in the lumen of the intestine, mixed with the coagulum which represents the secretion of the hepatopancreas. Since the food is almost pure proteid, and we know from the researches of Huet that the secretion of the "liver" is capable of changing proteid to "peptone" (albumose), we may presume that some product in this process may be found here. Fischer's researches on the effects of different killing fluids on proteid bodies enable us to decide this question with a high degree of probability. He classes albumoses among the "Granulabildner"—that is to say, they are precipitated in the form of granules insoluble in water by tannin, chromic acid, sublimate, platinic-chloride, formaldehyde, osmic-acetic, Flemming's and Hermann's mixtures; and they are precipitated in the form of granules soluble in water by alcohol, acetone, picric acid, picric acid-alcohol, picric-sulphuric acid (*loc. cit.*, p. 33). The fixation method of determining the presence of albumose would then be: (*a*) Precipitation with some one of each of the two classes of fixatives (Fischer recommends osmic-acetic and Hermann's for the first, and alcohol and picric acid for the second); (*b*) washing both in water; (*c*) staining with some dye which has a strong affinity for albumose (Fischer recommends Altmann's acid-fuchsine-picric-alcohol). If albumose is present it will be found in the first case, and will be washed out in the second. Figs. 1 and 2, Plate XVI, are from the same region of two intestines fixed twenty-four hours after feeding, the former in Hermann's fluid, the latter in alcohol; both were washed a long time in water (the former twenty-four hours, the latter fifteen); they were carried through the same reagents together, and finally stained in precisely the same manner, namely, in 15 per cent. acid-fuchsine in aniline water for five minutes at 54° C., then differentiated in picric-alcohol. (The effect of the picric-alcohol cannot be shown in the figure.) Figs. 3 and 4, Plate XVI, are from intestines treated as above after fifty hours from time of feeding.

In order to test Fischer's results more fully, I have performed a number of experiments similar to his on proteids obtained directly from Grübler's Laboratorium in Dresden. A summary of these experiments is given in Table II. It will be seen that my results confirm Fischer's in most respects essential to the precipitation of albumose. There is but one noteworthy difference, namely, that whereas Fischer obtained from Grübler's hemialbumose (protalbumose) a granular precipitate essentially like that from deuteroalbumose, I find only coagulum by $HgCl_2$.[11]

Peptone (depur. sicc. aus Fibrine, Grübler) seems to be a mixture of albumoses and true peptones. It is altogether likely that

---

[11] Several other fluids gave the same.

such a mixture occurs in the cells during absorption. I was unable to get a precipitate of the true peptones, after the removal of albumoses by $(NH_4)_2SO_4$, even by the strongest fluids ($HgCl_2$, Flemming's fluid, 1 per cent. chromic acid), which also is in agreement with Fischer. We may safely conclude that the large granules above mentioned contain albumose, and as such they will be designated hereafter.[12]

The exact nature of the finely granular substance, previously mentioned as coming from the nucleus, may now be considered. The very strong evidence that it is derived from the nucleus, and the fact that it is associated with albumose granules in the cell, both speak for a substance elaborated for the purpose of acting on the food. Fig. 14, sixteen hours after feeding, from a fresh intestine stained fifteen minutes in dilute Bismarck-brown, shows masses of granules about the nucleus. The appearance is strongly suggestive of zymogenesis (see figs. 20 and 21). Granules are very often seen about the nucleus in fresh intestines not previously stained, such as in fig. 14, and are not therefore to be ascribed to the effect of the fluid used. Since proteids can enter the cell only in the form of solutions, we can scarcely suppose that we are dealing with any stage of the food. If we may speak of the substance tentatively as zymogen, what further evidence have we that it is destined for ferment action ? When the lumen of the intestine contains secretion from the hepatopancreas, as is always the case when this body appears in the cells in large quantity, it is difficult to be certain whether or not these granules are poured out to mix with the secretion. If the quantity in the cell is great it is sometimes found on the luminal side; but the definite aggregations, which occur most often near the nucleus, are not found here, nor does one ever see distinct evidence of a streaming through the intima. Now, considering that inter-alveolar substance, with which this is to be classed, is capable of being moved by the killing fluids, and that the penetration in the cases mentioned is toward the lumen, it should be found on that side in greater quantity if it is destined for action in the lumen. Notwithstanding this evidence, however, and the further fact that, although it is plainly different from the "liver" zymogen, no secretion different from that of the "liver" can be distinguished

---

[12] It will be understood, of course, that the granule is in reality a compound of albumose with the precipitating fluid.

in the lumen, I would not go so far as to say that it *may* not escape from the cell. The structure of the cell plainly admits this possibility. All we can say at present is that where we might expect evidence of its passage into the lumen, no evidence is obtained.

To sum up the evidence thus far: The granules as such come from the nucleus; they are associated with food (albumose) in the cytoplasm; they stain only with difficulty; finally, there is no clear evidence that they escape from the cell. All these indicate an intracellular ferment. If it is such we should expect that it would appear in the cell before the food does, or even before feeding. Fig. 10, *B*, four hours after feeding, contains no albumose; it rarely appears in the cell earlier than the eighth hour after feeding. In the table, No. 3 is one of several intestines from animals starved two weeks and not fed before killing; small granules were found in considerable number which do not take the Biondi-Heidenhain stain. Again, McMurrich reports for starved specimens of *Armadillidium* some yellowish granules (which he regards as disintegration products apparently identical with these). Finally, if it is an intracellular ferment it should be found in *all* absorbing cells. The definite aggregations of granules which are found in the anterior cells are seldom met with in the cells of the median part. However, No. 44 of the table, killed in sublimate, stained in Biondi-Heidenhain, exhibited in these cells "small poorly staining granules on the cœlomic side" (also Nos. 13 and 18). In neither of these cases are the granules in masses; they are scattered all through the cœlomic end of the cell. While, therefore, the granules are abundant and definitely aggregated in all stages of absorption only in the anterior cells (see Table I), they do occur in all absorbing cells. There is evidence, which I shall consider presently, that some of the small granules of feeble staining capacity may represent a stage in the transformation of the food itself.

From eight hours onward to one hundred and twenty hours after feeding, albumose granules may be found in greater or less quantity in all the cells. The amount met with in any particular cell will depend upon the accidents of its formation in the lumen. The course it takes, once in the cell, seems to have no distinct reference to the organization of the cell, except so far as that may influence it mechanically. Fig. 2, Plate XVI, twenty-four hours, and Fig. 9, fresh, show the granules arranged in rows, following in a general way the course of the fibres. In these cases the albumose is plainly not influenced by the nucleus. If absorption goes on continually for some time a mass of granules will be found after fixing, on the cœlomic side of the nucleus (Figs. 12, sixteen hours, and 4, Plate XVI, fifty hours).

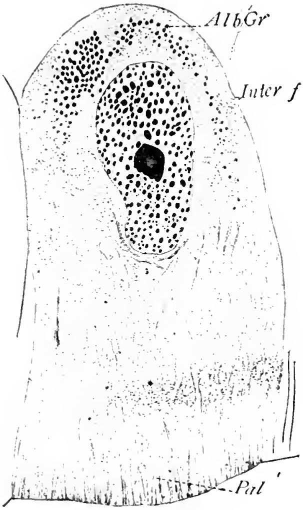


Fig. 12.—Absorbing cell × 600 from median portion of "mid-gut" of *Oniscus asellus,* 16 hours after feeding, fixed with Hermann's fluid. Intima is torn off. *Alb. Gr.*, albumose granules; *Pal.*, palisade; *Inter. f.*, intercellular fibre, showing continuity with the basement membrane.

It has been shown by Fischer (*l. c.*, p. 36 *et seq.*) that the size of the granules of albumose depends upon the strength of the solution, and upon the strength—*i.e.*, precipitating power—of the killing fluid. Thus he finds the average diameter of the granules precipitated by Altmann's osmic-bichromate mixture from a 10 per cent. solution is 1μ to 3μ; from a 3 per cent. solution, .7μ to 1.5μ; from 1 per cent., .5μ to .7μ. Again, the average diameter from a 10 per cent. solution precipitated by Flemming's fluid is .7μ to 1μ; by Hermann's, .7μ (fairly uniform); by 1 per cent. platinic-chloride, .7μ to 1μ; by 7 per cent. sublimate, .4μ to 1μ and *smaller.* Those represented in figs. 8 and 9, Plate XVI, and in many other cells of the same intestine, measure from .5μ to 2μ; they were precipitated with picro-acetic.[13] The granules in fig. 12 and several other cells of the same intestine measure from .5μ to 1.5μ; they were precipitated with Hermann's fluid. It is not important to attempt an exact determination of the strength in which the albumose may exist in the cells; but the above figures indicate that it may be as strong as a 10 per cent. solution, making allowance for the fact that Fischer's measurements were made for pure solutions, whereas in the cells they are of course mixed with other interalveolar substances. Fischer notes that albumose in mixture with an albumen precipitates larger granules than from pure solutions. He also observes that precipitated from such mixtures they are not uniformly distributed through the coagulum of the albumen, but are collected into small and large nests ("Anhaufung in Nestern"). Figs. 8 and 9, Plate XVI, and others show this arrangement.

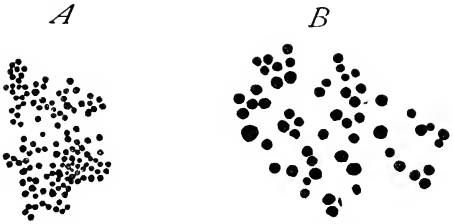


Fig. 13.—Granules of Peptone (depur. sicc. aus Fibrine), (Grübler) × 925. *A*, 2.5 per cent.; *B*, 5 per cent. solution precipitated on cover-glasses by Chromic acid (1 per cent.), stained in Iron-Hæmatoxylin. See Table II, Nos. (5) and (6).

The occurrence of little spaces about each granule of albumose in a coagulum of albumen, which Fischer has figured (*l. c.* Taf., figs. 2, 3, 4), is confirmed also by my figs. 6, 8 and 9, Plate XVI. This fact enables one to determine with clearness the relation of the granule to the alveolar structure of the cytoplasm. Thus, if the granule were precipitated *within* the alveole, and the structure were

---

[13] Picro-acetic is said by Fischer to precipitate albumose in a soluble form. I find this to be true if the fixation is followed by washing with water, but if followed with 70 per cent. alcohol the granules are not dissolved in this or subsequent fluids. The same is true of picro-sulphuric.

not destroyed by the fixation, the space should correspond to the neighboring alveoles in size—*i. e.*, in such cells as that represented in fig. 6, where the alveoles are so evident, the granule would be plainly seen encased by the alveolar wall. Such an appearance is seldom met with—indeed, the granule is often larger than the alveole (figs. 9, 11, *B*, 9, Plate XVI). Again, in favorable places (figs. 6, 8, Plate XVI), the alveolar walls can be seen intersecting the space about the granule.[14] The space does not correspond, therefore, to an alveole, but represents the area in the interalveolar substance influenced by the killing fluid to form a single granule. It appears, therefore, that the soluble food is independent of the cytoplasmic structure.

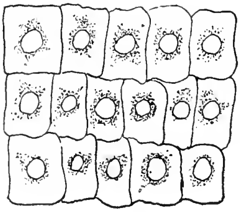


Fig. 14.—Outline drawing (with camera × 90) of an optical section of anterior cells, "mid-gut" of *Oniscus asellus*, fed with raw beef; intestine mounted in blood and stained 15 minutes in dilute Bismarck brown (1: 20,000) 16 hrs. after feeding. The granules about the nucleus take the stain and appear to be coming from the nucleus. This is precisely the appearance of zymogenesis in the hepatopancreas when treated in the same manner (figs. 20 and 21).

Having distinguished the albumose granules from the rest of the cell contents, we may inquire whether further chemical stages of the food appear in the fixed and stained sections in a form distinguishable by the microscope. It was mentioned farther back (p. 317) that evidence might be found for regarding some small granules of feeble staining capacity as a stage in the transformation of food. In the first place, it must be stated that the digestion of the food (raw beef) is pancreatic (*i. e.*, alkaline[15]) (see Sec. ix, *a*); and

---

[14] Cf. Hardy's figures, *loc. cit.*

[15] This we have on strong comparative evidence also. Thus Plateau (24) demonstrated (*a*) that the reaction in the crop of the Carabidæ and Dytiscidæ may be neutral before feeding, but is always alkaline after; (*b*) that the reaction in the "mid-gut" of the carnivorous chilopod *Lithobius* is alkaline, in that of the herbivorous diplopod *Julus may* be acid.

according to Neumeister's (27) scheme, the first bodies chemically recognizable in the tryptic digestion of proteids are deutero-albumoses. Now, deutero-albumoses, according to Fischer and this study, behave as we have described under the general name albumose (see p. 315). If granules appear before albumose is formed, therefore, it is not probable that they represent food. May those in question, however, not be albumose in a weaker solution, seeing that the size of the granules depends upon the strength of the solution? In answer to this question two facts may be mentioned: (*a*) whereas albumose granules take stains readily, these granules stain with difficulty; (*b*) where only a small number of albumose granules are present they are usually very much larger than these (figs. 8 and 9, Plate XVI). If, then, any of the granules designated as "small and poor-staining" (see Table I) are food, they must represent a stage following albumose. Fischer has found the true peptone (in Kühne's sense) very difficult to precipitate, and I have been unable to get any precipitate at all with killing fluids from the filtrate after treating Grübler's preparations of albumoses with $(NH_4)_2SO_4$. If the true peptone were precipitated *in the cell*, the granules would in all probability be very small, and Fischer finds them also very difficult to stain (wenig tinctionsfähig). Both these properties are exhibited by the granules in question. It is possible, therefore, that some of the small non-stained granules occurring with the albumose, or after albumose may be expected to have been formed, are true peptone. Granting this, however, we should still have to account for *a*, the appearance of the granules of this description in the starving cells, and *b*, the origin of many granules found in the living cells and in the fixed material immediately about the nucleus. The ferment hypothesis is still necessary to account for both these facts.

The attention of the reader will have been arrested by the densely staining mass represented in figs. 6 (text) and 8, Plate XVI, lying on the luminal side of the nucleus and extending toward the lumen. It will be seen to consist of densely staining strands (fig. 8), matted

---

Hoppe-Seyler (25) found the action of the "liver" ferment of the crayfish *Astacus fluviatilis* to be pancreatic and not peptic, although the reaction was slightly acid. Krukenburg (26) has shown the same to be true also of several Brachyura. Finally, the general adoption of the name hepatopancreas for the digestive gland of the Arthropoda was in recognition of the pancreatic nature of its secretion.

together and enclosing some albumose granules. In fig. 6 it consists, for the most part, of a homogeneous deeply staining mass enclosing a few granules. For a time I regarded these masses as the food, and the strands stretching toward the lumen as direct evidence that substances were being taken up by the nucleus. In such cases as that shown in fig. 8, Plate XVI, which are numerous with various fixations, there seemed to be good reason for thinking that the substance of this mass is passing into or from a granular form, under the influence of the nucleus. Where, as in this cell, the nucleus lies far out in the cœlomic end, the mass seemed to be crowding it in that direction. A number of considerations have led me to abandon this view. In the first place, it was evident from Fischer's results that the food, when it enters the cell, ought to appear, according to Neumeister's scheme, in the form of granules, not as a heterogeneous mass; secondly, when the origin of the fine granules was traced to the nucleus, another constituent of the mass was accounted for; thirdly, when the alveolar structure was made out with certainty, the homogeneous constituent was seen to be interalveolar in position. In such cases as fig. 6, where the alveoles are particularly distinct, the strands are not to be distinguished from the fibres except by their extent. Not until the injection experiments, mentioned on p. 306, were tried was it possible to account for the position of the mass with reference to the nucleus. Fig. 8, Plate XVI, is from an intestine killed in the ordinary way by penetration from the cœlomic side; fig. 7, *A*, is from one which was injected with the killing fluid. Since we know that the interalveolar substance, to which all of the constituents of this mass belong, is free to move about in the cell, it is clear that the position of the mass is referable to the purely mechanical effects of penetration of the killing fluid. The nucleus acts as an obstruction to the streaming set up by the fluid; and in some cases a kind of eddy of the interalveolar substance is formed behind it. In other cases the mass projects beyond the nucleus; here it is possible that the interalveolar substances have been checked by reaching the limit of concentration allowed by the spaces, and have been "fixed" in that position. Only by some such supposition can I explain the remarkably straight edge presented by the mass on the side from which it came (figs. 6 and 8, Plate XVI). Still a further evidence that the mass is wholly artifact is that it occurs with clearness only in the elongated cells, whose free ends are unprotected by a layer of muscle. We must conclude, therefore, that what in the first instance appeared to be so clear a case of cellular individuality in absorption, turns out to be only an artificial massing together of several of the cell constituents.

To return to the albumose, we have seen that it accumulates on the cœlomic side of the cell. It may be in contact with the basement membrane, and practically fill the whole cœlomic end. The next subject to consider is its fate. It has long been known for mammals that neither albumose nor peptone occurs in the circulation; in other words, the peptone is changed back to proteid *before* it reaches the blood stream. We might expect that such would be the case here also. The morphological support for this view is positive, so far as it goes. In extracting and fixing intestines some of the cœlomic fluid is invariably found precipitated on the outer surface; and in studying whole intestines, I have had occasion to precipitate large quantities of the cœlomic fluid on the slide: in no case have I seen albumose granules in the coagulum.

In several intestines the cœlomic end of the median cells was filled with a precipitate which might be described as mottled in appearance. There were no definite granules (Table I, Nos. 31 and 45), nor could the formation be described as a coagulum. Inasmuch as both these cases occur a considerable time after feeding, forty-two and one hundred and twenty hours respectively, we may suppose that the stage of the food represented is beyond albumose. Whether, however, the mottled precipitate is an imperfect granule formation, and this, instead of the small non-staining granules, represents the true peptone, or represents an intermediate stage in the inverse process toward albumen, I cannot say. In either case we would have good evidence that the food undergoes some change inside the cell. The intracellular ferment or ferments (for the zymogen granules may be of a complex nature) may be concerned in this change, in which case its association with albumose granules would be explained.

VI. FUNCTION OF THE TYPHLOSOLE.

We may properly discuss here the function of the infolded groove of cells which has been spoken of as typhlosole. The first mention of this structure which I have found in the literature is by Brand and Ratzeburg (28), where it is spoken of as a "furche" in which the anterior part of the heart lies. Lereboullet (*loc. cit.*) described it as well as could be expected with the magnifying powers at his command, and recognized that it must be of some considerable significance in the function of the intestine. He says: "On ne saurait admettre que les rigoles soient destinées à augmenter l'ampleur de l'intestine; leur étroiteness et leur étendue limitée semblent contraires à cette opinion. Je ne crois pas qu'on puisse les regarder comme des organes particuliers de sécretion ou d'absorption" (*loc. cit.*, p. 91).

"Le seul usage probable de ces rigoles me parait être de recevoir une portion de la bile pour la conduire dans le milieu de l'intestine, afin que ce liquide se trouve répartir d'une manière plus uniforme dans toute l'étendue du ventricule chylifique. En effet quoique les rigoles ne se continuent pas directment avec les deux embouchures des utricules biliaires cependant on comprend que dans les mouvements de contraction de l'estomac, une partie de la bile puisse s'écouler par ces canaux. On remarquera d'ailleurs que le ventricule chylifique est presque toujours entièrement rempli d'aliments, en sorte que la bile peut éprouver de la difficulté à se parter jusqu'à l'extrémité de ce long boyau" (p. 92).

Ide says: "Nous n'avons recueille aucune donnée positive au sujet de la fonction de la bande dorsale. On peut dire sans hérésie que cette production augmente la surface d'absorption de l'intestine; nous avons constaté en effet, que les aliments au moins la partie la mieux trituree pénétrant dans les deux rainures qui longent la band" (*loc. cit.*, p. 189).

Conklin was the first, so far as I am aware, to apply the term *typhlosole* to this structure. By analogy with other invertebrate intestines, this name implies that the function of it is to increase the absorbing surface. Schönichen finally ascribes to the structure a possible secretory or excretory function, and supports this view by the fact that the dorsal blood-vessel breaks up into a plexus at the place where the "Rinnen-apparat" ends.

The observations with reference to the function of the typhlosole made in the course of this study are as follows: in the first place, the cells of the typhlosole are looser in structure than the other cells of the intestine (see p. 297). On this account they are very profoundly affected by the killing fluid. When artifacts do not occur in any other part of the intestine, it is a common thing to find the typhlosole greatly ruptured (figs. 4, *B*, and Plate XVI, fig. 9). As will be seen from the same figures, the killing fluids act most powerfully on the inturned cells, just where the two streams of fluid, separated by the descending strip of muscle, are somewhat concentrated in their action. Often with sublimate-acetic and other very powerful reagents the upturned cells present horizontal "streams" of coagulated substance, which seems to indicate a movement of the cell contents toward the outside groove. I mention these artifacts because I was led by them at first to ascribe a *special* absorbing function to these cells.

Fig. 9, Plate XVI, represents albumose granules fixed in the course of passing through the cells of the typhlosole. We have then direct evidence that these cells share the functions of the others in the anterior end of the intestine, and confirmation of the view, expressed explicitly by Ide and implicitly by Conklin, that the infolding is for the purpose of increasing the absorbing surface. The quantity of both kinds of granules, however, is small as compared with that found in other cells. This may be due to the fact that in artificially fed animals the intestine was not gorged to the same degree of fullness which is common in the natural conditions. On the other hand, the fact that liquid food or secretion, or both, are often found in the grooves of the typhlosole in such intestines would indicate that these are not so highy specialized in these functions as the others, and would lend weight to the view expressed by Lereboullet that the furrows provide a means for the more ready passage of the secretion to the middle of the intestine, insuring thereby a more uniform mixture of the food and secretion. The direct evidence (exhibited in Table I) that the secretion is being poured into the intestine as long as forty-eight hours after feeding, and the facts, further: that under natural conditions the anterior end is often clogged up with bits of dry food; that in a freshly dissected animal whose intestine is full, the inner grooves are seen to stand up above the surface of the remainder of the intestinal wall, as if filled with something—plainly not solid food; that the character of the food, consisting as it does of substances often very difficult of penetration by the digestive fluids, requires the most thorough distribution of the secretion (which could scarcely be insured at the time of entering the intestine); and, finally, that the form of the typhlosole, narrow in front and widening behind, so that the grooves *may* permit the escape of the fluid secretion all along the line, and *must* do so at the extreme posterior end (figs. 3, 4), is such as the distribution of the secretion would require—all these considerations seem to the writer to constitute a strong chain of evidence that Lereboullet's view is the correct one, namely, that it is the *primary* purpose of this structure to distribute the secretion. That it did not develop on the ventral side in direct connection with the opening of the glands, instead of on the dorsal side, is remarkable. Certainly, this would seem to be the more natural position for a structure concerned in the distribution of a secretion which enters on the ventral side; because it would be the more certain of finding its way into the channels if they occurred on this side. "Nevertheless," as Lereboullet says, "one can understand that in the movements of contraction of the stomach a part of the secretion (bile) may flow by these canals."

VII. ABSORPTION OF CARBOHYDRATES.

This class of food substances is not at all favorable for a study of absorption by morphological methods. It is evident that none of the reagents ordinarily employed as fixatives act on carbohydrates in solution so as to render them visible to the microscope. A word on the digestion of starches, however, may not be without interest in this connection. Huet has found that the salivary glands (which Ide calls cutaneous glands) of *Ligia* produce diastase, and it is evidently to the secretion of this organ rather than to that of the hepatopancreas that he would ascribe the diastatic action in the intestine.[16] No effort has been made to confirm either Huet's or Ide's conception of the nature of the glands in question. It seems unlikely that a gland so small could have much to do with the action which we have now to describe.

Starved animals were fed on various kinds of starch,—cold-boiled potato, corn starch, dry bread, etc. The former proved to be especially palatable for some very large specimens of *Oniscus* which happened to be on hand at the time. They were allowed to eat freely of it for half an hour, in which time the intestine was completely filled. Twenty-four hours after they were killed, and the whole intestine subjected to Moore's test for sugar. Splendid

---

[16] Since he found the diastatic action of the "liver" secretion of *Ligia* only slight.

reactions for dextrose were obtained in a number of cases. Inasmuch as an effort was being made at the time to locate the dextrose in the cells, the other ordinary tests which require an alkali and heat were of necessity excluded. However, the reaction was controlled by trying intestines from animals known not to have eaten starch; and no indication of dextrose was obtained. Intestines were tested again fifty hours after feeding; and good indications were obtained.

Intestines like the above were tested also with iodine both twenty-four and fifty hours after feeding. In several cases the median arched cells gave a "port-wine" color at their free ends, indicative of either dextrine or glycogen, with the presumption in favor of glycogen.

VIII. Absorption of Fats.

In studying the absorption of fats the same feeding methods have been followed as for the absorption of proteids. Animals were isolated and starved from four to ten days, then fed with butter, beef suet or olive oil (the latter mixed with boiled potato, to enable the animal to grasp the food with the mandibles), all of which gave

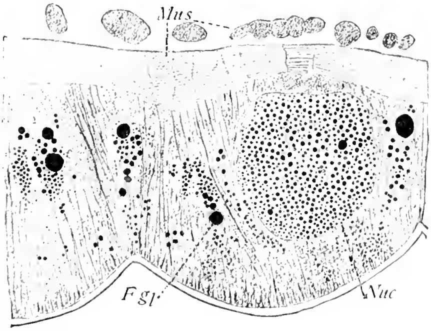


Fig. 15.—Section involving parts of two cells × 600 from anterior portion, "mid-gut" of *Porcellio scaber*, fed with butter, and fixed after 8 hrs. in 1 per cent. Platinic chloride 15 pts., 1 per cent. Osmic acid 4 pts. All black granules outside the nucleus are fat. *F.gl.*, fat globule encased by spherical film; *Mus.*, muscle, circular layer inside, longitudinal fibres outside; *Nuc.*, nucleus.

good results. As might be expected from the habits of land isopods, not all of the fat taken from a pure diet of this kind in the course of ten minutes' continuous feeding is absorbed. Pellets of waste containing a large proportion of fat were found forty-eight and seventy-five hours after feeding. But enough of the fat is absorbed, as may be seen from the figures, both to demonstrate the fat-digesting power of the hepatopancreas ferment and to follow the fat through the absorbing cells. Animals live indefinitely after eating the above-mentioned foods, and have been seen to eat the same repeatedly.

The digestion of pure fat, like that of pure proteids, is rather slow as compared with the action in mammals. At eight hours after feeding fatty globules may be seen in the epithelium of fresh intestines without the agency of stains. Fig. 15 shows an anterior intestinal cell from an animal fed with butter for fifteen minutes, the intestine fixed after eight hours in Hermann's fluid without acetic acid. The sections were stained in iron-hæmatoxylin. The size of the globules varies greatly, the larger ones being doubtless due to the fusion of several small ones. It will be seen also that no large globules are found near the free luminal edge of the cell, but that in general there is an increase in size with the distance from this edge. This is typical of the appearance presented by all absorbing cells at an early stage in the absorption. Later, as is shown in fig. 16 (12 hrs.), there is not so much difference in size.

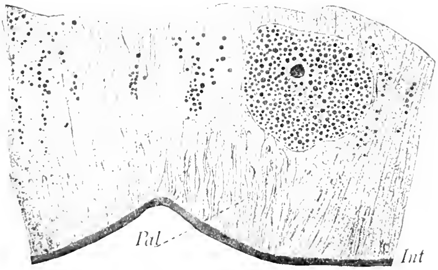


Fig. 16.—Section involving parts of two cells × 600 from intermediate portion, "mid-gut" of *Porcellio spinicornis*, fed with butter; intestine fixed after 12 hrs. as in fig. 15. All black granules outside the nucleus are fat. *Int.*, intima; *Pal.*, palisade.

From twelve hours after feeding onward, just as in the proteid absorption, the food is usually aggregated mainly on the cœlomic side of the cell (figs. 17, 16 hrs.; 19, 115 hrs.), although as in figs. 18 (50 hrs.) and 10, Plate XVI, (24 hrs.) it *may* be still widely scattered through the cell at a much later period. The difference here is due in part to the different kinds of fat used—butter in figs. 15, 16 and 17, beef suet in 19 and olive oil in 10, Plate XVI—and in part to the difference in form of the cells in anterior (15), intermediate (16) and median (18) portions of the "mid-gut."[17]

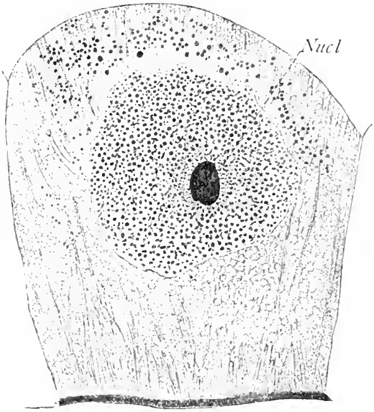


Fig. 17.—Section of cell × 600 from median portion. "mid-gut" of *Porcellio scaber*, fed with butter; intestine fixed after 16 hrs. as in fig. 15. All black granules outside the nucleus are fat. *Nucl.*, nucleolus: the chromatin is precipitated in short radiating strands immediately about its periphery.

Just as in the absorption of proteids, the passage of food through the median cell is facilitated by the relatively easy exit from the cell into the cœlome, while from the anterior cells the passage is hindered by the investing muscle layer. Consequently at any given time after the digested product has reached all the cells, the median

---

[17] The position of the fat in the cell is not affected by the direction of penetration of the killing fluid, as may be seen from the fact that fig. 18 is from an intestine injected from the posterior end with Hermann's fluid. There has been no movement of the fat on account of penetration from within.

cells show a more advanced stage of absorption. Here also the amount of food found at any given time in any particular cell is dependent on the accidents of position, of form and of digestive action in the lumen.

The relation of the fat globules to the cytoplasmic structure is again interalveolar (figs. 18 and 19, *A*). In both these figures fat globules appear to have penetrated the nucleus. This appearance is due in the former to imperfect fixation, the chromatin not being all precipitated (see section on structure of the nucleus); in the latter the globules are in reality above, *i. e.*, at a higher focus than the nucleus. No fat granules are ever found in the nucleus.

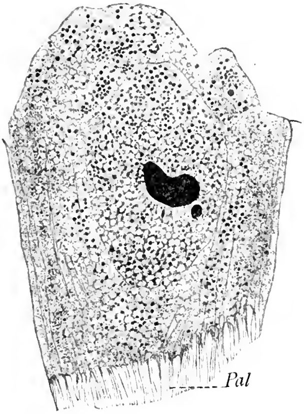


Fig. 18.—Section of cell × 600 from median portion, "mid-gut" of *Porcellio scaber*, fed with butter; intestine fixed after 50 hrs. in Hermann's fluid by injection from the posterior end. Nucleus is imperfectly fixed, and cytoplasm is slightly diagrammatic. Fat globules seldom inside alveoles. *Pal.*, palisade; intima torn off.

This last statement may fairly raise the question of the identification of fat globules. In sections from intestines treated with osmic acid and stained in iron-hæmatoxylin (fig. 18) how, it may be asked, are blackened fat globules to be distinguished from stained chromatin granules? Or, more broadly considered, can the fat be distinguished at all by color reactions? This question is important because upon its answer depends, largely, the physiological interpretation of the facts here presented.

In the first place, it should be said that the choice of iron-hæmatoxylin stain for the study of fat absorption was for the sake of very decided advantages from the morphological standpoint. The demonstration of the alveolar structure of the cytoplasm, for example, is much more satisfactory with this stain than with any other I have used. Fat globules may be quite clearly distinguished from other granules, black after osmic acid and iron-hæmatoxylin, by merely destaining to a considerable degree with the 1 per cent. iron-alum solution. Blackened deeply by osmic acid, they retain their color after other granules blackened only by the stain lose the color. This is the case in fig. 18; the black color in the fat granules is due solely to the osmic reaction.

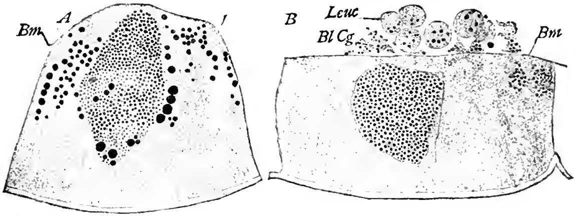


Fig. 19.—Sections of two cells × 600 from median portion, "mid-gut" of *Porcellio scaber*, fed with beef suet; intestine fixed after 115 hrs. in Flemming's fluid. *Bl.cg.*, blood coagulum; *Bm.*, basement membrane; *Leuc.*, leucocytes containing fat. All black globules outside the nucleus are fat.

Secondly, with acid fuchsine stain it is an easy matter to distinguish granules from fat globules. In fig. 10, Plate XVI, they are shown retaining the osmic color, while all the other cell parts are red. The nuclei which are not shown in these two cells were also red. Figs. 17 and 19 likewise are from sections stained in acid fuchsine; the fat globules were all black, the nuclei red. It has been seen (p. 315) that albumose granules take the acid fuchsine in aniline water even after an osmic fixation. It is consequently easy also to distinguish the fat globules from albumose granules. The food was pure fat or fat and carbohydrates mainly, and sections treated in the same manner as those in which albumose was demonstrated by this stain (namely, two to three minutes in a 7–15 per cent. solution in aniline water) always exhibit the blackened granules only. In fig. 10, Plate XVI, some small red granules are seen near the free edge of the cell; these may be due to the small amount of proteid in the boiled potato with which the olive oil was mixed, or may represent small globules composed in part only of fat.

Thirdly, the final test of fats is always the action of fat solvent —ether, xylol, benzole, etc. After most fixations, as is well known, fat is easily dissolved out by prolonged immersion in xylol or ether.

Thus the intestine from an animal known to have eaten only fat after a starvation of one week was fixed after twenty-one hours, first in 1 per cent. platinic chloride, washed in water and carried through the alcohols in the usual way to harden. Instead of imbedding at once, it was subjected to the solvent action of xylol for forty-eight hours. On sectioning and staining in acid-fuchsine no blackened globules were found in any of the cells.

But after osmic acid fixations the authorities are not agreed as to the solubility of fats in the ordinary solvents. Heidenhain (29) argued that certain black granules in the absorbing cells of mammalian villi and in the lymph corpuscles were not fat because they did not dissolve in xylol and ether, and on this fact he based certain far-reaching conclusions. Altmann (30), however, and Moore in Schafer's *Text-book of Physiology* (Vol. I, p. 458, note 5), state that prolonged treatment with osmic acid tends to render fat insoluble. This I can confirm from the following experiment concerning fat globules in cells:

Intestines from animals which ate butter for eight minutes after a starvation of one week, fixed in Hermann's fluid without acetic acid after sixteen hours and treated with xylol, exhibit abundant blackened granules. In one case (fig. 18) the intestine was fixed in Hermann's fluid, and after the sections were mounted one of the slides of the series was sketched with the camera while in oil of cedar in preparation for balsam. The position of every globule in the cell was noted. It was then placed in ether over night (fifteen hours) and was again examined in oil of cedar. No change in the globules had taken place. The slide was then placed in benzole for four or five hours and again carefully examined; no globules had dissolved, although the color had faded noticeably. There is no possibility of confusion with albumose granules in this case, as the animal was carefully isolated for nine days before feeding and was then allowed to eat only butter for ten minutes. It was killed and the intestine was fixed after fifty hours, when many globules are still to be seen in other slides of the series.

The first experiment mentioned above furnishes additional proof that the globules found in the cells are fat. Since there can be no question about the identity of the globules in the second experiment, it shows that osmium-fixed fat globules are practically insoluble in ordinary fat solvents. This is not true of fat outside the cells—that is, while still in the lumen.

Sections of intestine of an animal fed for twenty minutes on butter and fixed after seventy-five hours in Flemming's fluid without acetic acid, were mounted and stained in acid-fuchsine in the usual way. Instead of mounting in thick balsam, a large amount of oil and a little balsam were placed on the section. The next day the fat, densely blackened and enclosed by the epithelial wall, was seen to be diffusing out, and in a week it was entirely dissolved by the excess of cedar oil. The cells of the epithelium, however, still contained abundant globules blackened by the osmic acid.

That the globules last mentioned did not dissolve may be explained by supposing the fat inside the cell to be mixed with some coagulable substance.

Butter spread on a cover-glass and treated with Hermann's fluid for fifteen hours, then with ether (after dehydration), leaves a coagulated residue which retains its black color for more than two days in the solvent. Again, in teasing out in Hermann's fluid an intestine which had been filled with olive oil, it was observed that the oil, mixed with the secretion of the hepatopancreas, on escaping in the form of globules, took a brownish color at the periphery and the densely black color within. The brown color may have been due to fatty acid or to a film of the coagulated secretion.

Finally, as Altmann has observed, decomposition products or other diluting substances are probably responsible for the different degrees of intensity with which the osmium-blackening occurs or remains after treatment with solution agents (*loc. cit.*, p. 98). It is scarcely possible to suppose that the globules of fat inside the cell are wholly unmixed with the albuminous fluid contents of the cell, or with the immediate products of digestion.

The whole evidence for fat in the cells may be summarized as follows: (*a*) Oily globules are seen in the cells of fresh intestines from animals fed with fat; (*b*) these globules are dissolved by xylol after fixation in $PtCl_4$ (and certain other reagents—$HgCl_2$, chromic acid, etc.); (*c*) they stain densely black after all osmic fixations; (*d*) they retain this color after staining with acid-fuchsine in aniline water, and are thus distinguished from albumose granules; (*e*) they retain the black color after iron-hæmatoxylin and destaining with iron-alum, and are thus distinguished from chromatin granules, so that the granules inside the nucleus, which physically very much resemble the blackened granules in such preparations, are never oily in nature—in other words, the fat does not penetrate into the nucleus in appreciable quantities; (*f*) the insolubility of these granules in xylol and ether cannot be taken as an indication that they are not composed in part at least of fat, for, as Altmann observes, the solubility depends on the purity of the fat. Finally, the insolubility of globules in such cases may be due to admixture with some albuminous fluid which precipitates in the formation of the globule and constitutes its insoluble portion.

Granting now that the globules found in the absorbing cells after feeding with pure fats are really fatty in nature, it may be inquired how they came there, whether they are absorbed as such or whether they were synthesized from chemical products of digestion. In short, for which theory of fat absorption—the emulsion or the solution theory—do the facts speak? Without going into a history of this controverted question here, it may be pointed out, by way of introduction to the interpretation of what follows, that the morphological evidence is scarcely crucial evidence in point. For, on the one hand, it is claimed by the adherents of the solution theory that if fat globules are not demonstrable in the luminal border of the cell, but only after a portion of the cell has been traversed, then fat did not enter the cell *as such*, but has been synthesized somewhere in its course since entering. The emulsionists, on the other hand, say it is just as reasonable to suppose that the emulsion particles are so small that at the time they enter the cell they cannot be seen with the highest powers of the microscope, and become visible only when a number of them have fused together, as they plainly do.

The isopod, because of its small size, is not favorable for a chemical study of digestion. Consequently I have not attempted to supplement the morphological study by that means. Nevertheless, it seems worth while pointing out that the appearance here presented is all that is required by the solutionists for morphologica support to their view; while it is difficult to reconcile it with the emulsion view. Pflüger (31) has used Heidenhain's figures to show that fat does not appear in the striated border of mammalian epithelial cells, and he declares, quoting Funke (32) and Will (33), that it has never been so demonstrated except by Kölliker (34), who, as Pflüger says, wanted to see fat particles to substantiate his theory that the striæ are pores. My own observations on this point in the isopods were begun with the purpose, primarily, of demonstrating the pores in the chitinous lining (see p. 310). It was hoped that if fat is absorbed in the form of emulsion, it would blacken densely in the intima after osmic acid. Consequently particular attention has been given to this point. About twenty-five intestines from animals in all stages of digestion, from four hours to 145 hours after feeding, have been sectioned and each one examined carefully with this point in view. In no case have I seen a single cell whose intima contained demonstrable fat globules. (Note that in fig. 10, Plate XVI, the intima is stained with acid-fuchsine.) It has been previously mentioned that the globules on the luminal side of the cell are always small in size, while they increase gradually farther up the cell. This is manifestly what is required by the solution theory, as has been recognized by Funke, Will, Altmann, Krehl (35), Pflüger and others. If fat enters the cell in the form of fatty acid and glycerine, or soap and glycerine, and these are then synthesized into neutral fats under the influence of the cell, the neutral fat would naturally appear first in small globules at the luminal edge, and these would increase in size or in number, or both, the more the products of digestion were brought under the synthesizing action.

It cannot be denied, as urged by Heidenhain and others, that if fat did enter the cell in the form of a fine emulsion, and were then to fuse into larger globules, the same appearance might be presented; but there is no assignable reason then why larger globules are not formed in the membrane (intima of isopods) or on the luminal side of the cell. In line with Will's results, it may be remarked further that beef suet does not melt at the temperature of the isopod body (about 25° C.), and cannot therefore be emulsified. Hence the globules in fig. 19 must result from synthesis.

On the question of what effects the reverse action—the synthesis of the products of digestion into neutral fats—I can do little more than conjecture with others. Until recently no attempt has been made to seek out this agency further than to ascribe it to the epithelial cells (see Moore's review of the subject in Schäfer's *Text-book of Physiology*, Vol. I, p. 452).

Recently, however, Kastle and Loevenhart (36) have shown that the ferment lipase extracted from the pancreas of the hog has the power of bringing about the synthesis of ethel-butyrate from ethyl-alcohol and butyric acid—a reaction evidently equivalent to the synthesis of palmatin or stearin from glycerine and palmitic acid or stearic acid.

In considering the fate of albumose in digestion of proteids (see p. 317), I have ventured to ascribe a ferment nature to certain granules derived from the nucleus. It may be conjectured that some of these granules represent a ferment which has a fat-synthesizing action.

Prof. Moore, in Schäfer's *Text-book* (Vol. I, p. 457), says it is agreed by all authors that "fat passes from the epithelium . . . . in the form of an emulsion," and my acquaintance with the literature confirms this statement. I have found nowhere any intimation that the fat does not pass out of the cells as such. Even Levin (37), who maintains that the water-soluble products of fat digestion in the dog are taken up by the lymph cells only, and are by them conveyed directly to the lacteals, while the epithelial cells are stimulated by the bile and pancreatic juice to take up the fat itself, leaves the inference that the fat reaches the lacteal in the form of an emulsion. The evidence for this very general opinion is plainly that fat is always found in the form of globules on the way from cell to lacteal, either in the parenchyma cells of the villus or in the lymph cells. Heidenhain, Schäfer (38), Levin and many others have figured fat in transit in this form, and the very name of the vessel which receives the fat is witness to the multitudinous observations that the fat reaches it in the form of tiny globules or an emulsion.

Does it, however, follow that because the fat reaches the lacteal as an emulsion or is found on its way thereto in this form, that it therefore leaves the cell as such? Does not the very physiological reason for the splitting of fats into fatty acids and glycerine preclude the possibility of its passage through the basement membrane, unless we assume with Brücke (39) that there are discrete channels for the passage of the food to the lacteal? If it is true, as Moore intimates, that fat leaves the cell as such, then it ought to be preserved *in* the basement membrane by the osmic reagents. I have examined carefully all my preparations with the hope of finding some such evidence, but have not found a single cell in an intestine known to have contained fat which presented the expected appearance. In one or two cases where the animal was fed with raw beef, in which there may have been a slight trace of fat, the basement membrane was found filled with small granules which blackened densely with osmic fixations; but as judged by the number of globules in the cells after a full meal of fat, there were entirely too many of these for the small quantity of fat which it is possible to suppose may have been contained in the beef, since particular care was being exercised at the time to feed with lean meat free from fat. Moreover, the cells presented coincidentally with these globules fragmented nuclei,—probably a sign of degeneration (see p. 294).

It is significant that while I was confidently expecting to find fat globules in the basement membrane, none of the drawings made at that time and reproduced here shows blackened globules even in contact with the membrane, while some of them (fig. 18) show a gradation in size downward from the region of the nucleus to the basement membrane. At this time—sixteen hours after feeding—fat was passing through the membrane, probably in small quantity only, but in fig. 19, *A* and *B*, both from the same intestine, 115 hours after feeding, it must have been passing in considerable quantity. In *B* of the last figure, fat globules are seen lying against the membrane on the outside of the cell; but here, it must be said, the blood was precipitated on the intestine by removing the dorsum and fixing the intestine *in situ*. Only in such cases have I found fat globules immediately against the membrane in the coagulum outside the cell. This coagulum is often found in this position even on intestines fixed after removal from the body. The morphological evidence, therefore, is against the passage of fat through the membrane *as fat*. The conclusion must be that it is again split up in the cell and resynthesized in the cœlomic fluid.[18]

The same figure shows several leucocytes containing fat globules. Their position along the membrane cannot, of course, be taken to indicate a special agency in removing the fat from the cell, for

---

[18] Shortly after reaching this conclusion I received Loevenhart's (40) paper, setting forth the same view from very different considerations.

they are plainly subject to the physical action of the fixing fluid. The fat globules are inside the cells, however, and this must be accepted as evidence of their ability either to appropriate fat in their own metabolism, or to transport it in the metabolism of the body. I have seen nothing which would enable one to decide whether this action is anabolic or katabolic.

IX. Secretion in the Hepatopancreas.

Weber (41), who first accurately described the hepatopancreas, recognized in its walls four distinct layers: The *serous membrane* outermost, the *muscular* between this and the *basement membrane*, and finally the *epithelial* layer. While it is the last named only with which we are specially concerned here, it may be mentioned in passing that Weber's explanation of the form of the tubes by the arrangement of the muscles is important as bearing on the discharge of the secretion into the intestine (fig. 1). He shows in his figure that the spiral twist which the tube appears to have

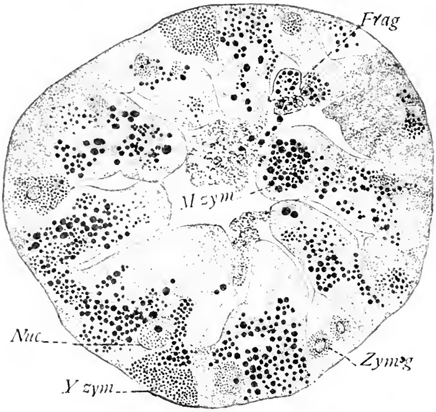


Fig. 20.—Section of a single tube of the hepatopancreas of *Porcellio scaber* × 120, showing discharge of secretion by fragmentation and by rupture of the cell membrane. *Frag.*, fragments of cell passing into the lumen; *M zym.*, mature zymogen passing into the lumen by rupture of the cell membrane; *Y.zym.*, zymogen in a young secreting cell; *Zym'g.*, zymogenesis in a young cell; *Nuc.*, nucleus of a mature cell.

undergone is due to the collection of muscle fibres into a more or less distinct band which takes a spiral course. Manifestly the peristaltic wave, beginning at the distal end and proceeding with greatest vigor along this band, will be more effective for producing a uniform and constant motion of the fluid contents than would the successive contractions of many separate bands.

The epithelium in the average physiological condition is composed, morphologically speaking, of two kinds of cells, namely, tall conical cells which project well into the lumen (often, indeed, almost meeting each other so as to obliterate the lumen) and, between these, lower cells which project less—often not at all (fig. 20). At both extreme ends of the tube the two forms of cells merge into one another and thereby constitute a uniform epithelium which, at the distal end, terminates in a proliferating mass of indifferent cells, and, at the proximal, passes over into the epithelium lining the grinding stomach. The cells of the hepatopancreas reveal a ground structure in some points like that of the

Fig. 21.—Section of single tube of the hepatopancreas of *Porcellio scaber* × 120, showing discharge of secretion by fragmentation of the cells. The cell *a* is represented with higher magnification in fig. 22.

intestinal cells. Examined fresh, large oily-looking globules are always to be found in the projecting cells, which, after most fixations, are represented by mere vacuoles. These increase in size from the base toward the apex, and often quite completely occupy the apical end, displacing the ground structure itself (fig. 22). Between the vacuoles, in well fixed cells, are to be seen small alveoles which, if the vacuoles be large and close together, are more or less distorted by the pressure. Between the alveoles and covering them, often so densely as to obscure them, are tiny granules representing interalveolar substance and alveolar contents. After some fixations, notably those containing sublimate, the cells appear to have a coarse fibrillar structure; but as this is not to be seen either in the fresh cell or after Hermann's, Flemming's, or Hermann's without acetic, it has been regarded here as an artifact similar to that produced in the intestinal cells.[19]

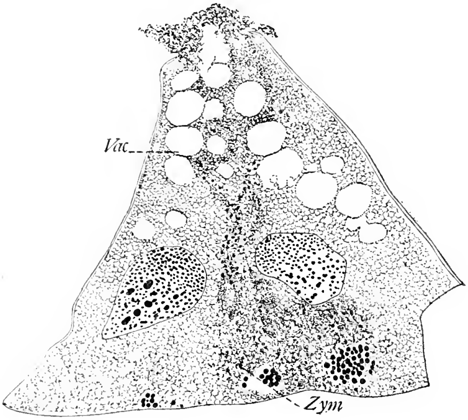


Fig. 22.—Cell *a* of fig 21 × 600. Escape of the secretion by rupture of the membrane at the free end of the cell. *Vac.*, vacuoles from which the globules of zymogen have been dissolved by the fixing fluid and other reagents; *Zym.*, zymogen granules disintegrating.

---

[19] Frenzel (46) sees a fibrillar structure in the "liver" cell of the marine isopods, relying on picro-sulphuric fixation. He does not, however, figure this for *Oniscus murarius*, on which he used osmic acid.

Each secreting cell has one or two, rarely three, nuclei. When there are two, which is by far the most common number, they are most often abreast of each other, at the same height from the base and at equal distances from the lateral walls (fig. 23). The form of the nuclei in the fresh condition is ellipsoidal or spherical. After several fixations it may present processes of various size and extent, but these again are to be ascribed to the unilateral penetration of the fluids (p. 305).[20]

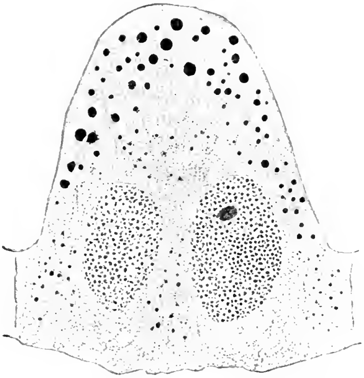


Fig. 23.—Section of a mature cell, × 600, of the hepatopancreas of *Oniscus asellus*, only moderately filled with zymogen. The gradation in size of the granules from base to apex of the cell is well seen here. Fixation, Flemming's fluid. Observe a space about each of the larger globules. Compare fig. 15.

---

[20] Prenant (42) has mentioned such processes toward the base of the cell as occurring after Flemming's fixation, and has interpreted them as analogous to those which were described by Conklin in the intestinal cells; also to those described by Korschelt for the nuclei of silk glands of the Lepidoptera and of the egg cells of *Dytiscus*. The fact that the processes are turned toward the source of nourishment and opposite the direction of penetration lends some probability to Prenant's view, whereas, in line with the results obtained by injection into the lumen of the intestine, one would expect the processes in this case to extend toward the lumen if caused artificially. In the absence of positive evidence from the experiment of injecting into the lumen of the hepatopancreas, which is very difficult on account of the small size of the tubes, it might be urged further in explanation of Prenant's observation, first, that Flemming's fluid is known to cause processes in the nuclei of the intestinal cells; secondly, that occasionally in these cells processes are

The constituent which gives character to the cells under consideration is the zymogen (figs. 20–23). In the fresh condition it is always seen as a dense mass of spherical yellowish granules surrounding the nuclei of the smaller cells. They are but rarely seen in the tall cells, the most obvious constituent of these being, as we have observed above, the oily-looking globules. On this account Weber called the smaller the "ferment cells," as opposed to the larger or "liver cells." Rosenstadt (44) for *Asellus*, Giard and Bonnier (45) for the parasitic Isopods and Frenzel (46) for the marine forms, as well as for *Oniscus murarius*, do not admit this distinction made by Weber. Claus says they are only extremes of the same kinds of cells, in no way to be distinguished. Frenzel regards the smaller as young cells and the larger merely as a later or older phase. He concludes, therefore, that the isopods are to be classed with the Phronimidæ, in that they produce both ferment and fat in the same cell, as over against the decapods, the Gammaridæ and Caprellidæ, which produced these in separate cells. Ide is inclined to adopt the view of Weber. My results confirm Frenzel, as will appear in the following discussion.

The behavior of the zymogen granules with reference to reagents is as follows. As was observed by Huet, they are speedily dissolved out by both water and alcohol. Reference to Table I, where are brought together data from a long series of different physiological conditions, shows that they are not preserved by alcohol (Nos. 24, 36, 38), only partially by picro-acetic (29, 43), and sometimes not by sublimate (28, 31), nor by sublimate-acetic (3, 9, 11, 13, 22, 41, 42, 44), nor formo-alcohol (32). They are always preserved by Flemming's, Hermann's and Hermann's without acetic (also osmic-acetic and osmium-bichromate, Altmann's). It will be seen also from the table that they are sometimes preserved in the small cells and not in the large ones (Nos. 11, 13, etc.), sometimes again in both kinds of cells, where they appear precisely alike (Nos. 15, 18, 26, etc.). With the osmic fixations, particularly the platinic-chloride-osmic acid mixture, they behave a little differently in the two kinds of cells. The densely aggregated granules about the nuclei of the small cells come through the stains wholly un-

---

seen extending opposite to the direction of penetration, while they are also occasionally seen in the cells of the hepatopancreas, extending toward the lumen after fixation; thirdly, as was remarked in the beginning, nuclei in the fresh condition are regularly curvilinear.

affected, exhibiting a brown color, plainly the characteristic osmic color. Those in the base of the large cells, on the other hand, take the stains. Thus in Nos. 21, 25, etc., stained in iron-hæmatoxylin, they appear brown and black respectively, while in No. 35, stained in acid-fuchsine, brown and red. After picro-formalin also (No. 16) those in the large cells stain red in Biondi-Heidenhain, while those in the small cells remain unstained.

In Nos. 1 and 2 there is a complete transition from one color to the other, some retaining no stain, others retaining only a light shade or only a peripheral ring of black, still others holding it densely. Moreover, the transition does not stop at granules of the same size; among those in the large cells which hold the stain most tenaciously there is a perfect gradation from small granules to large globular masses (fig. 20). The latter correspond to the contents of the vacuoles mentioned above (fig. 22). We have evidence, therefore, that the two kinds of cells are, as Frenzel holds, but the young and mature phases of the same kind. Our evidence goes a step farther. Frenzel found both zymogen granules and fat globules in the same cell, and from this concluded that all the cells produce both, the ferment during the early life and fat later. Now we have been able to trace a complete transition from the zymogen granules to the large globules, merely by securing a good fixation for all the cell constituents. The indication is, therefore, that we have to do not with two distinct products, but with different stages in the formation of a single product.

Before going farther with the present discussion it will be necessary to present the changes which the cells undergo in secretion. Fig. 21 represents a cross-section of No. 10 (Table I) preserved twelve hours after feeding—this following a fast of eleven days. In this case the large globules are not preserved, only their vacuoles being seen. At the bottom of the cells are masses of zymogen granules, some of which are becoming less distinct in outline, others are represented merely by a dense mass of small granules. Fig. 20 (No. 20), sixteen hours, after a fast of twenty-one days, shows the large globules preserved. In the former case, as well as in the latter, the ends of some cells have broken down and are undergoing a process of disintegration. Sometimes the whole end of the cell is involved in this destruction, or the end may break up into large or small fragments, or finally break off as a whole, and the larger or smaller pieces are then found in the lumen as far down as the canal which leads to the intestine, where they may lodge for a time and temporarily block the passage. In other cases still the globules only seem to be set free; while *the small zymogen granules seldom come near the discharging end.* The nuclei are not lost, nor is any part of the cytoplasm below them.[21]

After complete discharge the cells diminish rapidly in height until they are quite flat. Even at this size they are easily to be distinguished from young cells, which may as yet be no taller than they, by the absence of small zymogen granules about the nucleus, by the shape of the globules or globular spaces, and by a thickening of the free edge (when this is not lost). The last two effects are caused by a retraction, as if the cells were elastic. When discharged the spaces occupied by many of the globules are obliterated, and a thickening or moving together at the free edge occurs, forming a layer which always stains densely (fig. 21) (this is the thickening just mentioned). Those globules which are not discharged suffer a change of form by compression, so that they are always laterally elongated. I have not so far been able to follow the fate of the discharging cells further than this, or to obtain further evidence that they are completely destroyed and replaced by new cells.

It will be observed from the table that discharging cells may occur at any interval after a single meal up to 124 hours (No. 44), although there is a marked decrease in the number after forty-eight hours, and in some cases hardly any are to be found at ninety hours (Nos. 40, 41, 42).

In a single case (41) some of the young cells seem to be discharging a fluid substance; but as the fixation is one which does not always preserve the zymogen, and it has not been confirmed by any perfectly trustworthy fixation, no account has been taken of it here.

By whatever process the discharge takes place—fragmentation, dissolution, or mere evacuation—in every case there issues the fluid whose precipitate gives the characteristic coagulum. Fig. 20 shows some of the globules maintaining their identity for a time, but sooner or later dissolving. They are not the only source of the fluid, for, as in fig. 22, which contains a very abundant interalveolar substance, this as well as the alveoles of the cells contribute to its formation. As we have already observed, small zymogen granules,

---

[21] In one or two cases of excessive feeding, where the cells become enormously gorged with a substance which stains blue in Biondi-Heidenhain, after Zenker and sublimate, the nuclei may be displaced and lost in broken-off fragments (Nos. 14 and 46, table).

which are readily distinguished by color, do not contribute directly. Some of these appear to dissolve without being confined to a globule (as in the bottom of fig. 15), to be added to the interalveolar substance which precipitates in the form of very fine granules. Close comparison of this with the precipitate from the globules, as well as close scrutiny of the precipitate found in the lumen, fails to reveal any difference corresponding to granules and globules.

It would be unwise to attempt, from the facts thus far reached, to show that there is no chemical difference between the various cell constituents which ultimately share in the formation of the secretion, or still more that no corresponding differences are retained throughout the existence of the secretion. There is every reason for thinking that the secretion is far from simple in nature. So far as they bear on the occurrence of fat, however, the facts just rehearsed seem to speak very positively. Both Weber and Frenzel base their assertion that the globules contain fat on the osmic reaction and on the action of fat solvents (ether). Nothing is here urged against the facts alleged by these authors. What seems fatal against concluding therefrom that the substance in question is pure fat is that, as we have seen, it is never represented in the coagulum of the secretion by globular spaces such as fat ought to leave, and such as it always does leave when dissolved after fixation. The globular masses which *sometimes* come out of the cell as such, and do exist in the fresh secretion as oily-looking drops, invariably, so far as my observation goes, precipitate as a dense coagulum, not to be distinguished from the remainder of the secretion. What then is the nature of the globules? Aside from their oily appearance, nothing occurs in the literature reviewed which throws much light on their nature as they are to be seen in the fresh condition. Sufficient prominence has not been given either to the fact that in this condition they are to be seen in all sizes. They are usually much clearer looking than the zymogen granules, but even in this respect the limits are not sharp. Frenzel mentions the fact that the oil globules in *Ione*, *Gyge*, *Idotea hectica* and *Sphæroma* have almost always a definite color, "namely, in the first three greenish-yellow (*wie das Secret*), in the least one a brownish-yellow."

The conclusion which appears very evident from the foregoing is this: zymogen granules are merely young stages of the large globules or, conversely stated, the globules are but a matured state of the zymogen granules. The difference as to form, color, behavior toward fixing fluids and staining capacity is due to a difference in purity. The granules, densely packed about the nuclei of the young cells, are in a nascent state, consisting of a pure ferment-forming substance. In the larger cells—that is, as the young cells mature—the zymogen takes up fatty substance from the cytoplasm, and this dilutes the ferment-forming body, at the same time rendering it more soluble in certain reagents and improving its capacity for certain stains.

a.—Relation of Secretion to Feeding.

The column of Table I headed "Secretion in lumen" exhibits the relation of the quantity of secretion in the lumen and its passage into the intestine to the stages of absorption of proteids (raw meat) exhibited in the last columns. Owing to the method of removing from the animal tne intestine and hepatopancreas, by which their connection is often broken, the later datum was not in all cases to be had. It will be seen, however, that beginning with fresh condition—that is, animals taken quite at random from the natural habitat—and passing through the starved condition (No. 3) up to 124 hours after feeding, and to an animal kept a whole week on raw meat, there is almost always an "abundance" of the secretion in the lumen. In a few cases, as No. 3 (starved) and 42 (ninety-eight hours after feeding), the quantity in the proximal end of the tube is small. There is no very marked decline, although it might well be expected in the course of another day or two of fasting.

The chemical reaction of the secretion, as determined by teasing the "liver" on litmus paper, is slightly alkaline for animals taken from the natural state. The staining affinity of the secretion seems to vary. Thus in 13 and 22, both of *Oniscus*, starved twenty-one days and killed sixteen and twenty hours respectively after eating in the same fluid and treated precisely alike (stained in Biondi-Heidenhain), in the one case the secretion takes the methyl green, in the other the plasma ssain and comes out red. A number of such intestines have been seen, and both colors have been seen in the same intestine. If the staining is a chemical reaction, and there seems to be no doubt of it in this case, we must conclude that the reaction of the secretion must vary from acid to alkaline (as determined by Biondi-Heidenhain stain as an indicator). Not enough cases have been noted to establish any cycle of such change, or to relate it in any way with the quantity or kind of food. It is interesting, in this connection, to note that Krukenburg (26) has found a similar difference for *Carcinas mœnas.*

Huet has shown that the secretion of the hepatopancreas acts on the proteids (muscular fibre and albuminoids generally, white of egg, coagulated protoplasm of vegetable cells, etc.) in *Porcellio scaber* and *lævis;* on starch very slightly in the case of *Ligia;* while on fats he obtained only negative results (slightly emulsifies oil of olives). He concludes that the secretion is "not a true bile."

It has been seen in the section on the absorption of proteid that albumose appears in the intestinal cells in eight hours (in one case it was detected in four hours) after feeding. No attempt has been made to establish ultra-minimum time for the appearance of dextrose in the intestine after feeding with starch. The least time noted was twenty-four hours. There is good evidence that the "liver" secretion accomplishes the hydrolisis of fat. We may conclude that the secretion of the hepatopancreas contains ferments which act on all classes of foods.

X. SUMMARY AND CONCLUSIONS.

1. The apparatus concerned in the absorption of foods and the production of secretion in the land isopods consists essentially of simple tubes, the intestine and hepatopancreas, bathed and separated by the blood.

2. That part of the intestinal wall concerned in absorption is a single-layered epithelium composed of very large cells. That part of the hepatopancreas concerned directly in the formation of secretion is a single-layered epithelium, composed of smaller, young cells and larger, maturing or matured cells.

3. The intestine in the freshly hatched individual, a simple tube, grows by amitosis, especially at the time of moulting, as well as by enlargement of the cells. In the mid-dorsal line of the anterior portion a folding of the wall occurs later, giving rise to a structure which we have called, after Conklin, the typhlosole. The typhlosole arises in *Porcellio spinicornis* by a primary evagination of the median six longitudinal rows of cells; there is then a secondary invagination of the median two rows, which project into the lumen and extend laterally by their free margin so as to cover the lateral inner grooves formed at the sides, thereby cutting off, except at the posterior end of the typhlosole, two channels, more or less completely separated from the remainder of the lumen.

4. The intestinal epithelium is a syncytium, the cytoplasm being continuous from one cell to another. Intercellular fibres, together with furrows in the basement membrane and intima, serve to mark off the cells distinctly.

5. The cytoplasm of the intestinal cells is alveolar in structure. Between the alveoles is a homogeneous substance which precipitates as a finely granular coagulum. Intracellular fibres run between the alveoles; at the luminal side of the cell they are parallel and are greatly thickened so as to form a palisade from the intervals in which the cytoplasm may be excluded.

6. The nucleus of the intestinal epithelial cells is normally spherical in all physiological conditions; it is alveolar in structure in the fresh condition, and contains in "perfectly" fixed material numerous large granules of chromatin.

7. In the moult of the chitinous lining of the intestines the cœlomic side of the epithelial cell rarely suffers any change. The luminal side undergoes the following changes: the thickened ends of the fibres disappear; the alveolar structure at the same time becomes concealed by a fluid substance which precipitates in killing fluids in the form of fine granules. The new chitin is probably formed by some process of hardening this substance. After the new lining begins to appear, delicate fibres are seen on the luminal side of the cell. The strength of the palisade on the luminal side varies directly with the time from the last moult.

8. The land isopods after a period of starvation will eat various kinds of pure foods.

9. Starving for a considerable time (three weeks) produces the following changes in the intestinal cells: the interalveolar substance is reduced in quantity; the cytoplasm may withdraw from the luminal side, leaving elongated spaces between the fibres; vacuolations may appear elsewhere in the cytoplasm.

10. After feeding a starved animal for ten minutes on finely chopped raw beef, before any food is visible in the cells, definite masses of fine granules appear about the nucleus. Some of these at least come from the nucleus. They increase in number up to thirty hours after feeding. We have designated this granular substance as an intracellular ferment.

11. Eight hours after feeding a starved animal with finely chopped raw beef, albumose appears in the intestinal cells. The

course of the albumose through the cells is uninfluenced by the cell structure, except in a purely mechanical way. In traversing the cell it behaves independently of the cytoplasmic structure. Albumose may accumulate on the cœlomic side of the cell from sixteen hours onward after feeding. Judging by the size of the granules formed by precipitation with killing fluids, albumose may exist in the cell in as great as a 10 per cent. solution. Albumose has not been found in the cœlomic fluid. It is probable that the intracellular ferment is concerned in the change of food from the albumose stage to a later stage of the hydrolisis (peptone) or to a stage in the inverse process toward albumen.

12. The cells of the typhlosole absorb soluble foods. The primary purpose of the structure, however, is to provide channels through which the secretion of the hepatopancreas may flow, unobstructed by solid food, to the median portion of the intestine.

13. Dextrose is found in the intestines of animals which have been starved, fed on potato starch, then killed in twenty-four hours from the time of feeding.

14. Microscopical study of the absorption of fats indicates: (*a*) That this class of foods is hydrolized by the digestive secretion of the heatopancreas; (*b*) that they are absorbed in the form of cleavage products, and (*c*) are at least partially synthesized into neutral fats under the influence of ferment action inside the cell; (*d*) they leave the cell not as discrete fat particles, but probably in the form of cleavage products; (*e*) they appear in the blood coagulum and in the blood corpuscles as neutral fats, reducing osmic acid and not staining with acid-fuchsine.

15. The hepatopancreas contains but one kind of secreting cells. In a young stage these cells contain zymogen granules in nascent condition, densely massed about the nuclei; as the cells mature the zymogen granules take up from the cytoplasm fatty substance, whereby they become larger, looser in structure, more soluble in many fixing fluids and more receptive of certain stains. The ferment thus matured is set free into the lumen by (*a*) fragmentation of the cell, (*b*) dissolution of the cell, (*c*) evacuation from the cell.

16. The secretion of the hepatopancreas thus elaborated contains ferments which act on the three classes of foods—proteids, carbohydrates and fats.

TABLE I.

No.	Genus.	Days starved.	No of hrs. after feeding.	Fixation.	Secretion of Hepatopancreas.		Food in Cells of "Mid-gut."	
					In Lumen.	Zymogen in Cells.	Anterior Portion.	Median Portion.
1	P[22]	Fresh		Hermann's fluid[24] injected, 24 hrs.	Abundant.	All stages preserved. Small yellow to large black.	Food entering cells. Few gran. in various parts.	Gran. (albumose) on cœl. side of nucleus. (Fig. 9.)
2	P	Fresh		Hermann, 24 hrs.	Abund. Many cells recently disch.	Same as above.	No food distinguishable.	Gran. (albumose) luminal to cœl. side.
3	O[23]	14		Sublimate-acetic,[25] 3 hrs.	None in ant. Much in post.	Only in young cells.	Small gran. in masses.	Same scattered.
4	P	24	4	Hermann, 20 hrs.	Abundant. Cells in one tube all collapsed.		Few gran. (albumose) entering.	No. gran. (albumose).
5	P	24	4	Hermann (intestine injected), 20 hrs.	Abund. Luminal end of cells empty.	Young cells and in base of discharging cells.		Gran. chiefly on luminal side.
6	P	24	4	Hermann (intestine cut), 20 hrs.	Abund. Luminal end of cells empty.	Same as above.	Small gran. in masses.	
7	P	11	4	Platinic chloride-osmic acid mixture,[26] 15 hrs.			Small gran. in masses about nucleus. (Fig. 10, *B.*)	No free food distinguishable.

[22] *Porcellio.* [23] *Oniscus.* [24] For formulæ not given in the table, see Lee's *Vade Mecum*, 5th Ed. [25] Saturated aqueous solution of $HgCl_2$ with 2% acetic acid. [26] Hermann's fluid without acetic acid.

8	P	7	8	Platinic chloride osmic acid, 17 hrs.			Gran. (albumose) in masses of small granules. (Fig. 11, *A*).	No free food distinguishable.
9	P	14	9	Sublimate-acetic, 30 min.	Abund. Passing into int. Many cells disch. and l. end empty.	In young cells and up to nucl. in mature cells.	Few gran. (albumose) in streams.	Very little free food.
10	P	11	12	Platinic chloride-osmic acid, 15 hrs.	Abund. Passing into int. Many cells discharging.	In young cells and in mature cells to free end.	Small gran. in masses about nucleus.	Very few gran. (albumose).
11	O	2	12	Sublimate-acetic, 10 hrs.	Abund. Passing into int. Discharging cells in all parts.	In young cells.	Few gran. (albumose).	Gran. (albumose) on cœl. side of nucl.
12	O	21	16	Picro-acetic (Lee), 2 hrs.	In anterior end of intestine.		Small gran. about nucleus and in masses.	No free food distinguishable.
13	O	21	16	Sublimate-acetic, 30 min.	Abund. Passing into int. Cells all discharged. [Green.][27]	In young cells.	*Moulting.* No signs of food.	Small yellowish gran. abundant on cœl. side of nucl.
14	O	21	16	Zenker's fluid, 2 hrs.	Abund. Passing into int. [Red.]	In young and mature cells. Cells gorged with blue-staining substance.	Gran. (albumose) abundant.	Large gran. (albumose) on cœlomic side of nucleus.

---

[27] Color after staining with Biondi-Heidenhain.

TABLE I (*continued*).

No.	Genus.	Days starved.	No. of hrs. after feeding.	Fixation.	Secretion of Hepatopancreas.		Food in Cells of "Mid-gut."	
					In Lumen.	Zymogen in Cells.	Anterior Portion.	Median Portion.
15	O	21	16	Formalin-alcohol,[28] 2 hrs.	Abundant. Passing into int. [Red.]	In young and mature cells. (Yellow.)	Small gran. in masses (yellowish).	Gran. on cœl. side of nucleus.
16	O	21	16	Picro-formalin, 2 hrs.	Abund. Passing into int. [Red.]	Yellow in young cells. Staining red in B.-H.[30] in mature	Small gran. in masses (yellowish).	Gran. on cœl. side in few cells.
17	O	21	16	Platinic chloride-osmic acid, 24 hrs.	Abund. Passing into int. Many cells discharging.	Brown to black. young mature	Small granules scattered.	Gran. (albumose) on cœl. side.
18	O	21	16	Picro acetic (Conklin),[29] 2 hrs.	Passing into intestine.	Young and mature, clear yellow.	Small gran. in masses about nucleus.	Yellow gran. abundant, esp. on cœl. side of nucleus.
19	O	21	16	Hermann, 24 hrs.	Abund. Passing into int. Many cells just discharged.	Brown to black, both young and mature cells.	Gran. (albumose) abundant.	Gran. (albumose) on cœl. side.
20	O	21	16	Flemming (Strong), 24 hrs.	None in ant. portion of tube.	Smaller gran. not preserved. Large glob. in mature, black.	Small gran. in masses. (Fig. 10, *A*.)	Gran. in streams and on cœl. side.

---

[28] 5% formalin, 1 pt.; 95% alcohol, 2 pts. [29] Half saturated solution of picric acid in 50% alcohol, with 2% acetic acid. [30] Biondi-Heidenhain.

21	P	8	18	Platinic chloride-osmic acid, 24 hrs.	Abund. Passing into int. Cells in all stages of discharging.	Brown in young to black in mature cells.	Gran. (albumose) in streams. (Fig. 11, *B.*)	No free food.
22	O	21	20	Sublimate-acetic, 100 min.	Abund. Passing into int. Cells med. height. [Red.]	Only in young cells.	Small gran. in masses and scattered (yellowish).	Same gran. on cœl. side of nucl.
23	P	14	24	Hermann, 24 hrs.		Brown in young, black in mature cells.		Gran. albumose in streams. Plate XVI, fig.1
24	P	5	24	95% alcohol, 24 hrs.	Abundant.	Not preserved.	No albumose.	No albumose. Plate XVI, fig.2
25	P	8	24	Platinic chloride-osmic acid, 18 hrs.	Abundant. Cells discharging.	Brown in young, black in mature.	Small gran. in masses with large gran. (albumose).	Gran. (albumose) on cœl. side of nucleus.
26	P	14	26	Sublimate-acetic, 30 min.	Plentiful. None passing into intestine. Few cells discharging.	Young and mature, yellow.	No food found. Animal may have been about to moult.	
27	P	8	32	Platinic chloride-osmic acid, 24 hrs.	Abundant. Passing into int. Cells discharging.	Brown in young, black in mature.	Small gran. and large (albumose).	Gran. (albumose) on cœl. side.
28	O	2	32	Saturated sublimate, 2 hrs.	Quantity small in distal portion.	Not well preserved.	Small gran. in masses.	Gran. (albumose) on cœl. side.

TABLE I (*continued*).

No.	Genus.	Days starved.	No. of hrs. after feeding.	Fixation.	Secretion of Hepatopancreas.		Food in Cells of "Mid-gut."	
					In Lumen.	Zymogen in Cells.	Anterior Portion.	Median Portion.
29	P	14	42	Picro-acetic (Lee), 2 hrs.	Abundant. Most of cells disch. Some discharging.	In young cells.	Gran. in masses (albumose).	Gran. (albumose) on cœl. side of nucl.
30	O	14	42	Sublimate-acetic, 30 min.	None in prox. end of tube. Many cells discharged.	In young cells: in mature at proximal end.	*Moulting.* Small gran. on c. side.	*Moulting.* Small gran. on cœl. side.
31	O	14	42	Saturated sublimate, 2 hrs.	Abund. Passing into int.	Not much preserved.	Gran. (albumose) abundant.	Food not definite, gran. on cœl. side.
32	O	14	48	Formalin-alcohol, 1 hr.	Abund. in prox. end. [Red.]	None preserved.	Gran. in masses.	Gran. on cœl. side.
33	O	14	48	Picro-formalin, 50 min.			Very large gran. (albumose) with masses of small gran.	Gran. (albumose) on cœl. side.
34	O	14	48	Platinic chloride-osmic acid, 48 hrs.	Abundant. Passing into int. Many cells discharging.	Brown in young, black in mature. All glob. preserved.	Very large gran. (albumose) with masses of small gran. on c. side. Plate XVI, fig. 3.	Gran. (albumose) very abund. all through the cell.

35	P	12	50	Hermann, 48 hrs.	Abundant. Cells med. height in prox., discharged in distal.	Brown in young, red in mature. (Acid Fuchsine.)	Gran. albumose passing around nucl., also small black gran.	Gran. albumose very abundant, also small black gran.
36	P	21	50	95% alcohol, 12 hrs.	Abundant.	None preserved.	No albumose. Plate XVI, fig. 4.	No albumose.
37	P	20	74	Hermann, 12 hrs.		Brown in all cells.	Few gran. albumose.	Gran. albumose also small black gran. very abundant.
38	P	19	74	95% alcohol, 12 hrs.	Abundant.	None preserved.	No albumose.	No albumose.
39	P	14	90	Platinic chloride-osmic acid, 48 hrs.	Much in prox. end. Less in distal. Some cells discharging.	Preserved only in young cells.	Few gran. (albumose).	Few gran. (albumose).
40	P	14	90	Sublimate-acetic, 35 min.	Much. Young cells elongating.	Very abundant in young cells.	Small granules in masses, especially about nucleus.	No free food.
41	O	14	90	Sublimate-acetic, 40 min.	Little in prox. Much in distal. Some young cells seem to be discharging.	None preserved.	Flocculent gran. masses staining with Bismarck brown.	Same.

TABLE I (*continued*).

No.	Genus.	Days starved.	No. of hrs. after feeding.	Fixation.	Secretion of Hepatopancreas.		Food in Cells of "Mid-gut."	
					In Lumen.	Zymogen in Cells.	Anterior Portion.	Median Portion.
42	P	14	98	Sublimate-acetic, 40 min.	Little in prox. Much in distal.	Abundant in young only.	Flocculent gran. masses abundant.	No free food. Empty spaces in cell.
43	O	14	100	Picro acetic (Conklin), 4 hrs.	Little in all parts of tube.	Very little preserved.	Gran. in masses about nucleus (yellowish).	Same gran. on cœl. side of nucl.
44	O	14	120	Sublimate-acetic, 40 min.	Abundant throughout. Cells discharged.	Only in young cells, stains bluish. B.-H.	Small brownish gran. abundant. Large gran. (albumose) few.	Small, poorly staining gran. on cœl. side.
45	P	3	120	Hermann (intestine cut), 10 hrs.	Abundant. Most cells discharged.	Very abundant in young cells elongating.	Small gran. in masses.	Food not definite. Gran. on cœl. side
46	O	18	7 days on meat	Sublimate-acetic, 50 min.	Much. Cells gorged with blue-staining mass.	Few gran. yellow. Many in mature cells stain red, B.-H.	Gran. (albumose) very abundant.	Some very large gran. (albumose).

TABLE II.

	Precipitated by	Further Treatment.	Result.
(1) 1% Hemialbumose.	5% $HgCl_2$	Washed in alcohol, stained in 1% aqueous Acid Fuchsin, 10 min.	All coagulum, no granules.
(2) 1% Deutero-albumose.	5% $HgCl_2$	Dried from 95% alcohol, st. in 7% aq. Acid Fuch. 15 min.	Few very large granules in dense coag.
(3) 2% Peptone.	5% $HgCl_2$	Dried from 95% alcohol, st. in 7% Acid Fuch. in aniline water.	All very sharp granules of uniform size.
(4) 2% Peptone.	Flemming.	Washed 6 hrs. in running water, st. 7% Acid Fuch. in aniline water 10 min.	All sharp granules uniform size.
(5) 2.5% Peptone.	1% Chromic Acid.	Washed 6 hrs. in running water, st. 7% Acid Fuch. in aniline water 15 min.	Same as above, smaller than from 5% Pep. (q. v.), fig. 13.
(6) 5% Peptone.	1% Chromic.	Same as above.	All granules: not uniform. Larger than from 2.5% Pep. (q. v.), fig. 13.
(7) 5% Peptone.	Hermann's fluid without Acetic.	Same as above.	All granules uniform size, fig. 5, Plate XVI.
(8) 5% Peptone.	95% Alcohol.	Washed 1 hr. in running water (from 50% alcohol), drying, the granules melt away: may be re-precipitated.	Granules like above all dissolved.
(9) 5% Peptone.	5% (HgI_2 KI)	Washed in running water 4 hrs.	Granules like above slowly dissolve.
(10) { ½% Serumalbumen. ½% Deutero-albumose. }	{ 2% Osmic 1 pt. 2% Platinic-Cl. 3 pts. }	Washed 6 hrs. in running water, st. in Iron-Hæmatoxylin.	Few well defined granules in dense coagulum.
(11) { ½% Serumalbumen. ½% Deutero-albumose. }	Hermann.	Washed 6 hrs. in running water, st. in 7% Acid Fuch. in aniline water.	Granules imbedded in coagulum, fig. 6, Plate XVI.
(12) 2% Serumalbumen.	1% $HgCl_2$	Washed 6 hrs. in running water, then impregnated with [1% D., next line].	Coagulum in which were granules as in fig. 7, Plate XVI.
1% Deutero-albumose.	Flemming.	Washed 24 hrs. in running water, st. in 7% Acid Fuch. in aniline water 20 min.	

Bibliography.[31]

(1) Fischer, A. Fixirung, Farbüng und Bau des Protoplasmas, Jena, 1899.
(2) Van Gehuchten. La Cellule, VI, 1890.
(3) Ide, M. La Cellule, VIII, 1892, p. 99.
(4) Conklin, E. G. Amer. Nat'l, Jan., 1897, p. 66.
(5) McMurrich, J. P. Journ. Morph., XIV, 1897, p. 83.
(6) Schönichen, W. Zeitschr. f. wis. Zool., 1898, p. 143.
(7) Huet, L. Journ. d. l'Anat. et de la Phys., XIX, 1883, p. 241.
(8) Lereboullet, A. Mem. sur les crustacés de la famille Cloportides, etc., Strassburg, 1853.
(9) Lee, A. Bolles. La Cellule, XI, 1895, p. 37.
(10) Carnoy. La Cellule, I, 1885, p. 190.
(11) Von Bambeke, C. H. Archiv. de Biologie, VII, 1887, p. 349.
(12) Ziegler, H. E., und vom Rath, O. Biol. Centrlbl., XI, 1891, p. 744.
(13) Frenzel, J. Biol. Centrlbl., XI, 1891, p. 558.
(14) Löwit, M. Biol. Centrlbl., XI, p. 513, 1891.
(15) Ryder, J. A., and Pennington, Mary E. Anat. Anz., IX, No. 24–25, p. 759.
(16) Leydig, Fr. Arch. f. Anat., Physiol., Jahrg. 1855, p. 376.
(17) Leydig, Fr. Zeitschr. f. wiss. Zool., XXX, Suppl., 1878, p. 225.
(18) Hardy, W. B. Journ. Physiol., XXIV, 1899, p. 158.
(19) Foote and Strobell. Journ. Morph., 1900, XVI, p. 517.
(20) Schimkewitsch. Biol. Centrlbl., XVI, 1896, p. 177.
(21) Korschelt, E. Sitzungsbr. Ges. Nat. Fr., Berlin, 1887, No. 7.
(22) Braun, M. Arbeit aus Zool-Zoot. Inst., Würzburg, II, 1875.
(23) Mathews, A. E. Journ. of Morph., XV, Suppl., p. 172.
(24) Plateau, F. Mem. de l'Academie royale de Belgique, 42, 1878.
(25) Hoppe-Seyler. Pflüger's Archiv., XIV, 1877, p. 395.
(26) Krukenburg. Unters. aus dem phys. Institut, Heidelberg, II, Hf. 3, p. 261.
(27) Neumeister. Lehrbuch der physiologischen Chemie, 1893, p. 200
(28) Brand und Ratzeburg. Medicinische Zoologie, II, 1833.
(29) Heidenhain, J. Arch. f. ges. Phys., XLIII, Suppl.
(30) Altmann, R. Arch. f. Anat. u. Physiol., Anat. Abth., 1889, Suppl.
(31) Pflüger. Arch. f. ges. Phys., LXXXII, 1900, p. 303.
(32) Funke. Zeitscnr. f. wiss. Zool., VII, 1855, p. 315.
(33) Will. Arch. f. ges. Phys., XX, 1879, p. 255.
(34) Kölliker. Handbuch der Gewebelehre, 1863, p. 447.
(35) Krehl. Archiv. f. Anat. u. Phys., Anat. Abth, Suppl., 1890, p. 97.
(36) Kastle and Loevenhart. Amer. Chem. Journ., Dec., 1900.
(37) Levin. Archiv. f. ges. Phys., LXIII, p 171.
(38) Schäfer, E. A. Internat. Monatschr. f. Anat. u. Hist., Leipzig, II, 1885, p. 6.
(39) Brücke. Denkschriften d. Acad. d. wiss. Wien, VI, 1854, p. 99.
(40) Loevenhart, A. S. Amer. Journ. of Physiol., VI, 1902, p. 331.
(41) Weber, Max. Arch. f. mikr. Anat., XVII, p. 385.
(42) Prenant, A. Comptes Rendus, IV, p. 147.
(43) Korschelt, E. Arch. f. mikr. Anat., XLVII, Hf. 3, 1896.
(44) Rosenstadt. Biol. Centrlbl., VIII, 1888, p. 452.
(45) Giard et Bonnier. Contributions a l'étude des bopyriens, Travaux de l'inst. zool. de Lille, 1887.
(46) Frenzel, Joh. Mitth. aus der Zool. Sta. Neap, V, 1884, p. 50.

---

[31] Only works actually consulted are mentioned.

EXPLANATION OF PLATE XVI.

All figures drawn by the aid of the camera lucida × 600.

Fig. 1.—Median cell from intestine of *Porcellio scaber*, fed with raw beef; intestine fixed after 24 hrs. in Hermann's fluid (24 hrs.) and washed in water for 24 hrs. Sections stained in 15 per cent. acid-fuchsine in aniline water. *Alb. Gr.*, albumose granules.

Fig. 2.—Median cell from intestine of *Porcellio scaber*, fed with raw beef; intestine fixed after 24 hrs. in 95 per cent. alcohol (24 hrs.), washed in lower grades and finally in water 15 hrs. Sections stained in 15 per cent. acid-fuchsine in aniline water. Albumose granules washed out. Nucleus shows effects of unilateral penetration of the fixing fluid.

Fig. 3.—Median cell from intestine of *Porcellio scaber*, fed with raw beef; intestine fixed after 50 hrs. in Hermann's fluid (24 hrs.), and washed in water 24 hrs. *Alb. Gr.*, albumose granules.

Fig. 4.—Median cell from intestine of *Porcellio scaber*, fed with raw beef; intestine fixed after 50 hrs. in 95 per cent. alcohol (24 hrs.), and washed in water 15 hrs. Albumose granules washed out. The nucleus is distorted by the fixation. The mass which occupied the concavity of the nucleus previous to washing may have contained albumose. Compare fig. 3.

Fig. 5.—Two per cent. peptone (depur. sicc. aus Fibrine, Grübler) precipitated on cover-glass with Flemming's strong fluid. Washed in running water 6 hrs. Stained in 7 per cent. acid-fuchsine.

Fig. 6.—Two per cent. serumalbumen and 2 per cent. deuteroalbumose (Grübler) (equal parts) precipitated on cover-glass by Hermann's fluid, washed in running water 6 hrs., and stained in 7 per cent. acid-fuchsine in aniline water. *Cg.*, coagulum of albumen; *Alb. Gr.*, albumose granules.

Fig. 7.—Two per cent. serumalbumen precipitated by 1 per cent. $HgCl_2$ and washed in running water 6 hrs.; then impregnated with 1 per cent. Deuteroalbumose 2 hrs. and again precipitated by Flemming's fluid (24 hrs.), and stained in 7 per cent. acid-fuchsine in aniline water. *Cg.*, coagulum of albumen; *Alb. Gr.*, albumose granules.

Fig. 8.—Median cell from "mid-gut" of *Oniscus asellus*, fed with raw beef; intestine fixed after 20 hrs. in sublimate-acetic. Sections stained in Biondi-Hiedenhain. *Art.*, artifact caused by unilateral penetration of the fixing fluid (see p. 305); *Alb. Gr.*, albumose granules.

Fig. 9.—Median portion of the typhlosole from intestine of *Porcellio spinicornis*, fed with raw beef; intestine fixed after 24 hrs. in sublimate-acetic. *Alb. Gr.*, albumose granules.

Fig. 10.—Two anterior cells from intestine of *Porcellio scaber*, fed with olive oil and fixed after 24 hrs. in 1 per cent. platinic chloride 15 pts., 1 per cent. osmic acid 4 pts. Sections stained in 10 per cent. acid-fuchsine. All black granules are fat.

ADDITIONS TO THE JAPANESE LAND SNAIL FAUNA.—VI.

BY HENRY A. PILSBRY.

The present communication consists chiefly of detailed descriptions of species briefly defined in footnotes to my *Catalogue of the Clausiliidæ of the Japanese Empire,*[1] although a number of new species, not enumerated therein, are now defined. The discovery of all of these forms we owe to the continued exertions of Mr. Y. Hirase, of Kyoto, Japan.

Section MEGALOPHÆDUSA Boettger.

Clausilia mitsukurii Pilsbry.

> Pilsbry, these *Proceedings* for 1901, p. 648, footnote No. 2 (March 1, 1902).

Shell rimate, fusiform, *short* and *obtuse at the ends,* somewhat *Buliminus*-shaped; purplish-brown under a thin cuticle, which has been almost entirely lost in the type specimens. Surface dull, finely striate, everywhere extensively eroded by the joint action of free carbonic acid and mechanical wear. Spire tapering to the *very obtuse* apex. Whorls 8½ to 8¾, slightly convex, the latter half of the last whorl compressed, tapering. Aperture but slightly oblique, fleshy-brown within, oval or ovate. Peristome reflexed, flesh-colored, the upper margin adnate for a short distance. Superior lamella oblique, not reaching the margin, continuous within with the spiral lamella, which extends to a latero-ventral position. Inferior lamella retreating, distinctly truncate at its base, giving off a branch toward the superior lamella, strong, but slightly curved and obliquely ascending within, penetrating deeper than the superior lamella, to the ventral side. Subcolumellar lamella barely emerging. Principal plica short, latero-dorsal.

---

[1] In all cases the descriptions have been drawn from the original specimens defined in the footnotes of that catalogue, though in some cases additional material has also been studied in connection with the types.

About 8 short, almost tuberculiform palatal plicæ stand in a lateral position, the upper and lower ones being a little larger.

Length 28½, diam. 8½, length of aperture 9 mm.

Length 28¾, diam. 7½, length of aperture 8¼ mm.

Length 29, diam. 8, length of aperture 8½ mm.

Clausilium long and narrow, parallel-sided, tapering and thin at the distal end, moderately excised on the columellar side of the filament.

Tomisato, Kii. Types No. 82,468, A. N. S. P., from No. 762 of Mr. Hirase's collection.

In this species the spire is shorter, thicker and more obtuse than in any form of *C. martensi* which has come under my observation. It is also smaller, with fewer whorls.

In the type specimens there remains very little cuticle, and what there is is extensively, minutely pitted and of a yellow or golden color around the pits.

Named in honor of the well-known Japanese zoologist. It will be figured in connection with a review of the section *Megalophædusa*.

Clausilia ducalis var. **decapitata** n. v.

Much smaller than the typical *ducalis* or var. *dorcas*, base more tapering. Early whorls lost in the adult stage, only 7 to 7½ remaining, the summit being thus very blunt. The surface is dull, finely and weakly striate, more deeply so on the base. Palatal plicæ 4, the upper long; no lower palatal plica.

Length 25, diam. 6 mm.

Length 22½, diam. 6⅓ mm.

Kashima, Harima. Types No. 83,239, A. N. S. P., from No. 913*a* of Mr. Hirase's collection.

Section HEMIPHÆDUSA Boettger.

Group of C. sublunellata.

Möllendorff, Journ. Asiatic Soc. of Bengal, LIV, pt. 2, p. 63 (1885). Pilsbry, these *Proceedings* for 1901, pp. 477, 649.

This group was originally defined from species collected in the region of Nikko and Lake Chusenji, in Province Shimotsuke. Mr. Hirase's researches have now brought to light species far to the southward, in Kii Province, and extending its range northward to the southern part of Yesso. So far as present information goes, no species of the group occurs in Shikoku, southwestern Nippon or Kyushu. It seems to be a group of middle and northern Nippon. The most important structural peculiarities of the group are the absence of any pronounced emargination or excision of the clausilium on the columellar side of the filament, and the lack of a lower palatal plica. All the species are pale-colored.

Most of the species defined by von Möllendorff have not been figured, and were apparently described from very few specimens. In studying them I have found the table opposite, compiled from the original diagnoses, a useful aid;[2] and its publication may assist others.

Clausilia heteroptyx n. sp. Pl. XVIII, figs. 17, 18, 19, 20, 21, 22.

Shell rimate, stoutly fusiform, solid, light yellow, the cuticle partly worn off, somewhat glossy, lightly striate, a little more strongly so just behind the lip. Spire rather thick, regularly tapering, not attenuated, the apex obtuse. Whorls 9, but slightly convex, the last flattened, rounded beneath. Aperture but slightly oblique, ovate, the peristome continuous, appressed to the preceding whorl above, expanded and reflexed. Superior lamella oblique, rather high, continuous with the spiral lamella, which penetrates to about the middle of the ventral side. Inferior lamella forming a distinct though obtuse fold on the columella, somewhat thickened and bifurcate within, rather straightly ascending and thickened within the dorsal side, penetrating further than the spiral lamella. Subcolumellar lamella slightly immersed, the end visible in a front or oblique view, but not extending upon the lip. Principal plica not quite a half whorl long, the lower end visible deep in the throat, extending inward past a lateral position. Lunella straight and narrow, one or two short, oblique palatal plicæ above it.

Length 26.5, diam. 6.6, length of aperture 7.8 mm.

Length 25.2, diam. 6.5, length of aperture 7.2 mm.

Length 24, diam. 6.5, length of aperture 7 mm.

Clausilium not much curved, long, narrow and parallel-sided, the palatal side somewhat thickened, apex rather acuminate; there is no noticeable excision or emargination near the filament (Pl. XVIII, figs. 21, 22).

---

[2] The model is that of Prof. von Martens, used very successfully by him in the land mollusks of the *Biologia Centrali Americana*.

Species and Locality.	Shape.	Color, Sculpture.	Aperture.	Superior lamella.	Inferior lamella.	Subcolumellar lamella.	Principal plica.	Palatal plicæ.	Lunella.	Alt.	Diam.	Whorls.	Size of Aperture in mm.
C. sericina. L. Chusenji.	Rather swollen fusiform, solid.	Corneous; delicately striate, silky, the last whorl hardly more striate.	Rounded-piriform; perist. continuous solute, much thickened.	Strong, oblique, contiguous to spiral lam.	Inconspicuous in front, truncate below.	Slightly emerging.	Deep, hardly visible in the aperture.	2, the upper short, second punctiform or obsolete.	None.	22½	5	10-10½	5½ x 1
Var. *minor.* Yumagaaishi.	Ditto.	Ditto.	Ditto.	Ditto.	Ditto.	Immersed.	Ditto.	Ditto.	Ditto.	20½		11	
C. sublunellata. Mountains of Nikko.	Swollen fusiform, rather solid, 4 earlier whorls forming a cylindric, obtuse spire.	Corneous-brown, very finely striate	Long-piriform; perist nearly free, much thickened, a little reflexed.	Strong, oblique, triangular, continuous with spiral lamella.	Receding, straightened, strong within.	Immersed, visible in an oblique view.	Moderate, passing the lateral line.	2, the upper short, subparallel to the principal p.; lower very short.	Short and straight.	21	5	11	6 x 1
C. subulina. L. Chusenji.	Slenderly fusiform, rather solid.	Corneous?, sub-pellucid, delicately striatulate, the last whorl rugose-striate.	Rounded-piriform; perist. solute, thick, reflexed, sinuate above, white-lipped	Strong, oblique, continuous with spiral lamella.	Remote, disappearing below but giving off a nodule to the margin.	Emerging.	Moderate.	Upper plica diverging from principal plica.	Lateral, subobsolete, or formed of 2 or 3 punctiform plicæ.	16	3	10	3½ x 2¾
C. opeas. Mountains of Nikko.	Cylindric-fusiform, rather solid.	Corneous; finely striatulate, the last whorl rugose-striate.	Elongate-rounded; perist. solute, a little reflexed, slightly thickened.	Marginal, moderate.	Remote, inconspicuous, strong within.	Immersed, visible in an oblique view.	Slightly passing the lateral line.	Upper plica short, diverging, lower punctiform.	Short and straight.	17½	3½	10½	3½ x 2½
C. micropeas. L. Chusenji.	Long-fusiform, thin.	Pale corneous; finely costulate.	Rounded-piriform; perist. solute, a little reflexed.	Oblique, continuous with spiral lamella.	Remote, inconspicuous.	Immersed.	Quite short.	One short lateral upper plica and sometimes a 2d punctiform plica.	Reduced to a mere indication.	10½ to 11½	2¼ to 2½	9½	2-2¼ x 1¾-2

Tomisato, Kii. Types No. 82,485, A. N. S. P., from No. 764*a* of Mr. Hirase's collection. It occurs also at Nachi, Kii.

This species is related to *C. sublunellata* and *C. opeas*, both described by Dr. von Möllendorff from the mountains around Nikko, Prov. Shimotsuke. Compared with the description of *C. sublunellata*, the present species is less slender, with fewer whorls and a larger aperture. *C. opeas* is a smaller and much more slender species, with much smaller aperture.

A remarkable variation occurs in one of the specimens of the type lot opened, which has two short palatal folds above, not connected with the lunella (fig. 19).

In a specimen from Nachi opened, the single upper palatal fold is connected with the lunella (fig. 18). This specimen measures, length 27, diam. 6.8 mm., and has nearly 10 whorls.

Clausilia subulina var. **leucopeas** nov. Pl. XVIII, figs. 28, 29, 30, 31, 32.

Shell rimate, fusiform or somewhat cylindric, whitish-corneous or greenish-corneous, *densely and finely but sharply striate*, glossy. Spire tapering and attenuated above, though rather large at the summit. Apex obtuse. Whorls 10, convex, the last somewhat flattened, not more coarsely striate. Aperture somewhat oblique, piriform, the peristome continuous, very shortly free above, a little notched at the position of the superior lamella; white, reflexed and a little thickened within. Superior lamella rather strong, oblique, continuous with the spiral lamella, which extends inward to the middle of the ventral side. Inferior lamella receding, inconspicuous in a front view or forming a slight columellar fold; thickened and rather straightly ascending within, penetrating as far as or a little further than the spiral lamella. Subcolumellar lamella usually emerging to the lip-edge (fig. 30), but sometimes immersed (fig. 29). Principal plica strong, visible deep in the throat, extending to a latero-ventral position. Below it there is a short, oblique upper palatal plica, weakly connected with, or almost separated from, the rather narrow lunella, which is stronger below than above (and sometimes reduced or almost wholly wanting).

Length 15.7, diam. 3.8, length of aperture 3.5 mm.

Length 16, diam. 3.2, length of aperture 3.5 mm.

Length 14, diam. 3.3, length of aperture 3.3 mm.

Clausilium (Pl. XVIII, figs. 31, 32) long and parallel-sided, tapering-rounded and thin at the apex, hardly excised on the columellar side of the filament.

Ikoma, Kii. Types No. 82,484, A. N. S. P., from No. 766*b* of Mr. Hirase's collection. Also Tomisato, Kii, No. 766*a*, and Samotonaka-mura, Kii, No. 766*c* (Mr. Hirase).

This form seems to be related to *C. subulina* Mlldff., an unfigured species described from Lake Chusenji in Shimotsuke Province, west of beautiful Nikko. It is apparently somewhat less slender than that, not especially rugose striate on the last whorl, with a better developed lunella. I have not seen *C. subulina*.

Old specimens become dull and opaque, and lose much of the fine striation by wear. Some of the shells from Tomisato are of a light brown tint, others being whitish-corneous like the types. In two specimens opened from Ikoma (No. 769) the lunella is so weak as to be hardly perceptible. The indistinct vestige would not be noticed in these shells were it not better developed in others of the species. It is apparently an abundant shell in the Province Kii.

Clausilia sericina var. **rhopalia** Pilsbry. Pl. XVIII, figs. 23, 24, 25, 26, 27.

Pilsbry, these *Proceedings* for 1901, p. 624 (February 6, 1902).

Figures are here given of the types of this subspecies, not hitherto figured. It is a larger and stouter shell than *C. subulina* var. *leucopeas*, and the inferior lamella forms a more or less prominent columellar fold. It is from Mikuriya, Suruga.

Compared with the description of *C. sericina* Mlldff., from Lake Chusenji, these specimens differ in the emerging inferior lamella and the palatal armature, which, if von Möllendorff's description is correct, must be quite different, as he states, after mentioning the deeply placed principal plica, that it has two palatal plicæ, the upper short, second punctiform or obsolete, the lower and the lunella wanting. In *rhopalia* there is a single short upper palatal plica and a long, narrow lunella. In external contour the two forms agree.

The type of *C. sericina* was in the Hungerford collection, and its present location is unknown to me.

Group of C. validiuscula.

Clausilia carystoma Mlldff. Pl XVII, figs. 1, 2.

Möllendorff, Journ. Asiat. Soc. Bengal, LI, pt. 2, p. 6, Pl. 1, fig. 5 (1882); LIV, pt. 2, p. 65 (1885).

Specimens before me from Kobe, Setsu, the type locality, agree well with Möllendorff's description and figure, except in having 10 whorls instead of 9, and in being a trifle larger. The very short lunella is connected with the lower palatal plica in the specimen figured (figs. 1, 2), but in another it is a short fold exactly as figured for var. *jayi* (Pl. XVII, fig. 3). The figured shell measures length 15, diam. 3.7 mm. The spiral and inferior lamellæ are of equal length, reaching past the ventral side to a lateral position on the left side.

The species is somewhat remarkable for the nearly ventral position of the palatal plicæ, a point which von Möllendorff has emphasized. They are placed quite as in *Tyrannophædusa*, while in *Hemiphædusa* these plicæ are generally lateral or latero-dorsal. The long spiral lamella is also a Tyrannophædusan character.

The clausilium is narrow, parallel-sided, rather straight, noticeably oblique at the distal end (but not thickened there as it is in *Tyrannophædusa*), and excised on the columellar side near the filament. It is like that of var. *jayi.*

C. caryostoma is known only from Kobe, Setsu. The specimen figured was sent by the late Mr. B. Schmacker (No. 60,378, A. N. S. P.).

Clausilia caryostoma var. **jayi** nov. Pl. XVII, figs. 3, 4, 5, 6.

Shell rimate, fusiform, moderately attenuated above, glossy, brown, distinctly and finely striate, a little more coarsely so on the latter part of the last whorl. Whorls 10, moderately convex, the last flattened and tapering. Aperture ovate-trapezoidal, the brown-tinted peristome continuous, reflexed and thickened, shortly free and not emarginate above. Superior lamella rather small, oblique, slender, marginal, continuous with the spiral lamella, which penetrates inward *past the ventral side.* Inferior lamella receding, inconspicuous in a front view, rather low and obliquely ascending within, as long as the spiral lamella. Subcolumellar lamella varying from immersed to weakly emerging. *Principal plica very long,* extending from a ventral position above the sinulus nearly to the lip. Palatal plicæ three, *nearly ventral, the upper and lower long,* the intermediate one *short and small.*

Length 13, diam. 2.9, length of aperture 3 mm.

Length 12, diam. 2.8, length of aperture 2.8 mm.

Clausilium (Pl. XVII, figs. 4, 5) narrow, a little obliquely tapering at the apex, deeply excised on the columellar side of the filament.

Jo, Kii. Types No. 82,476, A. N. S. P., from No. 770*c* of Mr. Hirase's collection. Also Yamaguchi, Tajima.

This form differs from *C. caryostoma* chiefly in being smaller, less coarsely striate and more slender, with a larger aperture. Named for Dr. John C. Jay, author of one of the earliest papers on Japanese shells.

Clausilia graciæ Pilsbry. Pl. XVII, figs. 7, 8, 9, 10, 11.

Shell *very small,* slenderly fusiform, pale brown, finely striate, a little more coarsely so on the back of the last whorl. Upper half strongly attenuated, penultimate whorl somewhat swollen, latter half of the last whorl compressed and tapering, the position of the principal plica *marked by a shallow but distinct sulcus.* Whorls 9, the first rather globose, the rest moderately convex. Aperture slightly oblique, ovate-piriform, the peristome continuous, shortly free above, reflexed, and strongly thickened within. Superior lamella small and vertical, continuous with the spiral lamella, which ascends past the middle of the ventral margin. Inferior lamella receding, inconspicuous in a front view, but seen to form a distinct fold when viewed obliquely in the aperture; straightly and obliquely ascending within, penetrating as far as the spiral lamella. Subcolumellar lamella deeply immersed. Principal plica long and strong, extending from a latero-ventral position nearly to the lip. There are *two long, strong and oblique lateral palatal plicæ, with a strong, short lunella between them, not connected with either.*

Length 9.3, diam. 2.2 mm.

Length 7.7, diam. 2 mm.

The clausilium is narrow and parallel-sided, tapering at the distal end, and abruptly, deeply excised on the columellar side of the filament (figs. 7, 8).

Nachi, Kii. Types No. 82,458, A. N. S. P., from No. 794 of Mr. Hirase's collection.

This species shares with *C. hirasei* and *C. euholostoma* the distinction of being one of the smallest known from Japan. It is not closely related to any of the described forms, standing nearer *C. aulacophora, C. pigra* and *C. tosana* than to other species now known. It is much smaller than *C. caryostoma* or the variety *jayi.*

The diminutive stature together with the several characters italicized above readily distinguish the species. Some specimens taper more slowly and regularly than others, as the figures show.

Group of C. aulacophora.

This group passes into the group of *C. validiuscula* by such an easy transition that it is rather difficult to draw a line between them, although typical forms are so different. In the latter group there are several palatal plicæ standing between the upper and lower ones, while in the former these plicæ are united, and thereby transformed into a lunella.

Clausilia pigra n. sp. Pl. XXI, figs. 73, 74.

Shell rimate, rather slenderly fusiform, strongly attenuated above, light reddish-brown, finely striate (or smooth by wearing or erosion of the surface in some specimens). Spire very slender above, the first whorl rather globose, several whorls following not increasing in diameter (but in eroded individuals it is acute and tapering). Whorls 10 to 10½, convex, the last compressed laterally, tapering; *becoming free* for a short distance in front, and grooved above the position of the superior lamella. Aperture *piriform*, subvertical, the distinct sinulus retracted. Peristome continuous, white, reflexed and thickened, sinuous above. Superior lamella marginal, rather small, subvertical, continuous with the spiral lamella, which penetrates past the ventral side. Inferior lamella immersed, deeply receding, thick, straightened, branching and obliquely ascending within, penetrating as far as or less deeply than the spiral lamella. Subcolumellar lamella deeply immersed. Principal plica long, extending from the ventral side nearly to the aperture. Upper and lower palatal plicæ are connected by a straight lunella, forming a barrier shaped like the letter I, and exactly lateral in position.

Length 15.5, diam. 3.3, length of aperture 3.4 mm.

Length 14, diam. 3.3, length of aperture 3 mm.

Length 15, diam. 3, length of aperture 3 mm.

Clausilium narrow and parallel-sided, abruptly and deeply excised on the columellar side of the filament.

Kashima, Harima. Types No. 82,455, A. N. S. P., from No. 306*e* of Mr. Hirase's collection.

By the shape of the aperture and the forwardly built, shortly free last whorl, this species is related to *C. tosana* Pils.; but it differs from *tosana* in the more deeply penetrating lamellæ and principal plica, the distinct lunella connecting the two palatal plicæ I-like, and the larger size of the less slender shell. Moreover, the clausilium is deeply excised on the columellar side near the filament, as in *C. harimensis*, while in *tosana* it merely tapers there.

C. pigra is probably not closely related to *C. aulacophora*, although by parallel evolution it has attained the same type of palatal armature.

At Nametoko, Iyo, on Shikoku Island, a form of *C. tosana* occurs in which there is an imperfect lunella in place of the intermediate palatal plicæ, at least in some specimens (No. 82,288, A. N. S. P., from Mr. Hirase's No. 550*b*).

Group of C. awajiensis.

Two remarkable additions are made to this group in *C. agna* and *C. caloptyx*, the first very glossy and smooth, the second beautifully sculptured with strong riblets.

Clausilia subignobilis Pilsbry. Pl. XIX, figs. 33, 34, 35, 36.

These *Proceedings* for 1901, LIII, p. 655, footnote No. 9 (March 1, 1902).

Shell fusiform, attenuated above, very pale reddish-brown or gray-brown, somewhat glossy, finely striate, on the last half of the last whorl more coarsely so. Aperture trapezoidal-ovate, slightly oblique. Peristome well expanded, continuous, shortly free and concave or notched above. Superior lamella small, marginal, disconnected from or barely connected with the spiral lamella, which penetrates barely to the ventral side. Inferior lamella deeply receding, slender and vertically ascending within, about as long as the spiral lamella. Subcolumellar lamella emerging to the lip-edge, and bounded by grooves. Principal plica short, lateral, the lunella bow-shaped, its upper and lower ends bending strongly inward.

Length 15.2, diam. 3.5 mm.

Length 13, diam. 3.1 mm.

Clausilium narrow, parallel-sided, rounded at the apex, somewhat excised on the columellar side of the filament.

Hirado, Hizen, in western Kyushu. Types No. 82,954, A. N. S. P., from No. 733 of Mr. Hirase's collection.

Close to *C. shikokuensis*, in which, however, the spiral and inferior lamellæ are longer, the principal plica longer and stronger, the subcolumellar lamella is immersed, and the lunella is strictly lateral. In *C. subignobilis* the subcolumellar lamella emerges strongly, and the lunella is somewhat dorso-lateral. Mr. E. R. Sykes, who kindly compared it with the type of his *C. ignobilis*, now in the British Museum, writes that *ignobilis* is "a yellower shell with more cylindrical and larger earlier whorls, more like *C. ischna* and *C. iotaptyx*." Moreover, if the figure of *C. ignobilis* is correct, the lunella is lateral, not dorso-lateral, as it is in *subignobilis*.

The three species, *C. ignobilis*, *C. shikokuensis* and *C. subignobilis*, agree in the shape of the lunella, and are evidently closely related.

Clausilia tantilla Pilsbry. Pl. XIX, figs. 43, 44.

These *Proceedings* for 1901, LIII, p. 655, footnote No. 10 (March 1, 1902).

Shell very small, fusiform, attenuated above, the last three whorls rather large; dull reddish-brown or gray, without cuticle in adult shells; striate, but worn smoothish, the last whorl more coarsely striate behind. Whorls 8½, the first rather large, last compressed. Aperture slightly oblique, trapezoidal-ovate. Peristome reflexed and thickened, continuous, very shortly free above. Superior lamella small, abruptly lower where it joins the low spiral lamella. Inferior lamella receding, vertically ascending within. Subcolumellar lamella usually wholly immersed (but in one specimen of five emerging weakly to the lip-edge). Principal plica dorsal and lateral. Upper palatal plica short, a straight oblique, lateral lunella joining it in the middle. No lower palatal plica.

Length 9.5, diam. 2.5 mm.

Length 8.3, diam. 2.2 mm.

Gotō, Hizen. Types No. 83,023, A. N. S. P., from No. 813 of Mr. Hirase's collection. The locality was erroneously given "Goto, *Uzen*," in a former communication.

A very small form, differing from other known species of the group of *C. awajiensis* in the straight lunella, which does not curve inward below, and in the diminutive size of the shell.

Clausilia bigeneris Pilsbry. Pl. XIX, figs. 37, 38.

These *Proceedings* for 1901, LIII, p. 656, footnote No. 12 (March 1, 1902).

Shell fusiform, moderately solid, pale reddish-brown, apparently deprived of cuticle; surface lustreless, weakly striate: acutely tapering above to a small and rather acute apex. Whorls 10, moderately convex, the last compressed. Aperture shortly ovate, but slightly oblique. Peristome continuous, shortly free above, moderately thick and broadly flaring, reflexed, excavated at the sinulus. Superior lamella marginal, subvertical, continuous with the spiral lamella, which penetrates to the middle of the ventral side. Inferior lamella deeply receding, subvertical within the last whorl, a little thickened below, not extending inward as far as the superior lamella. Subcolumellar lamella deeply immersed. Principal plica strong, approaching the lip, extending slightly past the middle of the lateral position. Upper palatal plica short, oblique, slightly disconnected from the lunella. Lunella dorso-lateral, straight above, curving far inward below.

Length 14.3, diam. 3.5 mm.

Clausilium narrow, rounded at the apex.

Gotō, Hizen. Types No. 82,956, A. N. S. P., from No. 818 of Mr. Hirase's collection. The locality was incorrectly given as Goto, Uzen, in my preliminary description.

This species recalls *C. subaurantiaca* somewhat. The lip is unusually developed. The slight notch between the lunella and the short upper palatal plica is unlike the allied species, and reminded me at first of some species of the group of *C. sublunellata*, but the strong inward bend of the lower end of the lunella shows clearly that it belongs to the group of *C. awajiensis*.

Clausilia agna n. sp. Pl. XIX, figs. 39, 40, 41, 42.

Shell fusiform, moderately solid, the penultimate whorl widest, preceding and last whorls a little narrower, those above tapering to a somewhat obtuse apex. Brownish-yellow, somewhat transparent. *Surface brilliantly glossy,* as though varnished, showing some faint growth wrinkles under a lens. Whorls 7–8, moderately convex, the suture often appearing margined by transparence. Last whorl not differently sculptured. Aperture subvertical, squarish-ovate. Peristome expanded and narrowly reflexed, hardly thickened, the upper margin adnate or barely free from the preceding whorl. Superior lamella compressed, marginal, continuous with the spiral lamella, which does not reach quite to the middle of the ventral side. Inferior lamella deeply receding, a little thickened near its lower end, straightly ascending, not penetrating as deeply as the spiral lamella. Subcolumellar lamella weakly emerging. Principal plica short, visible within the mouth, extending inward past the lunella. Upper palatal plica very short, connected with a rather low, nearly straight, slightly dorso-lateral lunella, the lower end of which curves abruptly inward.

Length 10.2, diam. 2.5 mm.; whorls $7\frac{2}{3}$.

Length 8.6, diam. 2.3 mm.; whorls $6\frac{3}{4}$.

Clausilium (Pl. XIX, figs. 39, 40) parallel-sided, nearly straight, rounded apically, deeply excised on the columellar side of the filament.

Yakushima, Ōsumi. Types No. 82,959, A. N. S. P., from No. 663*c* of Mr. Hirase's collection.

This species resembles *Zaptyx* in texture and general structure, as well as in the form of the clausilium, but it differs in wanting the sutural plicæ and the accessory lamellæ of that group. It is remarkable for the varnish-like gloss of the surface.

Clausilia caloptyx n. sp. Pl. XIX, figs. 45, 46, 47, 48.

Very small, fusiform, pale corneous-brown, solid and strong, rather rapidly tapering above to a rather obtuse apex. *Surface regularly sculptured with strong, straight ribs*, very coarse for so small a shell. Whorls $7\frac{1}{2}$, convex, the last somewhat compressed, with the ribs a little more separated. Aperture squarish-ovate. Peristome white, continuous, reflexed, thickened within, very shortly free above, notched at the position of the superior lamella. Superior lamella marginal, compressed, subvertical, continuous with the spiral lamella, which penetrates scarcely to the ventral side. Inferior lamella receding, invisible in a front view, but appearing as a strong, deeply placed fold in an oblique view in the aperture; straightly ascending within, not penetrating quite so deeply as the spiral lamella. Subcolumellar lamella emerging. Principal plica short, extending from near the lip to a lateral position. Upper palatal plica very short, connected with the rather weak lunella, which curves inward at its lower end, and is dorso-lateral in position. Length 6.8, diam. 1.9 mm.; whorls $7\frac{1}{2}$.

Length 7, diam. 2 mm.; whorls $7\frac{1}{2}$.

Length 8, diam. 2.4 mm.; whorls 8 (larger form; see below).

Clausilium (Pl. XIX, figs. 45, 46) parallel-sided, the distal third straightened, the rest strongly curved; distal end slightly oblique and a little thickened; columellar side excised near the filament.

Yaku-shima, Ōsumi. Types No. 82,958, A. N. S. P., from No. 894 of Mr. Hirase's collection.

Very distinct from any known Japanese or Riukiuan species. The strength and coarseness of the sculpture is remarkable in so small a shell. The lamellæ and plicæ penetrate less deeply than usual.

One specimen (Pl. XIX, fig. 49) is larger and more obese than the others of the type lot, but it agrees in other characters.

The ribs are shown a little too much spaced on the last whorl of fig. 48.

Group of C. aulacopoma.

Shell similar to that of the group of *C. awajiensis*, except that a nodule-like lower palatal plica is developed inward from the termination of the lunella. Clausilium strongly curved, channeled on the outside at the apex.

The single species at present composing this group is strongly individualized by the peculiar modification of the clausilium.

Clausilia aulacopoma Pilsbry. Pl. XVII, figs. 12, 13, 14, 15, 16.

These *Proceedings* for 1901, LIII, p. 656, footnote No. 11 (March 1, 1902).

Shell fusiform, strongly attenuated above, brown, the surface lustreless, finely and weakly striate, more strongly so on the back of the last whorl. Whorls about 9½, convex, the apex small. Aperture trapezoidal-ovate, a little oblique. Peristome reflexed and thickened. Sinulus distinct and slightly retracted. Superior lamella marginal, small and low, continuous with the spiral lamella, which penetrates to the middle of the ventral side. Inferior lamella deeply receding, straightly ascending within the last whorl, distinctly thickened and a little sinuous near its lower end, a little shorter within than the spiral lamella. Subcolumellar lamella emerging to the lip-edge, though sometimes but weakly, and bounded by grooves. Principal plica extending from the dorsal nearly to the ventral side. Upper palatal plica short, united in the middle to the strong oblique, latero-dorsal lunella, which is straight above and curves inward below, its inner end being contiguous to a strong short, nodule-like lower palatal plica.

Length 13.5, diam. 3 mm.
Length 12.5, diam. 2.7 mm.
Length 12, diam. 3 mm.

Clausilium (Pl. XVII, figs. 13, 14) rather narrow and parallel-sided, very strongly curved, pinched into a channel or spout at the apex, abruptly and deeply emarginate on the columellar side of the filament.

Hirado, Hizen, in western Kyushu. Types No. 82,980, A. N. S. P., from No. 733*b* of Mr. Hirase's collection.

There is some variation in the degree of apical attenuation and in the emphasis of the subcolumellar lamella. Fig. 16 represents the type. Some specimens, as that drawn in fig. 12, are more swollen. The shell resembles species of the group of *C. awajiensis* in most of its characters, except for the nodule-like lower palatal plica, but it is very distinct in the specialization of the clausilium, which is channeled apically, much as in *C. crenilabium,* the channel apparently fitting over the lower palatal plica.

Section TYRANNOPHÆDUSA Pilsbry.

Group of C. mikado.

The forms described and illustrated below complete the illustration and description of the species and varieties now known of this section.

Clausilia aurantiaca Boettger. Pl. XX, figs. 50, 51, 52, 53, 54.

Boettger, Clausilienstudien, p. 68 (1877); Syst. Verz., p. 57 (1878); Jahrb. d. D. Malak. Ges., V, p. 101, Pl. 4, fig. 5.
Kobelt, Fauna Moll. Extramar. Jap., p. 95, Pl. 9, fig. 11 (1879).

This species was described from the "interior of Nippon" from specimens collected by Rein. Probably the types came from some province near the eastern end of the Inland Sea.

The shell is very solid for its size, fusiform, moderately attenuated above, the early whorls quite small. The subventral lunella is straight, connecting the two palatal plicæ like the letter I, but it is usually placed obliquely, crossing the line of the external striæ. The superior lamella is continuous with the spiral lamella, which penetrates inward across the ventral side to a point further inward than above the sinulus. The inferior lamella is equally long. The subcolumellar lamella typically emerges to the lip-edge. The shell usually is more or less orange-tinted brownish in color.

Specimens from Kobe, Setsu (B. Schmacker), are gray-brown or reddish-brown, worn, with 8½–10 whorls, and are about 13 mm. long. The subcolumellar lamella emerges.

Nohara, Yamato. Specimens measure from 12.3 x 3.3 mm. with 9½ whorls, to 14 x 3 mm. with 10 whorls. The subcolumellar lamella emerges.

Aiga, Kii. Glossy, orange-brown, transparent enough to show the lunella and plicæ through; whorls 9½–10½; length 11½–13½ mm. Subcolumellar lamella emerging.

Nachi, Kii (fig. 51). Brownish dark-red, opaque. Whorls 10 to 11; length 12¾ to 14 mm. The subcolumellar lamella emerges weakly or is immersed.

Kurozu, Kii. Whorls 10, length 12½–13 mm. The subcolumellar lamella emerges slightly or is immersed.

Ikari, Awaji (fig. 50). Color and texture as in last. Whorls 10; length 13–14 mm. The subcolumellar lamella emerges.

Suimura, Awa, Shikoku (figs. 52, 53). Rather light chestnut-brown, some specimens showing the lunella and plicæ through. Length 12–15 mm. The subcolumellar lamella emerges.

Obi, Hūga. The shells are gray-brown or reddish-brown, and measure 13 mm. long, 3 wide, with 10 whorls. The connection between the superior and spiral lamellæ is very low, almost interrupted, and the lunella is somewhat arcuate. The subcolumellar lamella emerges weakly. The clausilium of a specimen from this locality is figured (fig. 54).

Clausilia aurantiaca var. erberi Bttg. Pl. XX, figs. 55, 56, 57, 58, 59, 60.

Bœttger, Syst. Verz., p 57.
Moellendorff, J. A. S. B., LIV, pt. 2, No. 1, p. 65.
C. a. minor Mlldff., Journ. Asiatic Soc. Bengal, LI, pt. 2, No. 1, p. 9 (July, 1882); types from Nara, Yamato.

Smaller and somewhat more slender than *C. aurantiaca*, the subcolumellar lamella immersed; lip narrower; lunella not quite reaching the upper palatal plica.

This small form is usually fairly distinguishable from the typical *aurantiaca*. It extends from Harima to Yamato or Kii, specimens being before me from the following localities:

Tomisato, Kii. Whorls 8–9; length 10–11½ mm. The subcolumellar lamella barely emerges. It is not typical *erberi*. Perhaps referable rather to *aurantiaca* proper.

Gojo, Yamato. Length 10½, diam. 2 mm.; whorls 9½. Subcolumellar lamella immersed.

Nara, Yamato. Length 9½, diam. 2 mm.; whorls 9. Subcolumellar lamella immersed (Pl. XX, fig. 55, the palatal armature represented as though showing through, but the shell is opaque). This and the preceding are typical *erberi.*

Chikubu-shima, an island in Lake Biwa, Omi (fig. 56). Length varying from 10 to 12¾ mm.; whorls 9–10. The subcolumellar lamella is immersed. Though some specimens are rather large, their characters are otherwise as in the smaller ones with them. The shell figured in outline is 10.3 mm. long.

Kashima, Harima (Pl. XX, figs. 57–60). Glossy, handsome specimens, 10½ to 11½ mm. long, with 10 to 10½ whorls. The subcolumellar lamella is immersed; the palatal plicæ are long, but the lunella is very short in some examples (fig. 59), while in others it is as long as in shells from Yamato.

Clausilia aurantiaca var. **plicilabris** (A. Adams). Pl. XX, figs. 61, 62, 63.

C. plicilabris A. Ad., Ann. and Mag. Nat. Hist. (4 ser.), I, 1868, p. 469. Pfr., Monogr., VIII, p. 476. Kobelt, Fauna Moll. Extramar. Jap., p. 98.
C. aurantiaca var. *hypoptychia* Pilsbry, these *Proceedings* for 1901, p. 652, footnote No. 7.

Shell fusiform, moderately swollen, distinctly attenuated above, slender near the apex; whitish under a pale-brown cuticle, all of the specimens seen being more or less eroded on the surface. Closely striate. Whorls about 10½, the last one tapering. Aperture piriform. Peristome pale brown or dirty white, thick and somewhat broadly reflexed, crossed by *several unequal folds in the subcolumellar region.* Superior lamella rather strong, *becoming low within,* barely continuous with *or disconnected from* the spiral lamella, which penetrates just past the ventral side. Inferior lamella very deeply receding, nearly as long within as the spiral lamella. Subcolumellar lamella emerging to the lip-edge, accompanied by one or several accessory folds. Lunella joining the lower palatal fold near its inner end, scarcely connected with the upper palatal fold.

Length 15, diam. 3.4 mm.
Length 13.7, diam. 3.3 mm.
Length 16, diam. 3.3 mm.

Kashima, an island near Tanabe, Kii. No. 82,459, A. N. S. P., from No. 782 of Mr. Hirase's collection.

As in other *Tyrannophædusæ* of the typical group, there is a slight depression behind the outer and basal lips. It is more slender above and more swollen below than *C. orthatracta* Pils.

Further study of Adams' description convinces me that the form I named *C. aurantiaca* var. *hypoptychia* can be nothing else than *C. plicilabris* A. Ad., described from Tanabe, Kii, the description of which, so far as it goes, agrees exactly with the shells sent by Mr. Hirase. By "*lunella inconspicua*" Adams merely meant that it was not visible through the shell.

The degree of plication of the subcolumellar region varies within wide limits, as I have shown to be the case in several other species of *Tyrannophædusa*.

I do not give the name *plicilabris* precedence over *aurantiaca*, because the description published by Adams was not sufficient for the recognition of the species until specimens from the type locality came to hand.

One specimen which was sent with v. *plicilabris* (Pl. XX, figs. 64, 65) is much larger than the others, measuring, length 19, diam. 3.8 mm. It is densely and sharply striate, and has 13 whorls. This may perhaps prove, when more material is received, to be a distinct species. It is No. 83,134, A. N. S. P.

Group of C. bilabrata.

Clausilia dalli Pilsbry. Pl. XXI, figs. 75, 76, 77.

These *Proceedings* for 1901, LIII. p. 656, footnote No. 13 (March 1, 1902).

Shell *many whorled*, awl-shaped, the *upper half much attenuated*, *lower half obese*, pale brown, rather thin, scarcely glossy, all the specimens having the cuticle slightly worn below, wanting above; finely striate, more coarsely so on the back of the last whorl. Whorls 14½ to 15½, moderately convex, the first whorl rather globose, next 5 or 6 whorls scarcely increasing in diameter, those following enlarging slowly, the last three whorls forming about half the length of the shell, the penultimate whorl widest, last whorl narrower, compressed. Aperture trapezoidal-ovate, slightly oblique. Peristome continuous, thickened and reflexed, white, the right margin crossed by a single fold (the subcolumellar, fig. 76) or having a group of folds in that region (fig. 77). Superior lamella oblique, attaining the margin, rather widely separated from the spiral lamella. Spiral lamella continued inward to a point above the sinulus. Inferior lamella deeply receding, though often continued to the lip-edge, obliquely and straightly ascending within, and continued inward a little beyond the termination of the spiral lamella. Subcolumellar lamella emerging to the lip-edge, and usually bounded by grooves. The principal plica is about a half-whorl long, extending from a dorsal to a ventral position. The lunella is strong, latero-ventral, its upper end curving inward, lower end united to the lower palatal plica at or near its inner end.

Length 19, diam. 4.1, diam. of second whorl 1 mm.

Length 17, diam. 3.8, diam. of second whorl .8 mm.

Clausilium narrow, oblique at the distal end, thickened along the columellar margin and distally, as usual in *Tyrannophædusa.*

Tairiuji, Awa, Shikoku Island. Types No. 82,957, A. N. S. P., from No. 819 of Mr. Hirase's collection.

This peculiar species resembles *C. mikado* Pils. in its much attenuated, concave-sided spire, which is more slender than that of *C. iotaptyx* Pils. It stands between *iotaptyx* and *mikado* in the number of whorls. The aperture is formed about as in *C. iotaptyx,* not being built forward as in *C. mikado.* From both of the species named it differs in palatal armature, the lunella being like that of *C. bilabrata* Smith. The spire is apparently not subject to self-amputation, the apex being entire in the six specimens before me. The clausilium is of the shape usual in *Tyrannophædusa.*

C. dalli is named for the Honorary Curator of the Department of Mollusks of the U. S. National Museum.

Section EUPHÆDUSA Boettger.

Clausilia holotrema Pilsbry. Pl. XXI, fig. 72.

Pilsbry, these *Proceedings* for 1901, p. 654, footnote No. 8 (March 1, 1902).

Shell rimate, fusiform, the upper third rapidly tapering to a minute apex; *vinous brown, with a wide corneous zone below the sutures, which is largely covered with whitish papery cuticle* (like that of *Helicostyla*); some interrupted spiral lines of the same appearing upon the dark color, and oblique streaks on some earlier whorls. The base of the last whorl is pale-corneous. Surface somewhat glossy, evenly thread-striate obliquely. Whorls a trifle over 8, convex, the last well rounded beneath. *Aperture wide,* oval, vertical, the peristome expanded, subreflexed, somewhat thickened within, continuous, in contact with the preceding whorl above. *Superior lamella wholly wanting,* the spiral lamella arising far within. Inferior lamella forming a small and deeply-placed but prominent subhorizontal fold. Subcolumellar lamella deeply immersed. Principal plica short, dorso-lateral. Moderately long upper and lower palatal plicæ are developed (but apparently no lunella).

Length 12, diam. 3.1, length of aperture 3.2 mm.

Nachi, Kii. Type No. 82,454, A. N. S. P., from No. 789 of Mr. Hirase's collection.

A single specimen of this remarkable *Euphædusa* was sent by Mr. Hirase, with the remark that it seemed different from any other species. It stands in the middle between the "group of *C. hungerfordiana*" and that of *C. euholostoma*, as defined in my last paper upon this topic. Both of these groups have the superior lamella absent or vestigial, represented by a slight thickening of the peristome, and there is more or less whitish, papery cuticle, in streaks and spiral lines. *C. holotrema* resembles *C. hungerfordiana* in the palatal armature, but is more like *euholostoma* in the squarish-oval, not in the least piriform shape of the aperture. The dark, wide, wine-brown belt, contrasting with the corneous, white-variegated band above, makes it a conspicuous species. This belt terminates short of the outer lip, as shown by transparence in the figure. The single specimen received has not been opened, but this is the less essential because the palatal folds show through the thin shell.

Section STEREOPHÆDUSA Boettger.

Group of C. una.

Similar in general characters to the group of *C. japonica*, but with the right margin of the lip plicate, and having a short lunella developed in connection with the lower palatal plica; no intermediate palatal plicæ.

Clausilia una Pilsbry. Pl. XXI, figs. 66, 67, 68, 69.

These *Proceedings* for 1901, LIII, p. 656, footnote No. 14 (March 1, 1902).

Shell regularly tapering above, attenuated near the apex, very solid and strong, pale yellowish, slightly glossy, regularly, closely striate, the striation becoming much coarser on the back of the last whorl. Whorls 11½ to 12, moderately convex, the penultimate widest. Apical whorl globose, the next 2 or 3 whorls hardly increasing in diameter, last whorl a little compressed. Aperture ovate, hardly oblique. Peristome thickened and reflexed, continuous, shortly free above, a little notched or emarginate at the position of the superior lamella, *the entire upper and right margins closely and deeply plicate.* Superior lamella slender, subvertical, marginal, continuous within with the spiral lamella, which is high laterally, and continues inward to a point above the sinulus. Inferior lamella bifid, *appearing as a double fold below,* ascending in a wide spiral, and continued inward as far as the spiral lamella. Subcolumellar lamella emerging to the lip-edge. Principal plica over a half-whorl long, visible deep in the throat and extending inward to the ventral side. There is a small upper palatal plica, lateral in position and converging inward toward the principal plica, and a much longer, arcuate, lower palatal plica, from the middle of which a very short, rudimentary lunella arises.

Length 23, diam. 5.3 mm.

Length 21.5, diam. 5.2 mm.

Clausilium (Pl. XXI, figs. 68, 69) broad distally, irregularly rounded and strongly thickened at the apex, somewhat emarginate on the columellar side of the filament.

Gotō, Hizen. Types No. 82,955, A. N. S. P., from No. 816 of Mr. Hirase's collection. The habitat "Gotō, Uzen," given in my preliminary note, was erroneous.

Clearly a *Stereophædusa* by its clausilium, strongly spiral inferior lamella and palatal armature, yet unique in that section by the beautiful plication of the right margin of the peristome. No other species from Japan proper has such sculpture, a few forms of *Tyrannophædusa* alone having it much less developed and confined to the subcolumellar region; but in the section *Luchuphædusa* of the Riukiu Islands similar interlamellar plication exists. The double fold of the inferior lamella is also a rare structure, but it occurs in *Cl. excellens* Pfr., also a Riukiuan species.

Group of C. entospira.

Clausilia dæmonorum n. sp. Pl. XXI, figs. 70, 71.

Shell small, fusiform, rather thin, finely substriate, the latter part of the last whorl more coarsely so; glossy. Early whorls lost in the specimens described; the last whorl is laterally compressed, flattened, the base convex, full and somewhat sack-like. Aperture oblique, irregularly ovate, the peristome continuous, very shortly free above. Superior lamella small, marginal, short, *not continuous with the spiral lamella.* Inferior lamella receding, *becoming very high and approaching the superior lamella in the throat;* and within the last whorl *it ascends in a broad spiral curve.* Subcolumellar lamella emerging to the lip-edge. Principal plica rather short. Lunella rather short and arcuate. Clausilium unknown.

Length of specimen with $4\frac{3}{4}$ whorls remaining, 8.2, diam. 2 mm.

Length of specimen with $4\frac{1}{2}$ whorls remaining, 7.8, diam. 2.2 mm.

Kikaiga-shima, Ōshima group. Types No. 82,981, A. N. S. P., from No. 874 of Mr. Hirase's collection.

A fossil of the land-shell bed. It has the form, size and surface of a *Zaptyx*, but is unlike that group in the widely spiral ascent of the inferior lamella within. Whether the species is allied to *C. entospira*, which I have placed in *Stereophædusa*, or is an *Euphædusa* I am not prepared to say in the absence of the clausilium; for it has something in common with both groups—the spiral inferior lamella approaching the superior in the throat, the superior lamella not connected with the spiral, etc.; but provisionally, and merely to put it somewhere, I refer the species to the group of *C. entospira.*

EXPLANATION OF PLATES XVII—XXI.

PLATE XVII, Figs. 1, 2.—*Clausilia caryostoma* Mlldff. Kobe, Setsu.
Figs. 3, 4, 5, 6.—*C. caryostoma* var. *jayi* Pils. Jo, Kii.
Figs. 7, 8, 9, 10, 11.—*C. graciæ* Pils. Nachi, Kii.
Figs. 12, 13, 14, 15, 16.—*C. aulacopoma* Pils. Hirado, Hizen.

PLATE XVIII, Figs. 17, 20, 21, 22.—*C. heteroptyx* Pils. Type. Tomisato, Kii.
Fig. 18.—*C. heteroptyx* Pils. Nachi, Kii.
Fig. 19.—*C. heteroptyx* Pils. Tomisato, Kii.
Figs. 23, 24, 25, 26, 27.—*C. sericina* var. *rhopalia* Pils. Mikuriya, Suruga.
Figs. 28, 29, 30.—*C. subulina* var. *leucopeas* Pils. Ikoma, Kii.
Figs. 31, 32.—*C. subulina* var. *leucopeas* Pils. Samotonaka-mura, Kii.

PLATE XIX, Figs. 33, 34, 35, 36.—*C. subignobilis* Pils. Hirado, Hizen.

Figs. 37, 38.—*C. bigeneris* Pils. Gotō, Hizen.

Figs. 39, 40, 41, 42.—*C. agna* Pils. Yaku-shima, Ōsumi.

Figs. 43, 44.—*C. tantilla* Pils. Gotō, Hizen.

Figs. 45, 46, 47, 48.—*C. caloptyx* Pils. Yaku-shima, Ōsumi.

Fig. 49.—*C. caloptyx* Pils., an obese form from the same locality.

PLATE XX, Fig. 50.—*C. aurantiaca* Bttg. Ikari, Awaji.

Fig. 51.—*C. aurantiaca* Bttg. Nachi, Kii.

Figs. 52, 53.—*C. aurantiaca* Bttg. Suimura, Awa (Shikoku).

Fig. 54.—*C. aurantiaca* Bttg. Clausilium of a specimen from Obi, Hūga.

Fig. 55.—*C. aurantiaca* var. *erberi* Bttg. Nara, Yamato. The shell is opaque, the palatal armature being represented diagrammatically in this figure.

Fig. 56.—*C. aurantiaca* var. *erberi* Bttg. Chikubu-shima, Omi.

Figs. 57, 58, 59, 60.—*C. aurantiaca* var. *erberi* Bttg. Kashima, Harima.

Figs. 61, 62, 63.—*C. aurantiaca* var. *plicilabris* A. Ad. Kashima, near Tanabe, Kii.

Figs. 64, 65.—*C. aurantiaca* var. *plicilabris* A. Ad. Large form from the same locality.

PLATE XXI, Figs. 66, 67, 68, 69.—*C. una* Pils. Gotō, Hizen.

Figs. 70, 71.—*C. dæmonorum* Pils. Kikaiga-shima, Ōshima group.

Fig. 72.—*C. holotrema* Pils. Nachi, Kii.

Figs. 73, 74.—*C. pigra* Pils. Kashima, Harima.

Figs. 75, 76, 77.—*C. dalli* Pils. Tairiuji, Awa (Shikoku).

DESCRIPTIONS OF TWO SPECIES OF EXTINCT TORTOISES, ONE NEW.

BY O. P. HAY.

Testudo atascosæ sp. nov.

In the collection of the Academy of Natural Sciences of Philadelphia the writer has found certain bones which belong apparently to an undescribed species of the genus *Testudo*. These bones are accompanied by a label to this effect: "Miocene, E. W. Marnock, Atascosa county, Texas." How this material came to the Academy there is no record. Mr. Witmer Stone has suggested that it may have been derived from Dr. Leidy's collection; we know also that Mr. Marnock collected in Texas for Prof. Cope, but beyond this there is no indication that these bones were ever in the hands of either Prof. Cope or Dr. Leidy.

These remains consist of the left half of the anterior lobe of the plastron and the greater portion of the left side of the hinder lobe. Figures of these parts are here presented.

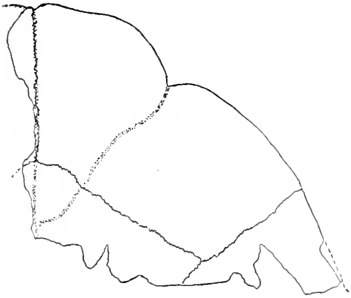


Fig. 1.

Fig. 2.

The species has been one of considerable size. The xiphiplastron has had a length of about 110 mm.; the whole posterior lobe a length approximately of 120 mm. The anterior lobe has had about the same length. We may perhaps safely estimate 200 mm.

for the length of the bridge, thus making the plastron 440 mm. long.

The anterior lobe (fig. 1) has been close to 200 mm. in width. The interclavicle, or entoplastron, has had a width of 100 mm.; its length has probably been about 80 mm., but its hinder border is missing. The gular scutes encroach on its anterior border. A broad rounded lip has projected beyond the gulo-humeral sulci about 28 mm. It has had a width of 80 mm., and is not notched in front. The whole border of the anterior lobe is acute, through the beveling off of the upper side. Fig. 2 is a section through the lip at the midline, and shows this beveling. The greatest thickness at the lip is 23 mm.; at a point halfway to the axillary notch this thickness has been reduced only to 21 mm.; near the notch it is about 10 mm. Superiorly the lip extends back about 50 mm. From the summit of the lip two ridges, with a shallow valley between them, run toward the axillary notch, diverging gently. There has evidently been no thoracic excavation beneath the lip behind. Such an excavation is found in *T. laticaudata*, *T. hexagonata* and in the living *T. polyphemus*.

Fig. 3.

Fig. 4.

Fig. 5.

The posterior lobe (fig. 3) has been broadly notched behind, the notch having a width of about 90 mm. and a depth of 35 mm. The terminal lobules are directed outward and upward, somewhat earlike, somewhat as they are in *T. polyphemus*, but not so narrow as they are in the latter. From the midline behind, the border is acute around the lobules and as far forward as about 35 mm. behind the hypo-xiphiplastral suture. Here it rather suddenly becomes broadly rounded, as shown by the cross-section (fig. 4). At the suture mentioned the thickness of the bone is 30 mm. The wall thus formed continues backward, descending somewhat, and meets the midline 15 mm. or more in front of the bottom of the notch. Fig. 5 represents a section through one of the lobules in a direction from its tip toward the centre of the hinder lobe. The greatest thickness is 22 mm.

The femoro-anal sulcus runs from the midline outward, so as to make the outer end of the anal scute somewhat wider than the mesial end. Antero-posteriorly, at the middle of its width, the scute is 40 mm. long.

It is probable that the deposits in which this tortoise was found belong to the Pliocene.

Terrapene eurypygia (Cope).

This species was described by Prof. Cope in 1869 (*Trans. Amer. Philos. Soc., XIV, new series*, p. 124), the type specimen being a small portion of the rear of the carapace. It was regarded as distinct from the common *Terrapene* of the region on account of the apparently greater width of the vertebral scutes. This seemed to be indicated by the contact of the last vertebral with the ninth marginal scute. No figure was made of the specimen, and nothing in addition was afterward published. The type has been examined by the writer.

In 1899 (*Jour. Phila. Acad.*, XI, pp. 193–267) Prof. Cope described various remains of the vertebrates which had been collected by Messrs. Dixon and Mercer in the Port Kennedy cave. Among other things there were three tortoises found, viz., *Clemmys insculpta*, *C. percrassa* and *Toxaspis* (*Terrapene*) *anguillulata*. There belonged to the collection, however, another box-tortoise which was not mentioned by Cope, and was perhaps not seen by him. Through the kindness of the management of the Academy this has been put in my hands for examination. These remains consist of almost the whole of the plastron and of various fragments of the carapace and the right humerus.

An examination of these bones showed that they belonged either to *Terrapene carolina* or to a species closely related to it. It was soon observed that the ninth marginal comes into contact with the last vertebral (fig. 6), a condition which recalled Cope's *Cistudo eurypygia*, and a close comparison proved that they are identical, one of the portions of the Port Kennedy specimen being fortunately the right margin of the rear of the shell from near the midline to the hinge. The question therefore arises whether or not the new material confirms Cope's view of the distinctness of the species.

The unusual width of the fourth and fifth vertebral scutes is proved by Cope's type and confirmed by the Port Kennedy specimen. Belonging to the latter is a fragment of the carapace presenting a part of the nuchal, a part of the first and second costals and the first and second peripherals (fig. 7). In *T. carolina* the first vertebral does not usually encroach on the first peripheral bone; in the fragment alluded to above the vertebral reaches over on the first peripheral nearly to the sulcus between the first and second marginals. The anterior vertebral must have been 34 mm. wide, about 6 mm. wider than in a specimen of *T. carolina* at hand. We must conclude that the other vertebrals were wider than they commonly are in *T. carolina*. An estimate makes it probable that the fourth vertebral in *T. eurypygia*, type, was about 42 mm. wide.

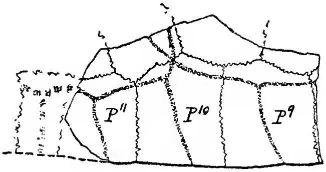


Fig. 6.

A comparison of the plastron of the Port Kennedy specimen makes it evident that this portion of the shell was almost everywhere thicker than in the corresponding parts of the living species. Nearly the whole of the border of the anterior lobe is thicker and with a more rounded edge. The hypoplastron of *T. carolina* at the hinge is 3 mm. thick; that of *T. eurypygia*, 4 mm. The thickness of the sloping, scute-covered border of the hinder lobe, at the junction of hypoplast and xiphiplast, is in *T. carolina* 5 mm. thick; in *T. eurypygia*, 7 mm. thick. This border is also wider in the latter species than in any specimens of the living species at hand.

No doubt all or nearly all the characters appealed to for the separation of Cope's species are more or less variable, but it appears unlikely that there should be so many deviations from the normal in one or two specimens. An examination of eighteen specimens of *T. carolina* revealed the fact that in one the fifth vertebral was in contact with the ninth marginal on both sides, while in another specimen these scutes were in contact on one side. In both cases, however, some of the scutes in the region were somewhat abnormal in their development. Leaving this out of view, we have the contact in about eight and one-third per cent. of cases. It appears unlikely that the only two specimens that we have of the fossil species would belong among this small minority.

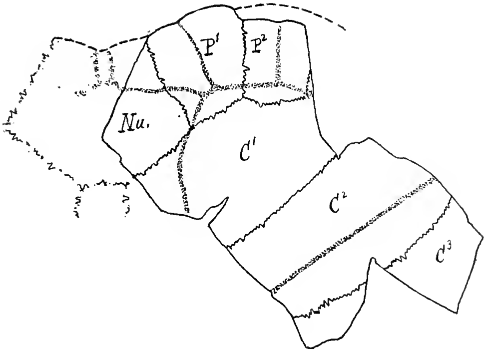


Fig. 7.

In the Port Kennedy specimen the anterior lobe is 51 mm. long, and 68 mm. wide at the hinge. In front of the hinge the width increases to 72 mm. The posterior lobe has had a length of at least 80 mm.

Fig. 6 presents a view of the fragment of the rear of the plastron of the Port Kennedy specimen, the interrupted lines having been added in order to show the position of the fragment. The crossing of the sulci on the upper portion of the drawing indicates the presence of a small scute cut off from the fifth vertebral, a slight abnormality. In fig. 6 the peripherals are numbered, but not the marginal scutes. The ninth scute is the one lying partly on the ninth peripheral and partly on the tenth. In both figures the bony sutures are represented by zigzag lines, while the sulci between the scutes are shown by dotted lines.

TWENTY NEW AMERICAN BATS.

BY GERRIT S. MILLER, JR.

This paper, published here by permission of the Secretary of the Smithsonian Institution, contains descriptions of twenty new American bats, the types of nineteen of which are in the United States National Museum. Six of these belong to the series of Mexican bats in the Biological Survey collection, kindly placed at my disposal, together with those in his private collection, by Dr. C. Hart Merriam.

Antrozous minor sp. nov.

Type.—Adult (skin and skull), No. 79,096, United States National Museum (Biological Survey collection). Collected at Comondu, Lower California, Mexico, September 20, 1895, by J. E. McLellan.

Characters.—Color as in the large *Antrozous pacificus* or slightly darker; size rather less than that of the small *A. pallidus.*

Color.—Dorsal surface buff, everywhere washed with wood-brown, but particularly on region behind shoulders. Under parts clear buff, paler than that of back and fading to cream-buff on middle of belly. Ears and membranes dark brown.

Skull and Teeth.—Skull narrower than that of the other species, the difference particularly noticeable in the posterior region of the braincase. Crown of upper premolar and of first and second upper molars much shorter in proportion to their width than in *A. pallidus* and *A. pacificus.* The lower molars are uniformly smaller than those of *A. pallidus*, but not different in form.

Measurements.—External measurements of type: Total length, 93; tail, 35; tibia, 20; foot, 10 (9); forearm, 48; thumb, 9.6; second digit, 40; third digit, 80; fourth digit, 68; fifth digit, 63; ear from meatus, 23; ear from crown, 19; width of ear, 16; tragus, 11.4.

Cranial measurements of an adult male from the type locality

(No. 96,491): Greatest length, 19 (21);[1] basal length, 17.6 (19); basilar length, 14 (15.4); interorbital constriction, 4 (4.6); zygomatic breadth, 11 (12.8); mastoid breadth, 9 (10); breadth of braincase above roots of zygomata, 8.6 (9); mandible, 13 (14.8); maxillary toothrow (exclusive of incisors), 6.8 (8); mandibular toothrow (exclusive of incisors), 7.6 (8).

Specimens Examined.—Five (four skins), all from the type locality.

Remarks.—*Antrozous minor* is a well-marked local species, combining the dark color of *A. pacificus* and the small size of *A. pallidus* with a peculiar form of the molar teeth.

Pipistrellus cinnamomeus sp. nov.

Type.—Adult female (skin and skull), No. 100,231, United States National Museum (Biological Survey collection). Collected at Montechristo, Tabasco, Mexico, May 4, 1900, by E. W. Nelson and E. A. Goldman. Original number, 14,136.

Characters.—Largest known American *Pipistrellus;* forearm, 37; greatest length of skull, 15. Ear shorter than that of *P. subflavus,* but much narrower. Color uniform cinnamon throughout, the individual hairs of the back with practically no trace of tricolor markings.

Ears.—The ear resembles that of *Pipistrellus subflavus* in general form, but it is shorter and very much narrower. Tragus straight, much like that of *P. subflavus,* but narrower.

Fur, Membranes, etc.—The fur is shorter and less woolly than that of *P. subflavus,* and it lacks the abundant sprinkling of long hairs characteristic of the latter. At middle of back the hairs forming the body of the fur are about 5 mm. in length. Interspersed with these are others 1–2 mm. longer, but quite unnoticeable except on close examination. In distribution of fur, as well as in other characters of external form, *Pipistrellus cinnamomeus* appears to be identical with *P. subflavus.*

Color.—Fur everywhere cinnamon, slightly more yellow than that of Ridgway, particularly on the under parts. The individual hairs are dark slate color at base, but this does not appear at surface unless fur is disarranged. In favorable lights the cinnamon of the hairs on the back may be seen to become lighter as it approaches

---

[1] Measurements in parentheses are those of an adult female *Antrozous pallidus* from Silver City, New Mexico (No. 66,110).

the dark basal area, thus distantly suggesting a tricolor pattern. Ears and membranes brown, the free edge of the wing apparently lighter, but this is perhaps due to some irregularity in drying.

Skull.—The skull is much larger than that of *Pipistrellus subflavus*, in this respect slightly exceeding that of *Myotis lucifugus*. In form it is longer and narrower than in the other American species of *Pipistrellus*, a difference which is particularly noticeable in the rostrum and palate. Thus, while the length of the bony palate is 1.4 mm. greater than in a fully adult *P. subflavus*, the width between middle molars is no more and the distance between roots of upper incisors is probably a little less than in the smaller species. Lachrymal foramen large, its centre over posterior root of large premolar; distance from its lower edge to rim of alveolus less than width of large premolar measured along cingulum. In *P. subflavus* this distance is distinctly greater than width of tooth. Bony palate more produced behind line of last molar than in the allied species, the median projection large and well developed. Audital bullæ of same relative size as in *P. subflavus*.

Teeth.—Aside from their much greater size, the teeth do not differ notably from those of *Pipistrellus subflavus*. Inner upper incisor distinctly smaller than outer, not approximately equal to it as is the case in *P. subflavus*. First upper premolar as large as outer incisor, slightly internal to toothrow, but plainly visible from outer side. First and second upper molars with a distinctly indicated hypocone, no trace of which is present in *P. subflavus*. Lower incisors crowded into a continuous row between the canines, the crown of the outermost subterete. Other mandibular teeth essentially as in *P. subflavus*, except for their greater size.

Measurements.—External measurements of type: Total length, 99; tail, 44; tibia, 15.4; foot, 9.6 (8); forearm, 37; thumb, 6.8; second finger, 35; third finger, 63; fourth finger, 53; fifth finger, 47; ear from meatus, 11.4; ear from crown, 9; width of ear, 7.

Cranial measurements of type: Greatest length, 15 (13);[2] basal length, 14 (12); basilar length, 11.6 (9.8); palatal length (median, but posterior spine not included), 6 (4.8); width of palate between middle molars, 3 (3); interorbital constriction,

---

[2] Measurements in parentheses are those of an adult *Pipistrellus subflavus* from Raleigh, N. C. (No 36,655).

4 (3.8); zygomatic breadth, 9 (8); breadth of braincase above roots of zygomata, 7.2 (6.4); mandible, 11.4 (9.8); maxillary toothrow (exclusive of incisors), 5.8 (4.6); mandibular toothrow (exclusive of incisors), 6 (4.6).

Specimens Examined.—One, the type.

Remarks.—This bat differs so widely from the other known American species of *Pipistrellus* as to need no special comparisons. Superficially it has much the appearance of an unusually red *Myotis lucifugus*, and only on examination of the teeth do the animal's true relationships become apparent.

A few individuals were found in an unoccupied house on the edge of the town of Montechristo. Apparently the species was uncommon.

Dasypterus floridanus sp. nov.

Type.—Adult female (skin and skull), No. 111,379, United States National Museum. Collected at Lake Kissimmee, Fla., March 28, 1901, by Dr. Edgar A. Mearns. Original number, 5,183.

Characters.—Color as in the large *Dasypterus intermedius* (H. Allen) and the small *D. xanthinus* (Thomas); size intermediate between these extremes.

Measurements.—External measurements of type: Total length, 129; tail, 52; tibia, 20; foot, 9 (8.4); forearm, 49; thumb, 10; second digit, 61; third digit, 98; fourth digit, 80; fifth digit, 65; ear from meatus, 17; ear from crown, 11; width of ear, 11.

Cranial measurements of type: Greatest length, 18 (19.8);[3] basal length, 16.2 (17.6); basilar length, 13.6 (14); median palatal length, 6 (6.4); interorbital constriction, 5 (5); zygomatic breadth, 13 (14); mastoid breadth, 10 (11); mandible, 14.8 (15); maxillary toothrow (exclusive of incisor), 6.8 (7); mandibular toothrow (exclusive of incisors), 7.8 (8).

Specimens Examined. — Eleven, from the following localities: Florida—Davenport, 1 (skin); Kissimmee, 3 (skins); Mullet Lake, 1; Old Town, 2 (skins); Louisiana—Lafayette, 2; Houma, 2 (1 skin).

Remarks.—*Dasypterus floridanus* differs from *D. intermedius* in the same manner as the Lower Californian *D. xanthinus*

---

[3] Measurements in parentheses are those of an adult topotype of *Dasypterus intermedius* (No. 1,439).

(Thomas), but to a much less degree. Indeed, it is probable that it intergrades with the Texan animal. The three specimens collected at Kissimmee by Dr. Mearns, taken in connection with those which I examined in 1897, show such constant differences from *D. intermedius* that it now seems best to recognize the Austroriparian race by name. More detailed measurements of the two forms will be found in *North American Fauna*, No. 13, p. 117.

NYCTINOMOPS gen. nov. (*Molossidæ.*)

Type.—*Nyctinomus femorosaccus* Merriam.

Characters.—Externally like *Nyctinomus.* Skull similar to that of *Promops,* except that the premaxillaries are separated in front by a very narrow space. Teeth as in *Nyctinomus,* but upper incisors parallel, the two occasionally in contact with each other.

Remarks. — Although intermediate between *Nyctinomus* and *Promops,* the group of species of which *N. femorosaccus* is typical forms a very natural genus. Its members have usually been referred to *Nyctinomus,* but Dr. J. A. Allen[4] has recently placed two forms (*depressus* and *affinis*) in *Promops.* In those thus far known there are only four lower incisors. I have examined the following species: *Nyctinomops femorosaccus* (Merriam), *N. yucatanicus* sp. nov., *N. aurispinosus* (Peale), *N. laticaudatus* (E. Geoffroy), *N. orthotis* (H. Allen), *N. depressus* (Ward), *N. affinis* (J. A. Allen) and *N. macrotis* (Gray). It is probable that *Nyctinomus megalotis* Dobson is also a member of this genus.

Nyctinomops yucatanicus sp. nov.

Type.—Adult female (skin and skull), No. 108,166, United States National Museum (Biological Survey collection). Collected at Chichen Itza, Yucatan, February 9, 1901, by E. W. Nelson and E. A. Goldman. Original number, 14,521.

Characters—Size and general appearance as in *N. europs,* but ear larger and with better developed keel, nearly as in *N. femorosaccus.* Skull slightly larger than that of *N. europs,* the rostrum longer and interorbital region more nearly cylindrical. Teeth as in *N. europs,* but larger.

Ears.—The ear agrees in all details of form with that of *Nyctinomops femorosaccus,* due allowance being made for its smaller size. The keel, however, may be a little less developed, though its

---

[4] *Bull. Amer. Mus. Nat. Hist.*, XIII, p. 91, May 12, 1900.

appearance may have been slightly altered by drying. It is quite different in form from that of *N. europs*, and not thickened at the edge as in *N. laticaudatus*. Antitragus large, in form exactly like that of *N. femorosaccus*, therefore higher in proportion to its width than in *N. laticaudatus* and *N. europs*. Tragus as in *N. femorosaccus*.

Color.—Dorsal surface uniform vandyke-brown, the hairs whitish at base, but not sharply bicolor. In certain lights the extreme tips of the hairs show a faint wash of wood-brown, and in others there is a strong sheen of bluish ecru-drab. Under parts like back, but strongly tinged with wood-brown. Ears and membranes dark brown.

Skull.—The skull is intermediate in size between that of *Nyctinomops europs* and the larger *N. laticaudatus* and *N. femorosaccus*. In form it shares to a certain extent the shortening of the rostrum that characterizes the Brazilian species, but this peculiarity is not carried as far, nor is the cylindric contour of the interorbital region noticeably impaired. The orifice of the anterior nares is more tubular than in *N. europs*, but less so than in *N. femorosaccus*.

Teeth.—The teeth agree in all respects with those of *Nyctinomops europs* except that the upper incisors are larger and more closely set.

Measurements.—External measurements of type: Total length, 98; tail, 42; tibia, 12.4; foot, 9 (7.8); forearm, 42; thumb, 8; second finger, 40; third finger, 81; fourth finger, 60; fifth finger, 42; ear from meatus, 15; ear from crown, 11.6; width of ear, 17; tragus, 1.8.

Cranial measurements of type: Greatest length, 17.2 (16.6);[5] basal length, 15 (14.8); basilar length (to posterior edge of palatal emargination), 13 (12.4); interorbital constriction, 3.4 (3.4); zygomatic breadth, 10 (9.4); greatest breadth of braincase above roots of zygomata, 8.8 (8); mandible, 12.4 (11.4); maxillary toothrow (exclusive of incisors), 6.4 (6.2); mandibular toothrow (exclusive of incisors), 7 (6.8).[6]

Specimens Examined.—Twelve, all from the type locality.

---

[5] Measurements in parentheses are those of a paratype of *Nyctinomops europs* (♀, No. 101,502).

[6] Some of the measurements of a skull of *Nyctinomops femorosaccus* from Fort Huachuca, Arizona (No. 36,038) are: Greatest length, 19; basal length 17; zygomatic breadth, 10; maxillary toothrow (exclusive of incisors), 7.6

Remarks.—Although *Nyctinomops yucatanicus* is in many respects intermediate between the small *N. europs* and the larger *N. laticaudatus* and *N. femorosaccus*, it is a very distinct species. Its relationships are evidently with the larger forms, though superficially it bears a close resemblance to *N. europs.*

Mr. Nelson and Mr. Goldman secured the specimens in crevices of the ruins at Chichen, Itza. A bat which they supposed to be the same was seen at Tunkas and Merida.

Molossus nigricans sp. nov.

Type.—Adult male (skin and skull), No. 90,941, United States National Museum (Biological Survey collection). Collected at Acaponeta, Tepic, Mexico, August 2, 1897, by E. W. Nelson and E. A. Goldman. Original number, 11,433.

Characters.—Slightly larger than *Molossus rufus* from Paraguay; color blackish-brown, the shoulders frequently though not invariably grayish. Red phase uncommon, brighter than that of *M. rufus*, but apparently less so than in *M. pretiosus.*

Color.—Type: Upper parts a uniform very dark seal-brown, interrupted on shoulders by a crescentic area of broccoli-brown about 10 mm. in width. This lighter color appears again as an ill-defined wash on head between ears. Under parts like back, but everywhere lightened by a wash of broccoli-brown, this most conspicuous on throat. Ears and membranes an indefinite blackish-brown. Red phase: The few specimens in the red phase have been immersed in alcohol for ten years and are therefore not to be trusted as regards color. They are now a uniform tawny, rather less bright than *M. pretiosus* in the same pelage.

Variation in color, as shown by the skins in the dark phase, is slight, and such as occurs is mostly a mere darkening of the general tint and the partial or complete obliteration of the shoulder crescent. In the majority of specimens, indeed, this crescent is absent.

Skull and Teeth.—The skull is about the same size as that of *Molossus rufus*, but the rostrum is heavier and the interpterygoid space and the palate are wider. On the other hand, the sagittal and lambdoid crests appear never to reach the extreme development seen in *Molossus rufus.*

Teeth as in *Molossus rufus*, but distinctly heavier throughout.

Measurements.—External measurements of type: Total length, 145; tail, 53; tibia, 18.6; foot, 12 (11); forearm, 52.6; thumb, 9; second finger, 48; third finger, 100; fourth finger, 80; fifth finger, 51.

Cranial measurements of type: Greatest length, 23.6 (23);[7] basal length, 19.8 (20); basilar length, 17.4 (17.4); median palatal length, 7.2 (7.2); interorbital constriction, 4.8 (4.2); zygomatic breadth, 15.2 (14); breadth of braincase above roots of zygomata, 11.4 (11); greatest height of sagittal crest, 2.2 (3); mandible, 17 (16.6); maxillary toothrow (exclusive of incisors), 8.8 (8); mandibular toothrow (exclusive of incisors), 10 (9).

Specimens Examined.—Forty-six, from the following localities in Mexico: Chiapas—Huehuetan, 1, Tonila, 1; Colima—City of Colima, 17; Jalisco—Teuchitlan, 1; Oaxaca—Llano Grande, 1, Tehuantepec City, 2 (1 skin); Tamaulipas—Alta Mira, 1; Tepic—Acaponeta, 8 (3 skins); Tuxtla—San Andres, 1 (skin); Vera Cruz—Catemaco, 7 (3 skins); Yucatan—Chichen Itza, 7 (skins).

Remarks.—That this bat is numerous in parts of Mexico is shown by the following extract from the collectors' field notes: "Common about the houses in Acaponeta. During the day they conceal themselves under the tiles of roofs. One man told us that he had killed over three hundred of them shortly before our arrival while at work on his roof."

Molossus pretiosus sp. nov.

1901. *Molossus rufus* Robinson and Lyon, Proc. U. S. Nat. Mus., XXIV, p. 156, October 3, 1901.

Type.—Adult male (skin and skull), No. 102,761, United States National Museum. Collected at La Guaira, Venezuela, July 13, 1900, by Wirt Robinson and M. W. Lyon, Jr. Original number, 106.

Characters.—Distinctly smaller than *Molossus rufus* from Paraguay; color rich dark reddish-brown, the shoulders frequently though not invariably chestnut. Red phase common, much brighter than in *Molossus rufus.*

Color.—Type: Upper parts seal-brown, somewhat more tinged with red than that of Ridgway. Shoulders washed with rufous. Under parts like back, but not as dark, and even more tinged with red. Chest sprinkled with whitish hairs. Ears and membranes blackish.

---

[7] Measurements in parentheses are those of an adult male *Molossus rufus* from Sapucay, Paraguay.

There is much variation in color, as pointed out by Robinson and Lyon. The young and a few adults are practically black. In others the rufous is more conspicuous than in the type, sometimes invading the entire pelage to the exclusion of the dark brown. In the completely red specimens the exact shade varies from burnt umber to a rather dark tawny.

Skull and Teeth.—The skull and teeth are much smaller than in true *Molossus rufus*, but I can detect no tangible difference in form, beyond the rather less development of the sagittal and lambdoid crests.

Measurements.—External measurements of type: Total length, 123; tail, 44; tibia, 18; foot, 11.4 (10.8); forearm, 45.4; thumb, 8.2; second finger, 42; third finger, 90; fourth finger, 70; fifth finger, 47.

Cranial measurements of type: Greatest length, 21 (23);[8] basal length, 18 (20); basilar length, 16 (17.4); median palatal length, 7 (7.2); interorbital constriction, 4 (4.2); zygomatic breadth, 13 (14); breadth of braincase above roots of zygomata, 10.6 (11.4); greatest height of sagittal crest, 1.8 (3); mandible, (16.6); maxillary toothrow (exclusive of incisors), 8 (8); mandibular toothrow (exclusive of incisors), 8.8 (9).

Specimens Examined.—Seventy-one (44 skins), all from the vicinity of La Guaira.

Remarks. — Specimens from Sapucay, Paraguay, essentially topotypes of *Molossus rufus*, which have been received within the past few months, show that the bat from northern South America is an easily recognizable form. The Paraguay skins are all a uniform reddish-brown, very near the raw umber of Ridgway. They are very uniform in color and show no tendency toward the bright tints of *Molossus pretiosus* in the corresponding phase. Neither is there any suggestion of a black phase. As far as can be determined from the material now at hand, we have a large southern form, true *Molossus rufus*, which apparently lacks the black phase and in which the red phase is very dull; a large northern form, *M. nigricans*, in which the red phase is rare, and a small form, intermediate in range, with both phases of pelage well developed and characterized by great richness of color.

---

[8] Measurements in parentheses are those of an adult male *Molossus rufus* from Sapucay, Paraguay.

Nyctinomus antillularum sp. nov.

Type.—Adult male (in alcohol), No. 113,188, United States National Museum. Collected at Roseau, Dominica, W. I., August 5, 1901, by H. Selwyn Branch.

Characters.—In general similar to the common *Nyctinomus* of the Greater Antilles, but size even less, the length of forearm (in sixteen specimens) ranging from 36.5 mm. to 38.5 mm.

Form, Color, etc.—In color and external form this species shows no peculiarities as compared with the common representative of the *Nyctinomus brasiliensis* group, occurring in Cuba, Jamaica and Porto Rico. As in the latter, the ears are relatively smaller than those of the continental members of the genus, extending, when laid forward, just to nostril instead of distinctly beyond end of muzzle. The usual brown and red color phases are represented, but as all but two of the specimens at hand have been preserved in alcohol no exact comparison can be made.

Skull and Teeth.—The skull and teeth do not differ appreciably from those of Cuban specimens of the larger West Indian form. The first lower premolar is very minute and without distinct cingulum.

Measurements.—External measurements of type: Total length, 83; tail, 30; tibia, 12; foot, 6.6 (6); forearm, 47.4; thumb, 7; second finger, 38; third finger, 70; fourth finger, 58; fifth finger, 40; ear from meatus, 15; ear from crown, 11.4; width of ear, 15.

Cranial measurements of type: Greatest length, 16; basal length, 14.8; basilar length, 12; median palatal length, 6; interorbital constriction, 3.8; zygomatic breadth, 9; breadth of braincase above roots of zygomata, 8; mandible, 11; maxillary toothrow (exclusive of incisors), 5.8; mandibular toothrow (exclusive of incisors) 6.

Specimens Examined.—Twenty-one, from the following islands: Dominica, 2; Montserrat, 1; St. Kitts, 6 (2 skins); St. Lucia, 11; Tobago, 1.

Natalus major sp. nov.

Type.—Adult male (in alcohol), No. 101,395, United States National Museum. Collected near Savaneta, San Domingo, W. I., by W. M. Gabb.

Characters.—Like *Natalus stramineus*, but much larger: Forearm, 42; longest finger, 80; greatest length of skull, 18.

External Form.—Except for its greater size, *Natalus major* so closely resembles specimens of *N. stramineus* from Dominica as to require no detailed description.

Skull and Teeth.—While the skull resembles that of *N. stramineus* in form it is readily distinguished by its larger size and heavier structure. The braincase in particular is greatly inflated as compared with that of the smaller species. Rostrum with sides nearly parallel. The teeth are similar in form to those of *N. stramineus.*

Measurements.—External measurements of the type and of an adult female from the type locality: Total length, ♂ 110, ♀ 116; head and body, ♂ 49, ♀ 53; tail, ♂ 61, ♀ 63; tibia, ♂ 22.4, ♀ 23; foot, ♂ 9 (7.6), ♀ 9.8 (8); forearm, ♂ 42, ♀ 43; thumb, ♂ 6, ♀ 6; second digit, ♂ 44, ♀ 43; third digit, ♂ 80, ♀ 82; fourth digit, ♂ 61, ♀ 62; fifth digit, ♂ 57, ♀ 58; ear from meatus, ♂ 15, ♀ 16.6; ear from crown, ♂ 12, ♀ 12.

Cranial measurements of type: Greatest length, 18 (17),[9] basal length, 16.4 (15.6); basilar length, 14.6 (14); median palatal length, 9.8 (8.8); breadth of rostrum at base of canines, 4.4 (3.6); interorbital constriction, 3.6 (3.2); zygomatic breadth, 9.6 (9); greatest breadth of braincase, 9 (7.8); mandible, 14 (13); maxillary toothrow (exclusive of incisors), 8 (7.8); mandibular toothrow (exclusive of incisors), 8.4 (7.8).

Specimens Examined.— Two, both from the type locality.

Remarks.—*Natalus major* has been compared with eighteen specimens of *N. stramineus* from the island of Dominica. None of the latter at all closely approaches it in size.

Natalus mexicanus sp. nov.

Type.—Adult female (in alcohol), No. 96,496, United States National Museum (Biological Survey collection). Collected at Santa Anita, Lower California, Mexico, in July or August, 1897, by J. F. Abbott.

Characters.— Smaller than *Natalus stramineus;* skull with rostrum more tapering anteriorly.

Color.—In color as in other external characters *Natalus mexicanus* apparently does not differ from *N. stramineus.* The only specimens of the latter that I have seen are, however, preserved in alcohol. Two well-defined color phases occur, a yellow and a

---

[9] Measurements in parentheses are those of an adult male *N. stramineus* from the island of Dominica (No. 113,695).

brown. In the former (represented by the type) the fur is everywhere ochraceous, that of the under parts uniform from base to tip of hairs, that of the back slightly washed with clay color. In the brown phase the fur is broccoli-brown, somewhat paler beneath the surface and on the under parts. All shades of intergradation between the two phases may be found in any series of specimens.

Skull and Teeth.—In general form the skull is like that of *N. stramineus*, but the braincase is smaller and the anterior part of the rostrum is more tapering, differences readily appreciable on comparison.

Measurements.—External measurements of type: Total length, 95; tail, 53; tibia, 19; foot, 7.6 (7); forearm, 35.4; thumb, 5; second finger, 37; third finger, 77; fourth finger, 56; fifth finger, 57; ear from meatus, 14; ear from crown, 12.

Cranial measurements of type: Greatest length, 16 (17);[10] basal length, 14 (15.6); basilar length, 13 (14); zygomatic breadth, 8 (9); interorbital constriction, 3 (3.2); greatest breadth of braincase above roots of zygomata, 7.6 (7.8); mandible, 12 (13); maxillary toothrow (exclusive of incisors), 7 (7.8); mandibular toothrow (exclusive of incisors), 7 (7.8).

Specimens Examined.—One hundred and seven, from the following localities in Mexico: Campeche—Apazote, 1 (skin); Durango—Chacala, 25; Jalisco—Ameca, 17; Itzatlan, 1 (skin); Lower California—San Jose del Cabo, 3; Santa Anita, 2; Sinaloa—near Mazatlan, 1; Plomasas, 9; Rosario, 42 (7 skins); Tuxtla—San Andres, 4 (1 skin); Vera Cruz—Mirador, 2.

Remarks.—*Natalus mexicanus* differs from its South American representative in the same characters and to about the same extent as *Dermonotus fulvus* and *Chilonycteris mexicanus*. In all three cases intergradation probably takes place between the large southern form and the smaller northern one.

Chilonycteris portoricensis sp. nov.

Type—Adult female (skin and skull), No. 102,358, United States National Museum Collected in cave near Pueblo Viejo, Porto Rico, W. I., March 19, 1900, by L. Stejneger and C. W. Richmond.

---

[10] Measurements in parentheses are those of an adult male *Natalus stramineus* from the island of Dominica (No. 113,605).

Characters.— Similar to the Cuban *Chilonycteris boothi* Gundlach, but with smaller ears.

Color.—Upper parts rather dark brown, the exact shade intermediate between the hair-brown and bistre of Ridgway. Under parts broccoli-brown washed with ecru-drab, particularly on throat. Wings and ears an indefinite blackish-brown.

Skull and Teeth.—The skull and teeth resemble those of *Chilonycteris boothi* in all respects. From that of the Jamaican *C. parnellii* the skull is similarly indistinguishable, but the teeth differ notably in the greater size of the second lower premolar. This tooth, crowded quite out of the toothrow in *C. parnellii*, so that the first and third premolars come fully in contact, is, in *C. boothi* and *C. portoricensis*, so placed as to separate the first and third by a distinct space readily noticeable when the toothrow is viewed from the outer side. This character, though apparently trivial, is perfectly constant in a series of seven specimens from Porto Rico, four from Cuba, and two from Jamaica.

Measurements.—External measurements of type: Total length (skin), 92; tail (skin), 22; tibia, 18.8; foot, 10 (9); forearm, 51.4; thumb, 8; second finger, 42; third finger, 85; fourth finger, 58; fifth finger, 58; ear from meatus, 20.

Cranial measurements of type: Greatest length, 20; basal length, 18.6; basilar length, 17; interorbital constriction, 4; lachrymal breadth, 7.4; zygomatic breadth, 11; mandible, 15; maxillary toothrow (exclusive of incisors), 8.8; mandibular toothrow (exclusive of incisors), 9.

Remarks.—The forms of the *Chilonycteris parnellii* group from Cuba, Jamaica and Porto Rico may be distinguished by the following key:

First lower premolar in contact with third, the second crowded out of toothrow on lingual side, ... *C. parnellii.*
First lower premolar not in contact with third, the second in toothrow, though usually displaced toward lingual side:
  Ear from meatus 23–24 mm., ... *C. boothi.*
  Ear from meatus 19–21 mm., ... *C. portoricensis.*

Chilonycteris mexicana sp. nov.

Type.—Adult male (skin and skull), No. 89,277, United States National Museum (Biological Survey collection). Collected at

San Blas, Tepic, Mexico, June 9, 1897, by E. W. Nelson and E. A. Goldman. Original number, 11,132.

Characters.—Similar to *Chilonycteris rubiginosa*, but size smaller and color (in brown phase) much less dark.

Color.—Brown phase, represented by the type: Dorsal surface a uniform brown, most closely resembling the broccoli-brown of Ridgway, but darker and with a mixture of both hair-brown and drab. The individual hairs are nearly uniform throughout their length, though the bases are faintly darker and the tips lighter. Under parts wood-brown, much lighter than Ridgway's Plate III, fig. 19, the hairs distinctly dark slaty-brown at base. Ears and membranes brown, somewhat darker than body.

Yellow phase: Entire body and head tawny-ochraceous, the hairs of the upper parts uniform, those of the belly dull brown at base.

Skull and Teeth.—Except for their smaller size, the skull and teeth do not differ appreciably from those of *Chilonycteris rubiginosa*.

Measurements.—External measurements of type: Total length, 82; tail, 20; tibia, 19.4; foot, 11.6 (10); forearm, 54; thumb, 7; second finger, 45; third finger, 90; fourth finger, 71; fifth finger, 67; ear from meatus, 21.

Cranial measurements of type: Greatest length, 20 (22);[11] basal length, 19 (—); basilar length, 17 (19); interorbital constriction, 4.4 (4.4); lachrymal breadth, 7.8 (8.6); zygomatic breadth, 11.8 (13); mandible, 15 (17); maxillary toothrow (exclusive of incisors), 9 (10); mandibular toothrow (exclusive of incisors), 9.4 (11).

Specimens Examined.—Ninety-four (9 skins), from the following localities in Mexico: Colima—Hacienda Magdalena, near City of Colima, 14; Durango—Chacala, 8; Jalisco—Ameca, 5, Bolaños, 4 (1 skin), near Ometepec, 3; Morelos (exact locality not known), 4; Oaxaca—Huilotepec, 1 (skin); Tepic—San Blas, 55 (7 skins).

Remarks.—The large *Chilonycteris rubiginosa* is represented in the National Museum collection by three specimens, one from Chontales, Nicaragua, and two from the island of Trinidad. They agree very closely in size, forearm 61–62 mm., and are not approached by any of the ninety-four specimens of *C. mexicana*. They are also much darker in color.

---

[11] Measurements in parentheses are those of an adult *Chilonycteris rubiginosa* from Chontales, Nicaragua (No. 37,515).

At San Blas *Chilonycteris mexicana* was very common in a small narrow cave which extended like a deep crevice into the base of the cliff on the hillside facing the town.

Mormoops tumidiceps sp. nov.

Type.—Adult male (in alcohol), No. 5,581, collection of Dr. C. Hart Merriam. Collected in the Point Gourde Caves, Trinidad, 1889, by Sir William Robinson.

Characters.—Externally similar to *Mormoops megalophylla*; skull larger and more swollen than that of the Mexican animal.

Color and other External Features.—After many years' immersion in alcohol the specimen presents no external characters to distinguish it from *Mormoops megalophylla.*

Skull and Teeth.—The skull differs from that of *Mormoops megalophylla* in greater size, due to increased breadth of both rostrum and braincase, though particularly of the latter. There is no other evident difference in form. Teeth as in *M. megalophylla* except that the premolars both above and below are slightly larger, a difference which may readily prove to be no more than individual.

Measurements.—External measurements of type: Total length, 92; tail, 26; tibia, 22; foot, 11 (10.4); forearm, 55; thumb, 7; second digit, 50; third digit, 102; fourth digit, 73; fifth digit, 65; ear from meatus, 14; ear from crown, 8.

Cranial measurements of type: Greatest length, 15 (14.6);[12] basal length, 15 (14.6); basilar length, 13.2 (13); median palatal length, 8.6 (8.4); least interorbital breadth, 5.6 (5); lachrymal breadth, 7.4 (7); zygomatic breadth, 9.8 (9.2); mastoid breadth, 9.2 (8.6); greatest breadth of braincase, 10 (8.8); mandible, 13 (12.8); maxillary toothrow (exclusive of incisors), 8.2 (8); mandibular toothrow (exclusive of incisors), 8.8 (8.4).

Specimens Examined.—One, the type.

Remarks.—The differences between *Mormoops megalophylla* and *M. tumidiceps* are of the same kind and extent as those separating *Natalus mexicanus* from *N. stramineus* and *Chilonycteris mexicana* from *C. rubiginosa.* The Trinidad *Mormoops* is very different from the small *M. intermedius* of Curaçao.

---

[12] Measurements in parentheses are those of an adult male *Mormoops megalophylla* from Tampico, Mexico (No. 60,378).

Dermanura rava sp. nov.

Type.—Adult ♂ (skin and skull), No. 113,338, United States National Museum. Collected at San Javier, northern Ecuador, August 10, 1900, by G. Fleming. Original number, 12.

Characters.—Smaller than *Dermanura cinerea* and *D. tolteca* and color much paler; ear with narrow whitish border. Skull smaller than that of *D. tolteca*, the palatine foramina much more numerous.

Color.—General color a light yellowish-brown, intermediate between the cream-buff and clay color of Ridgway, the upper parts, especially the region behind shoulders, washed with broccoli-brown. Face with four ill-defined whitish stripes. Ears and membranes light brown, the former distinctly edged with whitish.

Skull.—Except for its noticeably smaller size, the skull does not differ from that of *D. tolteca* in general appearance. It is distinguishable, however, by the number of small foramina in the palate, which persist as two conspicuous rows of small perforations even in very old individuals.

Teeth.—The teeth are similar to those of *Dermanura tolteca*, except that they are uniformly smaller.

Measurements.—External measurements of type (from well-made skin): Head and body, 55; tibia, 14; foot, 9.6 (8.6); forearm, 36; thumb, 10; second digit, 32; third digit, 82; fourth digit, 62; fifth digit, 59; ear from meatus (estimated), 14; noseleaf from margin of lip (dry), 10.

Cranial measurements of type: Greatest length, 20 (22.4);[13] basal length, 17 (20); basilar length, 15 (17); median palatal length, 9 (10); zygomatic breadth, 12 (13); mastoid breadth, 11 (12); interorbital constriction, 5 (6); mandible, 13 (14.6); maxillary toothrow (exclusive of incisors), 7 (7.4); mandibular toothrow (exclusive of incisors), 7 (7.4).

Specimens Examined.—Ten, from the following localities in northern Ecuador: San Javier, 2; Corondelet, 4; Pambilar, 4.

Remarks.—The series of ten specimens shows very little individual variation. In two skins from Corondelet the color is less yellow and more gray than in the others, a difference probably due to dichromatism.

---

[13] Measurements in parentheses are those of an adult male *Dermanura tolteca* from Tetela del Vulcan, Morelos, Mexico (No. 52,051).

Dermanura phæotis sp. nov.

Type.—Adult female (skin and skull), No. 108,176, United States National Museum (Biological Survey collection). Collected at Chichen Itza, Yucatan, February 10, 1901, by E. W. Nelson and E. A. Goldman. Original number, 14,537.

Characters.—Size and color as in *Dermanura rava*, but ears much darker and without the whitish border. Skull with broader, flatter rostrum than in the South American form.

Form, Color, etc.—In general appearance this bat so closely resembles *Dermanura rava* that no special description is necessary.

Ears.—In form the ears are similar to those of *Dermanura rava*, but they appear to be slightly larger, and in color they are a uniform darker brown, without trace of the whitish edging.

Skull and Teeth.—The skull closely resembles that of *Dermanura rava*, but the rostrum is broader and flatter and the median backward extension of the bony palate is wider. Molar teeth apparently a little narrower than in the related species.

Measurements.—External measurements of type: Tibia, 14; foot, 9 (8); forearm, 37; thumb, 9.6; second digit, 31; third digit, 78; fourth digit, 62; fifth digit, 57.

Cranial measurements of type: Greatest length, 19; zygomatic breadth, 11.6; mastoid breadth, 10.

Specimens Examined.—One, the type.

Remarks.—*Dermanura phæotis* is closely related to *D. rava*, but its characters are not closely approached by any of the ten specimens of the latter.

Vampyrops fumosus sp. nov.

Type.—Adult female (skin and skull), No. 105,530, United States National Museum. Collected on the Purus river, Brazil, March 24, 1901, by J. B. Steere. Original number, 24.

Characters.—Related to *Vampyrops infuscus* Peters and *V. dorsalis* Thomas, but size larger and color paler than in either. Face stripes barely indicated. Dorsal line present, but very faint.

Color.—General color broccoli-brown, slightly darker on head and nape, slightly paler on shoulders and sides of neck, the under parts washed with ecru-drab. From noseleaf to ear can be traced a faint pale stripe, not different in color from the surrounding parts. Dorsal line whitish, extending from neck to rump. It is plainly visible when the fur is smooth, but a slight disarrangement of the hairs causes it to disappear. Ears and membranes brown, not as dark as in *Vampyrops vittatus*, the only large species at hand.

Skull and Teeth.—The skull is considerably smaller than that of *Vampyrops vittatus*, but not noticeably different in form, except that the interorbital region is narrower and more distinctly concave. Anterior nares a little more produced backward than in the larger species.

Teeth as in *V. vittatus*, but uniformly much smaller, the outer upper incisors excepted. These are actually as well as relatively larger than in the larger animal.

Measurements.—External measurements of type (from skin): Head and body, 70; tibia, 24; foot, 13 (12); forearm, 56; thumb, 17; second digit, 46; third digit, 130; fourth digit, 93; fifth digit, 88; ear from meatus, 19; width of ear, 11.4.

Cranial measurements of type: Greatest length, — (30);[14] basal length, — (28); basilar length, — (24.4); median palatal length, 16 (16.6); interorbital constriction, 7 (7.6); zygomatic breadth, 18 (19); mastoid breadth, — (16); breadth of palate between middle molars, 8 (8.4); mandible, 21.8 (22.4); maxillary toothrow (exclusive of incisors), 12 (12.6); front of canine to back of second molar, 11.6 (12); mandibular toothrow (exclusive of incisors), 13 (13.4).[15]

Specimen Examined.—One, the type.

Remarks.—This species is readily distinguishable from *Vampyrops vittatus* by its smaller size, lighter color, and by the faintness of the face markings and dorsal line. In size it approaches *V. recifinus* and *V. infuscus*, though it is larger than either; forearm, 56, as opposed to 41 in *V. recifinus* and 52 in *V. infuscus*. From the latter it differs in the presence of the white dorsal line. The upper incisors probably show the first suggestion of the form found in *Vampyrops zarhinus* and *V. recifinus*, as the middle pair are smaller than in *V. vittatus*. They are, however, practically in contact with each other, though with a lens a slight space between them can be detected.

---

[14] Measurements in parentheses are those of an adult female *Vampyrops vittatus* from Valparaiso, Santa Marta region, Colombia (No. 15,101, Am. Mus. Nat. Hist.), kindly loaned by Dr. J. A. Allen.

[15] Some of the cranial measurements of the type of *V. recifinus* given by Thomas (*Ann. and Mag. Nat. Hist.*, 7th ser., VIII, p. 192, September, 1901) are as follows: Greatest length, 24; basal length, 19; front of canine to back of second molar, 8.4.

Stenoderma luciæ sp. nov.

Type.—Adult female (in alcohol), No. 110,921, United States National Museum. Collected on Santa Lucia Island, West Indies, February 4, 1901, by H. Selwyn Branch.

Characters.—Larger than *Stenoderma nichollsi* of Dominica, its nearest geographical ally, and inner upper incisors more noticeably bifid. Much smaller than *S. montserratense*, and with a distinct white shoulder spot.

Color.—After a year's immersion in alcohol the color of the fur is a uniform clay color, that of the back, limbs and membranes strongly washed with wood-brown, that of the under parts somewhat lightened by faintly paler hair-tips. A small but very distinct whitish spot on shoulder at point where membrane joins body. Ears and noseleaf light-brown. Membranes dark-brown throughout, except that the antebrachium has a distinct pale border extending from base of thumb halfway to shoulder. Bones of fingers and distal half of forearm much lighter than membrane.

Ears, Membranes, etc.—The ears, membranes and external features in general are as in a topotype of *S. nichollsi.*

Skull.—The skull is distinctly larger than that of *Stenoderma nichollsi*, but of essentially the same form throughout.

Teeth much more robust than those of *S. nichollsi.* The inner upper incisor is very distinctly bifid, in this respect differing notably from that of the related species. Crowns of first and second molars rather broader relatively to their length than in *S. nichollsi.*

Posterior molar minute, its area scarcely more than half that of middle incisor. Second lower molar with outline of crown more nearly square than in *S. nichollsi.*

Measurements.—External measurements of type: Head and body, 65 (53);[16] tibia, 19 (16.4); foot, 12.6 (12); foot without claws, 12 (11); forearm, 47 (44); thumb, 15 (11.6); second finger, 41 (36); third finger, 110 (96); fourth finger, 76 (70); fifth finger, 71 (66); ear from meatus, 18 (18); ear from crown, 14 (13.6); width of ear, 14 (14).

Cranial measurements of type: Greatest length, 23 (20.4); basal length, 20 (17); basilar length, 17 (15); interorbital constriction, 6 (5.4); zygomatic breadth, 15 (13.6); mastoid breadth, 12 (11); breadth of palate between middle molars, 4.4 (3.6); mandible,

---

[16] Measurements in parentheses are those of an adult male *S. nichollsi.*

13.4 (12); maxillary toothrow (exclusive of incisors), 7.6 (6.4); front of canine to back of second molar, 7.2 (6); mandibular toothrow (exclusive of incisors), 8 (6.8).

Specimens Examined.—Four, all from the type locality.

Remarks.—*Stenoderma luciæ* is readily distinguishable from *S. montserratense* by its smaller size and white-spotted shoulder, and from *S. nichollsi* by its larger size, heavier teeth, and distinctly bifid inner upper incisors.

Hemiderma tricolor sp. nov.

Type.—Adult ♀ (skin and skull), No. 114,005, United States National Museum. Collected in cave at Sapucay, Paraguay, December 5, 1901, by William Foster. Original number, 589.

Characters.—Size and general appearance as in *Hemiderma perspicillatum*, but fur longer and more silky in texture and the three color bands on the hairs of back strongly contrasted.

Color. —Hairs of dorsal surface with three sharply defined color bands. Beginning at base these are (*a*) hair-brown, much darker than that of Ridgway, 4 mm.; (*b*) grayish-white, 5 mm.; and (*c*) hair-brown like that of base, 2 mm. The extreme tips show a faint silvery-gray wash which varies in intensity according to light. As the fur is loose and silky in texture and everywhere glossy and variable with light the combination of colors is difficult to describe. On crown of head, sides of neck and region between and immediately behind shoulders the grayish-white appears conspicuously at surface, but elsewhere the hair-brown is in excess. The slightest disarrangement of the hairs brings the light band prominently into view. The color pattern of the back may be traced across under surface of neck, though much dulled. On chest and belly the basal area is a dull brownish slate color, succeeded by a narrow silvery-grayish band and a still narrower terminal strip of broccoli-brown. The extreme tips have the same gloss as those of the back, but the general color is broccoli-brown.

Skull and Teeth.—The skull and teeth do not differ appreciably from those of *Hemiderma perspicillatum*.

Measurements.—External measurements of type: Head and body, 68;[17] tibia, 16.4; foot, 13 (11); forearm, 42; thumb, 13; second finger, 32; third finger, 91; fourth finger, 65; fifth finger, 66; ear from meatus, 20.

---

[17] From fresh specimen, by collector.

Cranial measurements of type: Greatest length, 22.4; basal length, 19.6; basilar length, 17.6; interorbital constriction, 5.6; mastoid breadth, 10.8; mandible, 15; maxillary toothrow (exclusive of incisors), 7.4; mandibular toothrow (exclusive of incisors), 8.

Specimens Examined.—Six, all from the type locality.

Remarks.—Adults are very uniform in coloration, the five specimens showing no variations worthy of note. A half-grown young is dark sooty brown above, dull slaty below. The tricolored pattern of the hairs of the back is nearly as distinct as in the adults, and much more so than in *Hemiderma perspicillatum.*

Brachyphylla nana sp. nov.

Type.—Skull No. 103,828, United States National Museum. Collected at El Guama, Cuba, March 10, 1900, by William Palmer and J. H. Riley. Original number, 108.

Characters.—External characters not known. Skull much smaller than that of any other described member of the genus, its basal length only 22 mm.

Skull.—In general form the skull closely resembles that of true *Brachyphylla cavernarum* from the island of St. Vincent, but the interorbital region is less rounded and the interpterygoid fossa extends forward to within 1 mm. of posterior outline of palate.

Teeth.—The only teeth preserved are the anterior maxillary molars. These differ very conspicuously from the corresponding teeth of *B. cavernarum* in their much smaller size and in the relatively greater breadth of the palatal side of the crown.

Measurements.—Basal length, 22 (28);[18] basilar length, 21.6 (25); median palatal length, 10.4 (14); zygomatic breadth, 14.6 (17.4); breadth of braincase above roots of zygomata, 12 (13); interorbital constriction, 6 (6.8); lachrymal breadth, 8.4 (9); distance between outer edges of anterior upper molars, 9.8 (11); distance between inner edges of anterior upper molars, 5 (5.6); maxillary toothrow (alveoli, exclusive of incisors), 9 (11); crown of first upper molar, 3 x 2.6 (3.4 x 2.8).

Specimen Examined.—One, the type.

Remarks.—The single skull on which this species is based was found in a pellet of the Cuban barn owl. This and other

---

[18] Measurements in parentheses are those of a topotype of *Brachyphylla cavernarum* (♂, No. 106,085).

pellets of the same birds contained remains of *Artibeus*, *Phyllonycteris poeyi* and *Mus alexandrinus*.

Monophyllus cubanus sp. nov.

Type.—Adult male (skin and skull), No. 113,674, United States National Museum. Collected at Baracoa, eastern Cuba, February 6, 1902, by William Palmer. Original number, 645.

Characters.—Nearest the Jamaican *Monophyllus redmani*, but size less and skull with narrower rostrum and less deep posterior portion of mandible.

Color.—Upper parts broccoli-brown, rather darker than Ridgway's Plate III, No. 15, except in region across shoulders. Beneath ecru-drab, much tinged with dull brown. In some skins the brown of the upper parts approaches prouts-brown. Ears and membranes blackish.

Skull and Teeth.—The skull resembles that of *Monophyllus redmani* in general appearance, but the rostrum is much more slender, a character equally noticeable whether viewed from above or below.

Zygomata similar in form to those of *M. redmani*, but more lightly built. Mandible more slender than that of *M. redmani*, the difference particularly noticeable in the posterior portion, where depth at a point midway from coronoid process to condyle is much less relatively to distance between these points than in the Jamaican animal.

Teeth as in *Monophyllus redmani*.

Measurements.—External measurements of type: Total length, 67; tail, 8; tibia, 16; foot, 11 (10); forearm, 38.6; thumb, 11; second finger, 35; third finger, 80; fourth finger, 57; fifth finger, 50; ear from meatus, 13; ear from crown, 11.4; width of ear, 7.6.

Cranial measurements of type: Greatest length, 21.4 (22.4);[19] basal length, 20 (21.4); basilar length, 18 (19.4); zygomatic breadth, 9.6 (10); least interorbital breadth, 4 (4); breadth of rostrum at space between premolars, 3.2 (4); greatest breadth of braincase, 9 (9); maxillary toothrow (exclusive of incisors), 8 (8.6); mandible, 14 (15.4); mandibular toothrow (exclusive of incisors), 8.4 (9).

Specimens Examined.—Fifty-six (9 skins), all from the type locality.

---

[19] Measurements in parentheses are those of an adult male *Monophyllus redmani* from Kingston, Jamaica (No. 64,480).

Remarks.—*Monophyllus cubanus* is readily distinguishable from *M. redmani* by its small size and lightly built skull. In the general form of both skull and teeth it is, however, more closely related to the large Jamaican species than to the smaller members of the genus.

Monophyllus luciæ sp. nov.

Type.— Adult male (in alcohol), No. 106,095, United States National Museum. Collected on Santa Lucia Island, West Indies, February 4, 1901, by H. Selwyn Branch.

Characters.—Most nearly resembling *Monophyllus plethodon* of Barbados, but larger and with less crowded teeth.

Color.—After about a year's immersion in rum the specimens are rather darker and more tinged with red than in *Monophyllus cubanus*, but this character may be the result of the action of the preservative fluid.

Skull and Teeth.—In general form the skull agrees with that of *Monophyllus plethodon*, and differs from that of *M. redmani* and *M. cubanus* in the large, inflated braincase, broad interorbital region and short rostrum. The zygomatic arches are strong and well developed, more so, apparently, than in *M. plethodon*. Rostrum broader than in the Barbados species.

Teeth as in *Monophyllus plethodon*, except that the first upper premolar is separated from the canine and also from the second premolar by a narrow space, of much less extent, however, than in the other members of the genus.

Measurements.—External measurements of type: Total length, 80; tail, 15; tibia, 19; foot, 11 (10); forearm, 42; thumb, 11; second finger, 35; third finger, 88; fourth finger, 65; fifth finger, 55; ear from meatus, 15; ear from crown, 11; width of ear, 10.4.

Cranial measurements of type: Greatest length, 24 (21.6);[20] basal length, 22 (19.4); basilar length, 19.6 (17.8); zygomatic breadth, 10 (9.8); least interorbital breadth, 4.4 (4.6); breadth of rostrum at space between premolars, 4.6 (—); greatest breadth of braincase, 9.8 (9.8); maxillary toothrow (exclusive of

---

[20] Measurements in parentheses are those of the type of *Monophyllus plethodon*.

incisors), 8 (7.2); mandible, 15 (14); mandibular toothrow (exclusive of incisors), 8.4 (7.8).

Specimens Examined.—Sixteen, all from the type locality.

Remarks.—As might be expected, the *Monophyllus* of Santa Lucia is nearly related to that of Barbados. Its larger size and less crowded teeth readily distinguish it.

THE MOLLUSCA OF THE MT. MITCHELL REGION, NORTH CAROLINA.

BY BRYANT WALKER AND HENRY A. PILSBRY.

This report is based upon material collected by Messrs. James H. Ferriss and Bryant Walker in the summer of 1901.

The results of the "Pentadelphian" expedition of 1899 to the Great Smoky mountains[1] demonstrated the fact that these mountains, notably in their higher portions, possessed a fauna peculiar to themselves and quite distinct from that of Roan Mountain which lies about seventy-five miles to the northeast. And in connection with this, it was stated that "the mountain region between the Nolachucky and Clingman's Dome is wholly unknown malacologically."

The expedition of 1901 was undertaken primarily for the purpose of exploring Mt. Mitchell, the highest peak of the Appalachian range, with an altitude of 6,711 feet, of whose fauna nothing was known except a few species collected by Hemphill in a hurried visit nearly twenty years before, and incidentally to determine, if possible, whether the valley of the French Broad river, which here breaks through the mountains, is the dividing line between the Roan and Great Smoky faunas.

The party consisted of Messrs. Ferriss and Walker and two ladies. Leaving the railroad at Paint Rock, N. C., a little station on the French Broad river just over the line from Tennessee, altitude about 1,200 feet, two days were spent in exploring the banks on both sides of the river.

From there the route lay almost due south for ten mountain miles to Bluff mountain, which is the highest of the range lying south of the river for a considerable distance. It took the wretched crowbaits which hauled the camp equipage in a wagon that weighed more than the load, all hands pushing up the steep grades, nearly all day to reach Baker's, an old lumber camp, which marked the end of wagon travel. Here camp was made, and the next morn-

---

[1] *Vide* these *Proceedings*, 1900, p. 110.

ing the party "toted" themselves and their luggage to the summit. Bluff mountain derives its name from the long, narrow plateau nearly three-quarters of a mile in length which forms its top, the highest point of which is about 4,700 feet above the sea. The State line between Tennessee and North Carolina crosses its western extremity. The forest here is entirely of hard wood, and the greater part of the plateau is covered by high trees. Most of the underbrush has been cleared off from the summit, which is frequently used for camp meetings and other public gatherings. Most of the collecting here was done along the sides of the cove on the Tennessee side, where Wolf creek heads. The southern exposures, as usual, were too dry for satisfactory work.

Three days were sufficient to satisfy the party that the fauna was substantially that of the cove region, and that the mountain was too low for the development of any special fauna, such as had been found on the higher summits both to the north and the south. And, as the mountains immediately north of the river offered no better prospect, it was decided to return to Paint Rock and proceed directly to Mt. Mitchell.

From Black Mountain station on the Southern Railroad, the journey was made by wagon to Tyson's, an ancient inn at the foot of the Black Mountain range. Here the baggage was loaded on horses for the ten-mile climb to the summit of Mt. Mitchell. The road followed up the course of one of the branches of the North Fork of the Swannanoa river to its headwaters, from which a sharp ascent leads to the top of the ridge at Patton's Knob, at an elevation of 6,000 feet. From there the trail leads nearly due north around Potato Top, directly over Clingman's Peak (Mt. Gibbs on the map of the Topographical Survey), which is only a few feet lower than Mitchell, and where Ferriss "drew the first blood" by finding the long-sought *Vitrea clingmani* under a log beside the trail, and then winding around the Hallbach, and across Wilson's Gap on up to Mitchell. Here the summit is a small "bald," in the centre of which is the grave and monument of Prof. Elisha Mitchell, who lost his life while exploring this mountain in 1857. Camp was pitched just beyond the summit, at the head of a grassy slope and near a fine spring of the purest water. The forest extends clear to the top of Mitchell, and in some places the tops of trees have been cut off to allow a view from the "bald" which crowns the summit. It is almost wholly spruce and balsam, a few birches being found here and there. Open places are quite frequent, and are often covered with a dense growth of the hellebore, the favorite food of *Polygyra andrewsæ*. The ground is saturated with moisture and the rocks and fallen trees are covered with thick moss, which needs only to be sat upon to remind one of a sponge.

Two days were spent exploring the upper slopes of the mountain. Then Ferriss, with one of the guides, left on a three days' trip, following the Black Mountain chain to the north, along which five great peaks were to be seen ranging from 6,300 to 6,600 feet, and which seemed from the camp to be higher even than Mitchell itself. Following bear tracks along the ridge, he went as far north as the fourth peak (Cattail), from which he descended along Cattail branch to the Caney river, and thence up through Wilson's Cove to Mitchell, stopping for a short time at Meadow Cove. Two days were spent by the party in Wilson's Cove, which is heavily timbered with great basswoods and buckeyes, and most of the material was collected there. An attempt to follow down the northeast slope of the mountain along the headwaters of Rock creek, a tributary of the Toe river, was blocked by a high fall in the creek and was also conchologically a failure.

After spending a week on Mitchell, the party returned to Patton's Knob. Here Walker left to return home, and Ferriss continued the work alone. He explored Potato Top (6,600 feet), and crossing the gap which separates the headwaters of the Swannanoa river from those of the Toe, ascended the Pinnacle of the Blue ridge (alt. 5,600 feet), reaching the headwaters of the South Toe river on its easterly slope.

Returning again to Patton's Knob, he followed along the ridge to the west, camping at Balsam Gap, between the Ivy and Swannanoa rivers (alt. 5,000 feet). "Here the spruce forest ceases and the buckeyes and beeches set in." From this camp he went down the west slope of the gap to the Ivy river. Leaving the gap, he continued south along the ridge of the Great Craggy mountains as far as Big Craggy, where he camped until he was literally drowned out by the great storm of August 12 to 19. It rained almost continually while on Craggy, so that but little collecting was done. But he got down into Bee Tree Cove on the west side while there. "Timber was scarce on the tops of the Craggies. There was much pasture, and some of the red rhododendron. Wide 'balds,' but exceedingly rocky, the most mountainlike of anything I have seen" (J. H. F.). After the return from Craggy, the remainder of the time was spent in exploring Tyson's Cove.

THE FAUNA.

So far as the material before us affords a basis of judgment, it goes to show:

First.—That the French Broad river is not in itself the dividing line between the Roan and Smoky faunas.

Second.—That in all probability there is no sharp line of demarkation anywhere. But that in the intermediate region lying between these faunal centres, the species peculiar to each mingle to a greater or less extent, according as they find acceptable conditions of environment.

Third.—That in the French Broad river region there are a number of peculiar forms which tend to show that it has, at least, some of the characteristics of a distinct faunal area.

Thus, in the species which inhabit the lower levels between the mountains, and which may be considered as the cove fauna, we find that the great majority are species common in the Appalachian range along its whole extent. Occasionally, however, in these, such as *Polygyra tridentata* and *Pyramidula alternata*, local races are developed, which are eminently characteristic of the different regions.

In addition to these species of general occurrence, we find others which are apparently restricted to narrower limits and which, with the local races above mentioned, give these areas the peculiar features, which taken in connection with the still more differentiated elements occupying the higher levels, justify their separation as distinct faunas, or rather faunulas.

Taking the whole region from Roan to the Great Smoky mountains into consideration, however, we find that so far as the cove species are concerned, the differences are not so great as they appear at first sight, and that in reality they are comparatively small though sufficiently well marked. The only species peculiar to the coves around Roan are the large and small forms of *Polygyra tridentata*, *Pyramidula bryanti*, *Polygyra subpalliata* and *Ompha-*

lina rugeli. Of these, the first three are found as far south, at least, as the French Broad, and the last two are offshoots from the summit fauna slightly modified by more favorable conditions of environment. In the same way, of the species inhabiting the coves of the Smoky mountains, only *Polygyra christyi*, *P. depilata*,[2] *Pyramidula alternata costata*, *Omphalina fuliginosa polita*, *Omphalina lævigata latior* and *perlævis*, *Zonitoides patuloides* and *Punctum blandianum* have not as yet been found to range far enough to the north to mingle with the southern extension of the Roan species. *Polygyra chilhoweensis*, *P. pilula*, *P. monodon cincta* and *Strobilops labyrinthica strebeli* extend at least as far north as the French Broad river, and some of them much further.[3]

Thus we find a large proportion of what were supposed to be the characteristic cove species of these two regions mingled together in the valley of the French Broad.

On the other hand, just as there are some species peculiar to each of these regions, so we find in the coves tributary to the French Broad drainage a few characteristic forms, which seem to be (without exception) lacking in the coves both to the north and the south.

From Bluff mountain to Mitchell, throughout this region, there appears a peculiar form of *Polygyra andrewsæ*, which is intermediate in size and shape between the typical *andrewsæ* of Roan and Mitchell, and the larger variety *normalis*, which inhabits the coves from Roan to the Little Tennessee river, and is decidedly characteristic of the French Broad region. It extends, however, north into the lower coves of the Roan region.

The beautiful and long-lost *Pyramidula alternata mordax* is apparently restricted to a small portion of this area.

The almost total absence of typical *Gastrodonta gularis*, so abundant in Roan and in the Smoky mountains, and its replacement by two peculiar forms, var. *theloides* A. D. Brown and var. *decussata* P. and V., is also another striking feature of this region. Again, we find in the French Broad valley a number of species, mostly common and widespread, which are found in the Roan region, but

---

[2] The "*P. depilata*" collected at Johnson City, Tenn., by Rhoads (*P. A. N. S. P.*, 1896, p. 493) is *P. stenotrema nuda*. (*Vide* these *Proceedings*, 1900, p. 129.)

[3] *P. chilhoweensis*, Campbell Co., Tenn. (Wetherby), and Carysville. Campbell Co., Tenn. (Walker and Clapp coll.).

which seem to be missing in the coves of the Smoky mountains. Such are:

Polygyra inflecta.
Polygyra sayii.
Polygyra altispira.
Polygyra profunda.
Polygyra clausa.
Vitrea hammonis.
Omphalina fuliginosa.

Several of these species have a range along the Cumberland plateau considerably further south. But the assiduous collecting of Ferriss and others during several years has wholly failed to discover them in the coves of the Great Smoky range. Whether the valley of the French Broad is practically the southern limit of the range of these species along the main chain of the Appalachians is not known, as the region south of Bluff mountain is as yet wholly unexplored. But, from the comparatively few specimens found in 1901, it would seem to be a fair inference that such was the case.

Taking all these factors into consideration, we would say that as a whole, the cove fauna of the French Broad valley is more closely related to that of the Roan region than to that of the Great Smoky mountains.

The same general fact appears also when the fauna of the higher elevations is considered.

The characteristic species of the Roan summit fauna are:

Polygyra andrewsæ (typical).
Polygyra whcatleyi.
Polygyra subpalliata.
Polygyra altispira.
Omphalina rugeli.
Omphalina subplana.
Vitrinizonites latissimus.
Vitrea sculptilis.
Vitrca carolincnsis.
Gastrodonta capsella.
Gastrodonta capsella placentula.
Gastrodonta gularis.
Gastrodonta acerra.
Gastrodonta andrewsæ.
Gastrodonta cœlaxis.
Gastrodonta lamellidens.
Philomycus wetherbyi.
Philomycus hemphilli.
Succinea ovalis.

Of these,

Polygyra wheatleyi.
Omphalina subplana.
Vitrinizonites latissimus.
Vitrea sculptilis.
Vitrca carolinensis.
Gastrodonta gularis (in its various forms).
Gastrodonta acerra.

Gastrodonta capsella.
Gastrodonta capsella placentula.
Gastrodonta lamellidens.
Philomycus hemphillii.
Succinea ovalis,

are all found on the summits of the Smoky mountains and nearly all of them on Mitchell or Bluff mountain.

Of the remainder, *Polygyra andrewsæ* is the characteristic species of Mt. Mitchell, and *Polygyra altispira* and *Gastrodonta andrewsæ* were found generally distributed in the French Broad region, so that *Polygyra subpalliata, Omphalina rugeli, Gastrodonta cœlaxis* and *Philomycus wetherbyi* are really the only species peculiar to the Roan summit.

Upon the higher levels of the Smoky mountains, on the other hand, we find a larger number of peculiar species which do not seem to extend so far north as the French Broad. These are:

Polygyra ferrissii.
Polygyra clarkii.
Vitrea petrophila.
Vitrea pentadelphia.
Omphalina andrewsæ montivaga.
Vitrinizonites lasitismus.
Vitrinizonites uvidermis.

The apparent poverty of the higher peaks of the French Broad region in peculiar species was both a surprise and a disappointment. The probability that Mt. Mitchell, the giant of them all, would at least furnish a rival to the beautiful *Polygyra ferrissii* seemed so great, that the failure to find one was scarcely compensated by the rediscovery of the rare little *Vitrea clingmani* Dall. This seems to be the only species peculiar to Mt. Mitchell, and the expedition felt like engraving on its highest pinnacle the old proverb: "*montes parturiunt, nascitur ridiculus mus.*"

The following list of all the species known from the mountain region lying between Roan mountain and the Little Tennessee river will show the general range of each species in the three districts that have been explored, upon which the foregoing remarks have been based:

COMPARATIVE LIST.

R. = Roan ; F. = French Broad ; S. = Smoky.

	R	F	S
Helicina [2]*occulta*	x	x	x
Polygyra tridentata	x	x	x
tridentata tennesseensis.	x	x	
fraudulenta	x	x	x
rugeli	x	x	x
inflecta	x	x	
profunda	x	x	
sayii	x	x	
chilhoweensis		x	x
albolabris	x	x	x
albolabris major	x		
exoleta	x	x	x
ferrissii			x
subpalliata	x		
palliata	x	x	x
appressa perigrapta	x	x	x
clarkii.			x
andrewsæ.	x	x	
andrewsæ normalis	x	x	x
andrewsæ altivaga			x
andrewsæ intermedia	x	x	
thyroides	x	x	x
clausa	x	x	x[4]
wheatleyi	x	x	x
christyi			x
edwardsi	x		
edwardsi magnifumosa			x
stenotrema	x	x	x
depilata			x
hirsuta.	x		
pilula		x	x
altispira	x	x	
monodon cincta		x	x
Strobilops labyrinthica strebeli		x	x
Bifidaria contracta	x		x
pentodon	x		
Vertigo bollesiana			x
Cochlicopa lubrica	x	x	x
Circinaria concava	x	x	x
Omphalina kopnodes	x?		
fuliginosa	x	x	

	R	F	S
Omphalina fuliginosa polita.			x
lævigata	x	x	x
lævigata latior			x
lævigata perlævis			x
rugeli	x		
subplana	x	x	x
andrewsæ		x	x
andrewsæ montivaga			x
Vitrinizonites latissimus	x	x	x
latissimus uvidermis			x
Vitrea hammonis	x	x	x
wheatleyi	x		
clingmani		x	
petrophila pentadelphia.			x
indentata	x		
rhoadsi	x		x
sculptilis	x	x	x
carolinensis	x	x	
carolinensis wetherbyi		x	x
ferrea	x[5]		
approxima		x	
vanattai		x	
Euconulus sterkii	x		
fulvus?	x[6]		
chersinus			x
Zonitoides arboreus	x	x	x
patuloides			x
minusculus	x		
milium	x		
elliottii	x	x	x
Gastrodonta intertexta		x	x
acerra	x	x	x
demissa	x	x	x
cerinoidea?	x[7]		
ligera	x		
gularis	x	x	x
gularis lawæ		x	
gularis theloides		x	
gularis decussata		x	
gularis cuspidata	x		
suppressa	x	x	x
calaxis	x		

---

[4] *P. clausa* was not found in Smoky mountains. It occurs, however, at Hayesville, N. C.

[5] This species also occurs at Lickstone mountain, near Waynesville, N. C.

[6] Cited by Wetherby. We have seen no specimens, and it is quite probable that the identification is erroneous as the group had not been differentiated when Wetherby's list was published.

[7] These species were cited by Wetherby in 1881. As they are not included in his later paper (1894), it is probable that he found that his former identification was erroneous.

	R	F	S		R	F	S
Gastrodonta interna	x	x	x	*Pyramidula alternata*		x	x
andrewsæ	x	x		*alternata fergusoni?*	x[8]		
multidentata	x			*alternata costata*			x
lamellidens	x	x	x	*alternata mordax*		x	
clappi			x	*perspectiva*	x	x	x
walkeri			x	*bryanti*	x	x	
significans?	x[7]			*Helicodiscus lineatus*	x		x
capsella	x		x	*Punctum pygmæum*	x		
capsella placentula	x		x	*blandianum*			x
Agriolimax campestris	x			*Sphyradium edentulum*	x		
Philomycus carolinensis	x	x	x	*Succinea ovalis*	x	x	x
wetherbyi	x			*Carychium exiguum*	x		
hemphilli	x	x	x				

LIST OF SPECIES.

HELICINIDÆ.

Helicina occulta Say.

Wilson's Cove, Mt. Mitchell. A few large specimens, diam. 7¼ to 8 mm., were found under the dead leaves around the roots of the basswoods and buckeyes; all were of the uniform deep reddish-yellow color characteristic of the species from other localities. There was no apparent tendency to the great variation in color noted by Wetherby in the Roan mountain specimens.

HELICIDÆ.

Polygyra tridentata (Say).

With the exception of the large variety found at Paint Rock mentioned below, this species, which was found nearly everywhere, shows but slight variation from a common type, which seems decidedly characteristic of the whole region from Roan to the Smoky mountains. It is usually rather small, varying from 12½ to 14 mm. in diameter at Roan to 17 to 18¼ at Bluff mountain.

The size seems to increase quite regularly from the north to the south, specimens from Cat-tail (14 to 15) being smaller than those from Wilson's Cove (13¾ to 15¾), while these are decidedly smaller than those from Paint Rock and Bluff mountain. This race, for it hardly seems to be sufficiently differentiated to be entitled

---

[8] Specimens from Roan before us belong to the smooth form hereinafter mentioned, but are not typical *fergusoni*. Wetherby's specimens were probably the same.

to varietal rank, is characterized by closely coiled whorls and usually rather high spire, in this respect showing some approach to *P. fraudulenta.* But the aperture is usually quite typical in the position and shape of the lip teeth. Occasional specimens exhibit a slight tendency to "dishing" of the upper portion of the lip, but in such instances the deepest concavity of the lip is between the labial teeth rather than opposite the upper tooth, as in *fraudulenta,* nor is there any rounding out of the upper lip so characteristic of that species. The shell is usually of a deep reddish horn color, with a rose-tinted lip, and closely and rather heavily striate. Wetherby (*Journ. Cin. Soc. N. H.*, 1894, p. 211) has called attention to this form as peculiar to the Roan region, and the material before us shows that it extends through this whole region with but slight variation except in size. The "buttressed" lower tooth developed in the Smoky mountains[9] seems peculiar to that region, as no tendency in that direction appears in any of the shells collected in the French Broad drainage. Three of five specimens from Bluff mountain have an unusually heavy wide flat white lip, which sensibly diminishes the aperture. In addition to the localities already mentioned, Ferriss reports it from Tyson's Cove, Meadow Cove, Ivy river, Toe river and Bee Tree creek.

Polygyra tridentata tennesseensis n. v.

At the foot of the high bluffs which line the south side of the French Broad river below Paint Rock, just over the line in Tennessee, there occurred a very distinct form of *P. tridentata,* characterized by its large size, depressed *complanata*-like form, but closely and regularly striated. The lip is that of the typical *tridentata,* with rather small marginal teeth. Of twenty specimens the smallest was 19 and the largest 24 mm. in diam., the average being 22½. Only two were less than 21. This form is probably the same as that mentioned by Wetherby[10] from Braden mountain, Campbell county, Tenn., and is the same described by Clapp[11] from Oakdale, Morgan county, and Concord, Knox county, Tenn. It is also the same form found at Elizabethton, Tenn., and erroneously by one of us referred to var. *complanata.*[12] The Elizabethton

---

[9] *Vide* these *Proc.*, 1900, p. 117.

[10] *Journ. Cincinnati Soc. N. H.*, 1904, p. 212.

[11] These *Proceedings* for 1900, p. 117.

[12] *Nautilus,* XII, 120.

examples are lighter in color than the Paint Rock specimens and rather smaller, being from 19½ to 21¼ mm. in diameter, in this respect resembling the Morgan county shells, described by Clapp.

Polygyra fraudulenta Pilsbry.

Meadow Cove, a single typical example, diameter 15 mm.

Polygyra rugeli (Shuttl.).

Of general occurrence, but not so abundant as in the Great Smoky mountains. At Paint Rock, south side, where it occurred with *P. tridentata tennesseensis*, the specimens were uniformly large, 13¼ to 14¼ mm. in diameter. Another lot from the same side, collected later by one of the guides, but probably further down the river, were smaller, 11 to 12¼ mm. Similar specimens were found at Paint Rock creek, on the north side of the river. This seems to be the prevailing size throughout the French Broad region, and only occasional specimens from Bluff mountain, Tyson's Cove and Wilson's Cove exceeded 13 mm. in diameter. Ferriss found a few specimens also at Meadow Cove, Ivy river, Toe river and Bee Tree creek.

Polygyra inflecta (Say).

At Paint Rock, on the south side of the river, all the specimens were small, 9 to 9¼ mm. in diameter, with the whole shell more or less tinged with pink and frequently the lip as well.

In the coves around Mitchell, Cat-tail, Tyson's and Wilson's, all the specimens were albinos and quite large, 13½ to 14 mm. in diameter. Not a single normally colored individual was found in any of these localities. While occasional albino examples are not uncommon in nearly all the American Helicidæ, this occurrence of a race wholly albino inhabiting a large extent of territory is quite without precedent. Why this one species should be affected in this way is difficult to understand. None of the other species in the district exhibited any tendency to albinism to any greater extent than is likely to occur anywhere. It forms one of the striking peculiarities of the Mitchell fauna, and is analogous to the occurrence of *Polygyra subpalliata* at Roan, which is always of the same pale-green color.

Polygyra profunda (Say).

Paint Rock, south side, two specimens only; evidently scarce.

Polygyra sayii (Binn.).

Paint Rock, south side, and Wilson's Cove, a few specimens with no special characteristics.

Polygyra chilhoweensis (Lewis).

Paint Rock creek, on the north side of the river. Two specimens only. This extends the range of this species considerably farther north than has hitherto been recorded.[13]

Along the Cumberland plateau it has, however, a range considerably farther north, having been found in Campbell county by Wetherby.[14] Similar specimens are now in the collections of G. H. Clapp and Bryant Walker. It seems probable that the French Broad valley is about the northern limit of the range of this species along the Appalachians.

Polygyra albolabris (Say).

This species occurred only at Paint Rock, on the north side of the river, where it is apparently quite abundant. All the specimens are more or less deeply tinged with rose and one is obscurely banded below the suture. They are very similar to the Cade's Cove examples mentioned in the report on the "Pentadelphian" expedition.

Polygyra exoleta (Binn.).

Paint Rock, south side, two specimens. Cat-tail branch, one example.

Polygyra palliata (Say).

Paint Rock, south side, four specimens, 22 to 24 mm. in diameter; quite typical.

Polygyra appressa perigrapta Pilsbry.

Paint Rock, on both sides of the river, Bluff mountain and Wilson's Cove. Noticeably smaller and more compressed than those from the Smoky mountains. Of fifteen specimens from these localities, the smallest was 15½ mm. in diameter, the largest 17½, average 16½ mm., while those from the Smoky region range

---

[13] In the J. H. Thompson collection, now in the possession of one of us, are two specimens labeled "Roan Mt. ex auctore." As the species is not cited by Wetherby from Roan and there are no specimens from that locality in the Lewis collection, now owned by Mr. G. H. Clapp, it seems probable that there is some mistake in regard to the Thompson shells.

[14] *Jour. C. S. N. H.*, 1894, p. 212.

from 19 to 21½ mm. and are in every way larger and finer specimens.

Polygyra andrewsæ (W. G. Binn.).

The typical form of this fine species was quite abundant all along the ridge from Clingman Peak to Mt. Mitchell. It is partial to the hellebore (*Veratrum viride*) which grows rankly in the open spaces, and was usually found either roosting beneath the large leaves or hidden in the grass around the roots. The shells are exceedingly fragile and were often crushed between the fingers in the slight pressure occasioned by lifting them from their hiding-places. They are uniformly of a dark olive-green color, with a thin, narrow, concave lip. Of sixty-five specimens the largest was 27¼ mm. in diameter, the smallest 22¼, average 24$\frac{9}{10}$. Compared with Roan mountain specimens they differ only in size, being on the average slightly larger. Of thirty-nine Roan specimens the smallest was 19, the largest 22$\frac{2}{10}$. The shells from both localities are alike in the extreme fragility, narrow lip and shape. And in both places this form is found only on the highest parts of the mountain.

Polygyra andrewsæ normalis Pilsbry.

This form is purely a cove dweller and is rarely found at an elevation of more than 5,000 feet. From 1,200 to 4,000 is about its usual range. It occurred sparingly on both sides of the river at Paint Rock (alt. 1,200 feet), and on Bluff mountain as far up as Baker's (alt. 3,000 feet). These specimens were of the usual type and varied from 35¼ to 37½ in diameter.

It also occurred at Tyson's Cove (alt. 4,000 feet), Meadow Cove and Wilson's Cove (alt. 3,500 feet). Those from Wilson's were the largest yet seen. Of thirty-seven specimens, the largest was 40½ mm. in diameter, the smallest 34, average 37¼. They vary considerably in shape, frequently becoming subconical as shown by the following measurements: 37½ x 32, 41¼ x 35¼, 39¼ x 35 and 38¼ x 28¼. Occasional pale-green albinos occurred.

Polygyra andrewsæ intermedia n. subsp.

Throughout this region, occupying the higher levels from 3,500 to 5,000 feet, and thus ranging above the var. *normalis*, but below the typical *andrewsæ*, was found a well-marked race which cannot be satisfactorily assigned to any of the recognized varieties. It is intermediate between the typical form characteristic of the higher altitudes of Roan and Mitchell and subsp. *altivaga*, which similarly occupies the summits of the Smoky mountains. In texture, sculpture, color and character of the peristome it is nearer to *altivaga*, but in shape is more like the typical *andrewsæ*. On the whole, however, it is more nearly related to the former. It may be characterized as typical in shape, but larger, with a stronger, thicker shell, closely and regularly striate, lighter in color being usually with a strong yellowish tinge, frequently pale green, and occasionally tinged with red; the lip is decidedly different from the typical *andrewsæ*, being broader and flatly reflected; in many cases the reflected portion is decidedly convex, being rolled back so that the center of the face of the peristome projects beyond the outer edge. Compared with var. *altivaga* it is decidedly less globose, being wider in proportion to its height. The aperture also is proportionately wider than in *altivaga*.

It was first met with on Bluff mountain at Baker's, and ranged from there to the summit. Of eight specimens, the largest was 30½ mm. in diameter, the smallest 26½, average 28¾ mm. The largest example compared with a Thunderhead specimen of the same diameter, 30½ mm., will show the following difference in height and breadth which is characteristic of the race:

	Diam.	Total Alt.	Alt. of Axis.
Bluff mountain (*intermedia*), . .	30½	22	15½
Thunderhead (*altivaga*), . . .	30½	22	16½

Potato Top (4,000 feet), six specimens, largest 30 x 20¼, smallest 26¼ x 20, average 28½ mm.

Vance's branch, North fork of the Swananoa river, two specimens, rather heavier than usual, 26 x 20 and 26¼ x 20 mm.

Bee Tree creek, Craggy mountains (alt. 3,500 feet), three specimens similar to those from Vance's branch. Shells as thick as those of subsp. *normalis*. These specimens are very close to subsp. *altivaga*, and have the notch at the upper end of the peristome as in that form. They measure 25, 27 and 27¼ mm. in diameter. One of them is decidedly reddish horn-colored. On Craggy, Ferriss found *intermedia* all along from 4,500 to 6,000 feet. He remarks that its habits are similar to those of *Polygyra exoleta* and solitary.

Two specimens from Balsam Gap, Ivy river (alt. 3,500 feet), are more nearly allied to the typical form, both in texture and the width of the peristome. But in one example this is decidedly reflexed, and in the other the whole shell is strongly tinged with red. They measure 25¼ and 26½ mm. in diameter. There is no evidence of any tendency to bands, nor to the development of a parietal tooth so characteristic of *altivaga*, in any of these specimens.

This form extends as far north as Roan mountain. Four specimens from Roan mountain R. R. Station are as heavy as an ordinary *P. albolabris*, with a broad, thick, flattened or convex lip, and of a decided yellow-horn color. They measure 27¼ x 23, 27¼ x 22, 26 x 19¾, 27½ x 21 mm., and approach var. *altivaga* very closely.

Polygyra thyroides (Say).

Paint Rock, north side; Tyson's and Wilson's Coves. Scarce.

Polygyra clausa (Say).

Two specimens only at Paint Rock, on the south side of the river.

Polygyra wheatleyi (Bland).

This species was found nearly everywhere and usually in abundance. There is no apparent tendency to develop a smaller race on the higher portions of Mitchell as on the peaks of the Smoky mountains, although three-fourths of the specimens from Mitchell and Cat-tail were edentate, while those from Bluff mountain were all dentate and with the outer margin of the lip dark colored. These varied from 13¾ to 16 mm. in diameter, while those from Mitchell and Cat-tail averaged larger, running from 14¼ to 16. Ferriss found it also at Paint Rock, Tyson's, Wilson's, Meadow Cove, Great Craggy, Bee Tree Cove and Toe river.

Polygyra stenotrema (Fer.).

Common on both sides of the river at Paint Rock. One only from Wilson's Cove. All these have a rather wide lip notch, otherwise typical.

Polygyra altispira Pilsbry.

> "*Stenotrema hirsutum* Say. An elevated, somewhat carinated variety," Wetherby, Some Notes on American Land Shells, No. II, p. 7, No. 33, in Jour. Cincinnati Soc. N. H., IV, 1881, p. 329. Natural History notes from N. C., No. 2, in Jour. Cin. Soc., 1894, p. 212.
>
> *Polygyra hirsuta altispira* Pilsbry, Nautilus, VII, p. 141 (April, 1894).

This species was first noticed in 1881, by Mr. A. G. Wetherby, as a variety of the widespread *P. hirsuta* Say. Compared with

P. hirsuta it differs in the following respects: *P. altispira* is more elevated, the spire being conical, with an additional whorl; the notch in the basal lip is wider, with a well-developed tooth on each side in place of an even edge, and the "fulcrum" is much smaller. These differences are constant in a large series of each examined and, in the absence of intermediate forms, warrant us in giving *altispira* specific rank. *P. altispira* is usually larger than the other species. It is densely hirsute or bristly above and below, the bristles erect and standing about as close as in *P. hirsuta.*

P. depilata of the Great Smoky range differs from *P. altispira* chiefly in the shallower notch of the basal lip and the totally diverse character of the surface.

Mt. Mitchell, mostly large, 6½ x 9 to 9 x 11 mm., spire lower than in Roan mountain types. Many of the lots are larger shells than at Roan mountain, with the spire less raised.

P. altispira seems to range along the eastern slope of the mountains as far south at least as Swain and Jackson counties, where a small form occurs at Balsam mountain and elsewhere. The region lying between Asheville and these counties is wholly unknown conchologically. Balsam mountain, 5½ whorls, diam. fully 8 mm. Smallest from Jackson county, 5⅓ whorls, diam. 7 mm. As small as *hirsuta,* but have the wide notch, small fulcrum and rather harsh or stiff pile of *altispira.* The character of the bristles separates this small form from *magnifumosa.*

P. altispira was not found at Paint Rock, where it is apparently replaced by *P. pilula;* but nearly everywhere else it was found in considerable abundance. The localities comprise Bluff mountain, Mitchell, Cat-tail, Wilson's, Meadow Cove, Tyson's, Ivy river and Bee Tree Cove.

Polygyra pilula Pilsbry.

Polygyra hirsuta pilula Pilsbry, Proc. A. N. S. Phila., 1900, p. 132.

Paint Rock, on both sides of the river. This species was originally described as a variety of *Polygyra hirsuta.* Its occurrence at Paint Rock was quite unexpected, and gives it a much more extended range than was anticipated when first noticed. This fact and the evident stability of its peculiar characteristics, as shown by the specimens before us, without any apparent tendency to merge into the typical *hirsuta,* justify us in according to it specific rank.

Polygyra monodon cincta (Lewis).

Paint Rock, south side, one specimen, with the umbilicus somewhat smaller than in the types.

Bluff mountain, two specimens, with umbilicus almost closed. The occurrence of this species in the French Broad valley, far north of any previous records, was one of the surprises furnished by the collection of 1901.

PUPIDÆ.

Strobilops labyrinthica strebeli (Pfr.).

Helix strebeli Pfr., Malak. Blätt., VIII, 71, t. 1., figs. 5–8 (1861).

Paint Rock, south side, a single specimen only. This is much farther north than previously recorded and, like the preceding species, is a striking example of the mingling in the French Broad valley of the southern species with those coming from the north

ACHATINIDÆ.

Cochlicopa lubrica (Müll.).

Potato Top, where Ferriss found typical examples, is the only locality represented in the present collection. Walker found it, however, several years previously on Town mountain near Asheville.

CIRCINARIIDÆ.

Circinaria concava (Say).

Paint Rock, on both sides of the river; Bluff mountain, Wilson's, Tyson's, Cat-tail and Ivy river.

Common everywhere and of good size, ranging from $17\frac{1}{4}$ to $21\frac{3}{4}$ mm. in diameter.

ZONITIDÆ.

Omphalina fuliginosa (Griff.).

Typical specimens were found on both sides of the river at Paint Rock.

Omphalina lævigata (Raf. Beck).

One mature specimen, 19 x $13\frac{1}{2}$ mm., and several immature ones were taken on the north side of the river at Paint Rock.

Omphalina subplana (Binney).

This was one of the most abundant species, both at Bluff mountain and Mt. Mitchell. Very large fine specimens were found on the south side of the river at Paint Rock, frequently reaching 22 and 23 mm. in diameter. Both here and at Bluff mountain a peculiar form was found with more convex base, not excavated around the umbilicus, and approaching *O. rugeli* W. G. B. Many of the specimens from these localities were quite green. Found also at Tyson's, Potato Top, Ivy river, Toe river, Wilson's and Cat-tail.

Omphalina andrewsæ Pilsbry.

Very rare, apparently at about the extreme of its northern range, but quite typical. Mt. Mitchell, 2; Wilson's, 1; Potato Top, 2, and Tyson's, 1.

Vitrinizonites latissimus (Lewis).

This species, which was not uncommon on Mt. Mitchell, was found only sparingly at other localities. Those from Bluff mountain were considerably larger than those from Mitchell, reaching 19¼ mm. in diameter. It occurred also at Paint Rock, south side; Tyson's, Wilson's, Meadow Cove and Bee Tree creek.

Vitrea carolinensis (Ckll.).

Vitrea carolinensis Ckll., Nautilus, XII, p. 120.
Zonites carolinensis Ckll., Binney, Bull. M. C. Z., XXII, p. 167, Pl. III, fig. 7.

The type specimens as described by Cockerell have 5 whorls with a maximum diameter of 10 mm. This form occurred in 1901 only at Paint Rock. It is not found in the Great Smoky mountains, and from present information it seems to be a rare form of very limited distribution.

Vitrea carolinensis wetherbyi Ckll.

Nautilus, XIV, p. 45 (1901).

Paint Rock, Bluff mountain, Tyson's, Wilson's, Mt. Mitchell, Cat-tail, Pinnacle of the Blue ridge, Toe river and Potato Top.

In the report of the expedition of 1899 the specimens of *V. carolinensis* were found to belong to a small race, ranging from 5½ to 7 mm. in diameter. Cockerell has since distinguished it under the above varietal name. With the exception of some from Paint Rock, all the specimens collected in 1901 belong to this smaller variety, which, though not found anywhere in abundance, occurred in nearly every locality. It is intermediate between typical *V. carolinensis* and *V. indentata*.

Vitrea sculptilis (Bld.).

A single specimen, diameter 8½ mm., was taken on Bluff mountain.

Vitrea hammonis (Ström.). Pl. XXIII, figs. 10, 11, 12.

Paint Rock, south side, one specimen. The shell figured for comparison with the following species is from Mohawk, N. Y.

Vitrea clingmani Dall. Pl. XXIII, figs. 1, 2, 3.

Zonites wheatleyi W. G. Binney, Man. Am. Land Shells, 223.
Vitrea wheatleyi clingmani Dall, Nautilus, XI, 100 (1890).
Vitrea clingmani Dall, Proc. A. N. S. P., 1900, p. 150, fig.

As stated in Dall's description cited above, the types of this rare species were taken by Hemphill at or near Clingman's Peak, or Mt. Gibbs according to the map of the Topographical Survey. The first specimens in 1901 were found on Mt. Clingman, beside the trail just north of the summit. Four specimens were found under one log a short distance below the summit of Mt. Mitchell on the northeast side. It is evidently rare on Mitchell, as most careful search failed to bring any more to light. A single specimen was taken on Wilson's Cove and another on Cat-tail.

Ferriss found it in some greater quantity on Potato Top, but it appears to be rare even there.

V. clingmani is peculiar to Black mountain range. It is one of the largest of the Vitreas and, once seen, is easily recognized. The animal is dark bluish-black, and when alive the whole shell appears black; in this respect it reminds one of *Zonitoides nitidus* Müll. When cleaned the shell varies from a yellow to reddish horn-color, but occasional specimens are tinged with green as stated in Dr. Dall's description.

Vitrea approxima W. and P., n. sp. Pl. XXIII, figs. 7, 8, 9.

Shell about the size and shape of *V. hammonis*; glossy, smoky greenish horn-color, tinged with pink above; umbilicus round and deep; slightly convex above, whorls 4½, regularly increasing, surface sculptured above with irregularly spaced radial grooves similar to those of *V. hammonis*, but less crowded and with microscopic revolving impressed lines; aperture transversely rounded-lunate. Alt. 2, greater diam. 4½ mm.

Two specimens only of this species, which cannot be satisfactorily assimilated with any of the described species, were taken in Wilson's Cove, Mt. Mitchell. It is closely related to *V. hammonis* in shape, and in the regularly increasing whorls, but differs in color, in the less crowded sculpture of radial grooves, the presence of microscopic revolving sculpture, which is absent in *hammonis*, and in having nearly a whorl additional. In the examination of these forms for the revolving sculpture a compound lens of at least 100 diameters is necessary for satisfactory results. *V. wheatleyi* and *V. petrophila pentadelphia*, which have similar sculpture, differ in having a more open umbilicus and in the rapid enlargement of the last whorl. It differs from *V. rhoadsi* by the smooth base (*V. rhoadsi* being radially grooved beneath), the closer radial grooves, wider umbilicus, and in color.

Vitrea vanattai P. and W., n. sp. Pl. XXIII, figs. 4, 5, 6.

Shell rather narrowly umbilicate (the umbilicus about one-sixth the diameter of the shell), depressed, thin, honey-yellow and translucent. Sculpture of many deeply impressed, irregularly spaced radial grooves, much less conspicuous beneath, and very fine, rather faint, close spiral lines. Whorls 5, slowly increasing, the last much wider. Aperture oblique, broadly lunate, the peristome simple and thin as usual. Alt. hardly 2, diam. 4.5 mm.

Mt. Mitchell, two adult specimens and one young.

This species belongs to the same group as the preceding, from which it differs in color, the more depressed body-whorl, less crowded and deeper radial grooves, which are more distinct beneath, in having a half-whorl more and a wider umbilicus. In *V. hammonis* the sculpture is much closer, the grooves of *V. vanattai* resembling those of the species of the section *Glyphyalinia.* It resembles *V. clingmani*, but with the same number of whorls the shell is much smaller, and the shape of the aperture differs somewhat.

It is named for Mr. Edward G. Vanatta, in recognition of his long and careful work upon the smaller Zonitidæ of the collection of the Academy.

The group of *V. hammonis, clingmani, approxima* and *vanattai* consists of species similar in general form and in the coarser sculpture. *V. hammonis* differs from all the others by the smaller number of whorls and less depressed contour; *V. clingmani,* with the same number of whorls as the following species, is conspicuously larger. *V. approxima* and *V. vanattai* have about the same number of whorls, but the former is greenish, less deeply sculptured, and with a narrower umbilicus than *V. vanattai*, which is yellow and less fragile.

V. clingmani was drawn on a smaller scale than the other species on the plate.

Zonitoides arboreus (Say).

Paint Rock, on both sides of the river, Bluff mountain; Mitchell, Cat-tail, Wilson's, Tyson's, Potato Top and Ivy river. In Tyson's Cove this species was found in great abundance. It was also common on Potato Top. Elsewhere it seemed to be comparatively rare.

In addition to the more obvious differences between this species and *Vitrea hammonis*, *Z. arboreus* under a glass of high power will be found to have the surface covered with numerous very fine, impressed revolving lines which are lacking in *hammonis*.

Zonitoides elliottii (Redfield).

Common at Paint Rock, on both sides of the river, and at Tyson's. A few were also taken on Bluff mountain and a single specimen in Wilson's Cove, Mt. Mitchell.

Gastrodonta intertexta (Binn.).

Not taken in 1901. It occurs, however, at Asheville, where it was found by Walker on a previous visit.

Gastrodonta acerra (Lewis).

Paint Rock, Mt. Mitchell, Cat-tail, Tyson's, Potato Top, Meadow Cove, Ivy river and Toe river.

Apparently not as abundant in this region as it is either at Roan or in the Smoky mountains. It was more numerous in the Mt. Mitchell region than around Paint Rock and Bluff mountain. As usual in any considerable suite of specimens, there is considerable variation in the height of the spire. Those from Cat-tail were unusually fine, the largest examples of the two forms measuring 17½ x 14 and 16¾ x 11½ mm.

Gastrodonta demissa (Binn.).

Not taken in 1901. It has been found on Town mountain, near Asheville, by Walker.

Gastrodonta suppressa (Say).

This species did not occur in the collection of 1901. It has, however, been found at Asheville, on Town mountain (coll. Walker). It was also found at Spencer's Cabin on Thunderhead in 1899, but was overlooked at the time of making the report.

Gastrodonta gularis (Say).

At Paint Rock, on the north side of the river, a form of this species was taken which is like the depressed examples from Hayesville, N. C., mentioned in the report of the Pentadelphian expedition. Aside from this lot, no specimens were taken agreeing with the form of *gularis* almost everywhere prevailing in the Great Smoky mountains.[15] In its place, three well-marked subspecies of *gularis* occurred.

Gastrodonta gularis theloides A. D. Brown, n. subsp. Pl. XXV, figs. 1, 2, 3, 4.

Shell glossy, yellow, perforate, with moderately raised, dome-shaped spire, composed of 7½ to 8 narrow, closely coiled whorls; the last hardly regular at the periphery in adult shells; rather strongly striate above, nearly smooth beneath, with faint traces of spiral striæ near the umbilicus, where the base is rather conspicuously excavated. *Aperture somewhat triangular, the sloping basal lip being straight.* The peristome is acute, strengthened within by *a rather wide, low callous rim. Adult shells are without teeth or laminæ.* Alt. 4½–5, diam. 7½–8 mm

Young shells (5 to 6 mm. diam., Pl. XXV, fig. 4) are nearly discoidal, with the umbilicus as wide as in adults, base glossy, sculptured like the adult shells, the aperture armed within with two long strong lamellæ, the summit of the outer one curving toward the inner; there is also, in early stages, a smaller lamella peripheral in position.

"North Carolina" (A. D. Brown coll., No. 56,914 A. N. S.); Black mountains, N. C. (Henry Hemphill); abundant on Bluff mountain; a few only at Meadow Cove, Wilson's and Mt. Mitchell.

Fig. 3 is from one of A. D. Brown's specimens; figs. 1, 2, 4 are from Bluff mountain shells, collected by Walker.

This race was recognized by A. D. Brown many years ago and named in his collection (now in coll. A. N. S. P.), but it seems never to have been characterized by him. Various correspondents in America and England have submitted similar shells to one of us, and had them so named; owing to the desire to avoid overloading the nomenclature of a difficult group, the name has not hitherto been published.

---

[15] *Vide* these *Proceedings* for 1900, pp. 142, 143.

The specimens now brought to light demonstrate the necessity of recognizing the race. It differs from *G. g. lawæ* (W. G. B.) in the much narrower umbilicus; from *G. gularis* of the Great Smoky mountains in being toothless in the adult stage, and with a more excavated base and straighter basal lip. No adult shell, in a large number examined, possessed internal laminæ.

Gastrodonta gularis lawæ (W. G. B.). Pl. XXV, figs. 10, 11, 12.

Zonites placentulus (Shuttl.), W. G. Binney, Terr. Moll. U. S., V., p. 124, fig. 44, Pl. III, f. L. (dentition) and remarks, but not the description (1878).

Zonites lasmodon var.? W. G. Binney, Ann. N. Y. Acad. Sci., I, pp. 358–362, Pl. 15, f. e. (1879).

Zonites lawi W. G. Binney, 1st Supplement to Terr. Moll., V, p. 142, Pl. 2 (reprint of Pl. 15, Ann. N. Y. Acad. Sci, I), fig. e (1883). Manual of Amer. Land Shells, p. 221, fig. 235.

The shell is yellow, glossy, with moderately elevated, dome-like spire, composed of 8 closely coiled whorls; surface rather closely wrinkle-striate, the striæ strongest near the suture, weaker below, where a few faint spiral striæ may be traced. Last whorl rounded, hardly angular, even in front. *Umbilicus wide, open, deep and well-like*, the bases of the first whorls visible in its depth. Aperture small, irregularly lunate; peristome acute, strengthened within by a rather thin, diffused white callus, which becomes heavier within the columellar margin, making a slight convexity or low boss near the axis. Columellar margin somewhat straightened. Alt. 4.7, diam. 7.8 mm., width of umbilicus 1.3 mm.

The above description and figures 10–12 represent the type shell, which differs from most other specimens in being without internal lamellæ. Binney (*Supplement*, p. 143) mentions that "there is a variety in which is a heavy internal callous or plate-like teeth within the aperture," and this (Pl. XXV, figs. 14, 15, 16, 17) is certainly the prevalent form in the localities collected at in 1901. These dentate specimens have the long, strong, arching basal lamella of *G. gularis cuspidata*. Whether the lamina-bearing form will eventually be separated from the toothless typical form remains for future investigation, the material now available being insufficient for a decision.

This race has not hitherto been defined, although Binney has figured it in three publications. The figures, however, were not good, and on account of its association with the very different *G. placentula* (Shuttl.), it has not been generally recognized by students of our land snails. The toothless form occurs in Monroe county, Tenn., where it was collected by Miss Annie Law, together with specimens provided with internal laminæ. These were distributed to Mr. Binney, Dr. James Lewis, and probably others. The Lewis collection was sold, and there are specimens from this source in the collections of George H. Clapp, G. K. Gude, the Academy of Natural Sciences, and perhaps others. The toothless specimen illustrated in figs. 10–12 is No. 294 of the Binney and Bland collection, American Museum of Natural History, kindly lent by Mr. L. P. Gratacap. It is the individual figured by Binney, referred to at the head of this account.

The form was given specific rank by Mr. Binney, but in our opinion it is merely a subspecies of the variable *G. gularis*, distinguished by the wider umbilicus, and the absence of teeth in some adult specimens. *G. gularis theloides* differs from *lawæ* by its very small umbilicus. In *G. lasmodon* the umbilicus is still wider. The size of the umbilicus varies a good deal in the North Carolina specimens. Thus in specimens from Paint Rock, measuring 8 mm. diam., the umbilicus is from 1 to 1.7 mm. wide.

The young shells are always toothed (Pl. XXV, figs. 14, 15), there being a long outer lamella, a shorter baso-columellar, and in early stages a small supra-peripheral plait. The umbilicus is broad and the periphery situated high on the last whorl. The shell figured measures 5 mm. diam.

It is quite common on both sides of the river at Paint Rock. Two only on Bluff mountain.

Gastrodonta gularis decussata Pilsbry and Vanatta, n. subsp. Pl. XXV, figs. 5, 6, 7, 8, 9, 13.

Shell somewhat dull, brownish, *narrowly umbilicate*, with moderate or high, dome-shaped spire, composed of 8 flat whorls, *the last angular at the periphery.* Closely, sharply and strongly striate above, less so beneath, where there are usually *traces of spiral striæ* near the periphery. Aperture lunate, peristome thin and acute, armed within with a blunt tooth on the middle of the columella, and *a high, short, erect lamella* within the outer-basal margin. Alt. 5.5, diam. 7.8 mm. Alt. 5, diam. 8.2 mm.

Young shells (Pl. XXV, figs. 8, 13, diam. 6 mm.) are biconvex, depressed, acutely angular or carinate, more strongly striate beneath than adults, and with the striæ on the outer half of the base *decussated by many impressed spirals* (fig. 8). The internal lamellæ are long, as in the young of other forms of the *gularis* group.

Most abundant on Mt. Mitchell, the type locality. Found also at Tyson's, Wilson's, Potato Top, Cat-tail, Ivy river, Bee Tree Cove and Bluff mountain.

This variety was first recognized several years ago by Mr. Vanatta and one of the present writers, among specimens collected by Mr. Hemphill, labeled "Black Mts., N. C." The specimens were found with *G. gularis theloides.* On account of the small number of specimens (two adult and one young), it was not defined at that time. The abundant material taken in 1901 places the subspecies upon a secure basis. It differs from *G. gularis* and the racial forms subordinated to that species in the strong sculpture, comparatively dull surface, the decussation and acute carination of the young shells, and the short, high, erect lamella of the adult stage. Compared with *G. collisella* Pils., the var. *decussata* is seen to differ in the closer and flat whorls of the spire, flattened instead of swollen base, carinate periphery, etc. Young shells resemble *G. intertexta* in sculpture.

Gastrodonta interna (Say).

Common on both sides of the river at Paint Rock and at Tyson's. A few were also taken on Potato Top, Cat-tail and in Bee Tree Cove.

Gastrodonta andrewsæ (W. G. Binney).

Very abundant on Potato Top and not uncommon on Mt. Mitchell and Bluff mountain. A few were also taken on Cat-tail and at Bee Tree Cove, Toe river and at Paint Rock, on the south side of the river. One specimen from this last locality has the teeth fused together, forming a continuous rib across the cavity of the shell as in *G. lamellidens.*

Gastrodonta lamellidens Pilsbry.

A single specimen was taken on Bluff mountain, and another on the Toe river side of the Pinnacle of the Blue ridge.

PHILOMYCIDÆ.

Philomycus carolinensis (Bosc.).

Not so abundant as in the Great Smoky mountains. A few only were seen on Bluff mountain and Mt. Mitchell.

Philomycus hemphilli (W. G. Binney).

Common on Mt. Mitchell, which is the type locality.

ENDODONTIDÆ.

Pyramidula alternata (Say).

The typical form occurred only at Paint Rock, on both sides of the river. Those from the north side have the ribs much heavier and farther apart than those from the south side.

At Tyson's, Wilson's and Ivy river were found smoother, brighter forms, approaching *fergusoni* Bld. somewhat, especially in the gloss, but with the ribs more prominent. The spiral sculpture is well developed, the spiral lines being unusually prominent. This micro-sculpture, however, is practically the same in *mordax*. Periphery rounded. This is a race of the region, unlike the Great Smoky forms and the antithesis of *mordax*. This form, according to Wetherby[16] (who refers it to var. *fergusoni*), is the only form of *alternata* found at Roan mountain. Roan specimens, however, though more lightly ribbed than those from Mitchell, are nearer to them than to the typical *fergusoni*. The same form also occurs at Elizabethton, Tenn., and Scott county, Va. In the latter locality it is said to be "found only on trees high up on the mountains" (G. H. Clapp). This tree-climbing habit is also noticed by Wetherby, but was not observed by any of the party in 1901.

Pyramidula alternata mordax (Shuttleworth).

In 1852, Shuttleworth[17] described his *Helix mordax* from specimens collected by Rugel in the mountains of North Carolina. The original description was reprinted by W. G Binney in *Terr. Moll.*, III, p. 19, but by a clerical error the dimensions of *Zonites placentula*, which was described at the same time, were included in the description of *mordax*. Shuttleworth's description may be translated as follows:

"Shell widely and perspectively umbilicated, depressed, sublenticular, carinate, thin, yellow horn-color, ornamented with interrupted red streaks in bands, beautifully sculptured with strong flexuose ribs above and below; whorls 5½, flat; aperture very oblique, angularly crescentic, oval; peristome simple, acute. Greater diam. 18, lesser 16, height 6 mm.

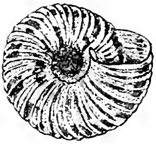
---

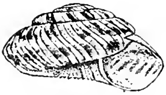
[16] *Jour. Cincinnati Soc. N. H.*, 1894, p. 75.

[17] *Bern. Mittheil.*, 1852. 195.

"Hab. in the mountains of North Carolina; more than 12 specimens taken by Rugel.

"Obs. very close to *H. alternata*, but distinguished by the stronger ribs which are 1 mm. apart. *H. cumberlandiana* Lea (perhaps a wholly abnormal form) in which the carina is similar, differs (according to the figure) in having the shell only lightly striate, not costate."





Many attempts to identify this form have been made by Binney and others, but, as stated by one of us,[18] the shells usually labeled *mordax* are referable to another strongly ribbed form of *alternata*, and do not fulfill the requirements of Shuttleworth's diagnosis given above.

As this was the only species of land snail belonging to the Eastern fauna that had not been satisfactorily determined, the discovery by Mr. Ferriss of specimens agreeing almost exactly with the original description of *mordax* is a matter of great interest. These specimens were found in Tyson's Cove (alt. 4,000 feet), which lies between the Great Craggy mountains and the Pinnacle of the Blue Ridge and at the southern extremity of the Black mountain chain, and in Bee Tree Cove (alt. 3,500 feet), which lies just west of the Great Craggy mountains. As both Tyson's and Patton's Knob were well-known resorts long before the Civil War, it is quite likely that this is the original locality. Of course this is a mere supposition, but the fact that the form has never been found elsewhere, and that in Shuttleworth's time the locality was one of the few accessible to the ordinary traveler, would seem to render it quite probable.

There would seem to be no question but these shells are the long-lost *mordax*. They agree exactly with Shuttleworth's description in having heavy ribs, fully a millimeter apart at the periphery, and which extend on the under side into the umbilicus. The carina is

---

[18] *Nautilus*, XV, p. 7.

well developed, though rather more rounded than in var. *carinata* Pils., but the under side just below the carina is distinctly concave, as in *Pyramidula bryanti*. This disappears somewhat in full-grown specimens toward the aperture, but is always evident on the first two-thirds of the last whorl, and is particularly marked in the young shells. The micro-sculpture is well developed, consisting of very fine irregular lines of growth between the ribs, which are cut transversely by numerous fine revolving lines. The only difference observable in these shells is that of size. Of our specimens none equals the dimensions given by Shuttleworth. Our largest example has a greater diameter of 17½, lesser 15, with an altitude from the base of 6½ mm. If Shuttleworth's types measured only 6 mm. from the basal lip, they are more lenticular than any form of *alternata* yet known, and the true *mordax* yet remains to be discovered. It is probable, however, that Shuttleworth followed Pfeiffer in measuring the height from the base of the axis.

The form here figured as *P. a. mordax* seems to be confined to a particular zone on the mountainside, and does not appear to mix with the smooth form of *alternata*. "It has the same habits as the common form, around old basswood and tulip tree logs, but the two were never together *Mordax* dwelt in the tulip tree belt, and the common form was both above and below, but never in that belt" (J. H. F.).

Pyramidula perspectiva (Say).

Paint Rock, on both sides of the river, fairly abundant; scarce in Wilson's Cove, and a single specimen only from Cat-tail.

Pyramidula bryanti (Harper).

The original description of Harper[19] is not as full in detail as could be desired. Wetherby's observations[20] are far more exact and give a better idea of the specific characters. As he states, "the whorls are heavily ribbed above and below, the rib terminating at a sharp angle on the upper and under outer edges of the body whorl, leaving a concave space between, which is comparatively smooth." In occasional specimens, however, toward the aperture the ribs, in a less developed form, are carried across from one carina to the other. The types came from Mitchell county, N. C., and probably from Roan mountain. At any rate, Roan mountain specimens are quite typical in every respect. Typical

---

[19] *Jour. Cincinnati Soc. N. H.*, 1881, p. 258.

[20] *Jour. Cincinnati Soc. N. H.*, 1881, p. 328. Reprint, p. 7.

examples were found not uncommon at Paint Rock, on the south side of the river, and specimens nearly so, differing, however, in the less acute development of the lower carina, occurred in Wilson's and Tyson's Coves.

On Cat-tail and Potato Top and in Bee Tree Cove, the specimens have both the keels less acute, and are more striate below the periphery. This form is intermediate between the typical *bryanti* and the Mt. Mitchell form which has the characteristics of a well-marked subspecies, the base being regularly costulate, the keels blunt and the intercarinal concavity nearly obsolete, much as in *perspectiva*. Young shells, however, are less specialized and resemble the intermediate form mentioned above. But the internal columellar tubercle, exceedingly constant in *perspectiva*, is wholly wanting. It is a peripheral form, probably at the geographic confines of the range of *bryanti*.

SUCCINEIDÆ.

Succinea ovalis Say.

A single young specimen was taken at Paint Rock, on the south side of the river, and two examples of the thin mountain form were found in the gap between Mt. Mitchell and Clingman's Peak.

The form here referred to is that commonly known as *S. obliqua* Say. Say described *Succinea ovalis*[21] in 1817 and *S. obliqua* in 1824.[22] Gould in 1841[23] referred the form commonly known as *ovalis* to Say's *ovalis* of 1817. Say's types of *ovalis* are in the collection of the Academy and belong to the form usually known as *obliqua*. This being so, *ovalis* has priority and must consequently be used, *obliqua* falling into the synonymy. The use of *obliqua* for Say's species was inaugurated arbitrarily by Dr. Amos Binney[24] in an "attempt to reconcile the differences" in the use of the names by retaining *ovalis* for Gould's species and applying to "Mr. Say's species his second name *obliqua*." This, of course, he had no right to do.

AMNICOLIDÆ.

Pomatiopsis lapidaria (Say).

A pale-green form of this species, rather more slender than the common northern form, was taken at Paint Rock, on the south side of the river.

---

[21] *J. A. N. S. P.*, I, 15 (1817).
[22] *Long's Exped.*, II, 260 (1824).
[23] *Invert. Mass.*, 194.
[24] *Terr. Moll.*, II, 64.

PLEUROCERIDÆ.

Goniobasis proxima symmetrica (Hald.).

Paint Rock creek, N. C. This was the only species of fluviatile mollusk found during the trip.

No indications whatever of Unionidæ or Pleuroceridæ were found in the French Broad at Paint Rock.

EXPLANATION OF PLATES XXIV AND XXV.

[ERRATA.—References to "Plate XXIII" on pages 431 and 432 should read *Plate XXIV*.]

PLATE XXIV, Figs. 1, 2, 3.—*Vitrea clingmani* Dall. Potato Top, Black Mts., N. C. No. 83,262 A. N. S. P.

Figs. 4, 5, 6.—*Vitrea vanattai* P. and W. Mt. Mitchell, N. C. No. 83,261 A. N. S. P.

Figs. 7, 8, 9.—*Vitrea approxima* W. and P. Mt. Mitchell, N. C. No. 83,260 A. N. S. P.

Figs. 10, 11, 12.—*Vitrea hammonis* (Strom). Mohawk, N. Y. No. 53 A. N. S. P.

PLATE XXV, Figs. 1, 2.—*Gastrodonta gularis theloides* (A. D. B.). Bluff Mt., N. C. No. 83,263 A. N. S. P.

Fig. 3.—*G. g. theloides*. Aperture of a specimen from A. D. Brown's collection. No. 56,914 A. N. S. P.

Fig. 4.—*G. g. theloides*. Basal view of a young shell from Bluff Mt., N. C. No. 83,263 A. N. S. P.

Figs. 5, 6, 7.—*G. g. decussata* P. and V. Three views of the type, Mt. Mitchell, N. C. No. 83,265 A. N. S. P.

Fig. 8.—*G. g. decussata*. Much enlarged view of a segment of the base of a young specimen from Bluff Mt., N. C. No. 83,264 A. N. S. P.

Fig. 9.—*G. g. decussata*. Another specimen from the type lot, Mt. Mitchell. No. 83,265 A. N. S. P.

Figs. 10, 11, 12.—*G. g. lawæ* (W. G. B.). Three views of the type specimen. Diam. 8 mm. No. 294 of the "Binney and Bland Collection," American Museum of Natural History, N. Y.

Fig. 13.—*G. g. decussata*. Young shell from Bluff Mt., N. C. Same specimen shown in fig. 8.

Figs. 14, 15.—*G. g. lawæ*. Young shell from North side of the French Broad river at Paint Rock, N. C. No. 83,266 A. N. S. P.

Figs. 16, 17.—*G. g. lawæ*. Adult shell of the laminate form. North side French Broad river, Paint Rock, N. C. No. 83,266 A. N. S. P.

SYNOPSIS OF THE AMERICAN MARTENS.

BY SAMUEL N. RHOADS.

The results summarized in the following paper are based on a rather extended examination of skins and skulls of *Mustela americana* from representative localities throughout its wide range. from the northern United States to the treeless regions of the Arctic zone. This study was primarily begun to determine the status of the southeastern marten, in connection with my recent work on the mammals of Pennsylvania and New Jersey. It has resulted in classing the southeastern animal as the most depauperate and light-colored representative of the group, and belonging more strictly to the type which Turton named from pale examples probably obtained from southeastern or central Canada. For purposes of nomenclature I have restricted typical *americana* to this region, making the east and west coast forms and the northern race, described by later authors, of subspecific value. Owing to the wide variation of *color* in this animal—skins from such widely separated habitats as the Pacific and Atlantic coasts at the same latitude being often found alike, and apparent dark or light races well known to the fur trade coming from isolated localities not correlated with faunal and floral environment in the zoogeographic sense—I have made such characters of subsidiary value to those of size and relative proportion in body, tail and foot measurements, in the character of pelage, and, above all, to cranial characters. As the latter have been largely made the basis of the examinations of Brandt, Baird, Gray, Coues and Allen, the chief monographers of the group, my own remarks will be the more pertinent from this standpoint.

The number of American specimens of skins and skulls upon which I have based these studies has been much larger than ever before brought together. They may be roughly listed as follows: Pennsylvania and Maine, 15; Quebec, 1; Ontario, 8; North Labrador, 4; New Brunswick, 30; Colorado, 6; Mackenzie prov., N.W.T. = Great Slave lake to Mackenzie bay, 26; Alaska, 7; British Columbia, Rocky mountains, 2; Cascade mountains, Washington, 30. For the use of this fine series I am indebted to the officers of the American Museum of Natural History, Field Columbian Museum, U. S. National Museum, Museum of Comparative Zoology and the Academy of Natural Sciences, Philadelphia.

Only skulls of the oldest adult males have been used in the comparative cranial diagnoses and measurements, viz., those in which the upper cranial sutures have so disappeared that the nasals are indistinguishable from the premaxillaries. I am aware that Dr. J. A. Allen has long ago (*Bull. U. S. Geol. Sur. Territ.*, 1876, Vol. 3, pp. 328–330) arrived at the same conclusions that I have reached concerning the small size of southern American martens by an independent investigation, in part, of the same specimens. But his researches were chiefly directed to a consideration of the differences between the American and Old World martens, and did not include specimens from Labrador and the Cascade mountains. I have been fortunate in securing several specimens, from the U. S. National Museum and the Academy of Natural Sciences, of Old World martens typical of *M. foina*, *M. martes* and *M. zibellina*, and am thus enabled to discuss their relationships with those of America. A series of thirty skulls from Kamschatka merit special mention.

As I now understand their relationships, the North American martens consist of three species and three subspecies, viz., the South Canadian marten, *Mustela americana* Turton; the Arctic marten, *M. a. actuosa* Osgood; the British Columbia marten, *M. a. abietinoides* (Gray); the Labrador marten, *M. a. brumalis* (Bangs); the Newfoundland marten, *M. atrata* Bangs; the Cascade mountain marten, *M. caurina* Merriam, and the Rocky mountain marten, *M. c. origenes* Rhoads.

Mustela americana Turton. South Canadian Marten.

1802. [*Mustela*] *americanus* Turton, Linnæus, Syst. Naturæ, Vol. I, p. 60.
1819. *Mustela vulpina* Rafinesque, American Jour. Science, 1819, p. 82. (Upper Missouri river = *M. americana* with white-tipped tail.)
1820. *Mustela leucopus* Kuhl, Beiträge Zoologie, p. 74. ("In Canada" = *M. americana* with white-tipped feet.)
1823. *Mustela huro* F. Cuvier, Diction. Sci. Naturelles, Vol. 29, p. 256. (Restricted types from the habitat of the Huron Indians, *fide* Milbert, viz., region east and south of Georgian bay, west peninsula of Ontario = *M. americana typicus*, pale form ("*blond clair*").

Type Locality.—Turton says his *M. americanus* " inhabits North

America." Undoubtedly his material was based on specimens from eastern Canada or the northeastern United States. He describes a light tawny, white-headed form, which applies more distinctively to the martens of southeastern Canada and the eastern United States as contrasted with those from farther north or from New Brunswick and Labrador. On this basis and to more intelligently map out the distribution of the subspecies already described without overturning names recently proposed, I restrict the type locality of *americana* to the region occupied by the small pale martens of southern Canada and the northern United States. The type specimens on which Turton based his species probably came from Ontario or Quebec through the Hudson Bay Company.

Faunal Distribution.—The habitat of *Mustela americana americana* is restricted to the forested areas enclosed by the following localities: Hudson bay, Northeast territory (of Labrador), Quebec, Nova Scotia, Massachusetts, northern Pennsylvania, south in the mountains to Colorado, Utah, eastern Oregon and Washington, eastern British Columbia, Alberta, Saskatchewan and southern Kewatin, south of latitude 55°.

Description of Species.—Smallest and palest of the American martens. Pelage relatively short. Colors most variable of the group, ranging from white-headed, yellow-bodied individuals to blackish-brown ones. Color of throat and breast patch varying from white to pale-orange, sometimes reaching from chin to sternum and from base of ears to insertion of forelegs, sometimes confined to a stripe or scattered spots across lower neck. These remarks in part apply to all our martens. The distinguishing color characteristics of typical *americana* may be stated to be the average paleness and yellowness of outer fur and the clear ash of basal under fur, as contrasted with all other races, and in the strongly contrasting colors of the fore parts with the hinder parts. The upper head, ears and neck are generally a pale drab-gray (*Ridgway's Nomenclature of Colors*), this often reaching half-way down the back; the lower back, thighs and rump are tinged with an unnamed shade of color combining pale-orange, rufous and yellow in an indescribable combination not found in other geographic races. This whole area is sparingly tipped with black. The bases of hairs are pale smoke-gray. The darker parts of fore and hind feet and legs and tail-brush are blackish seal brown. Certain areas within the range of *M. americana americana* above given furnish martens whose average pelts are so dark as to give them a standard market value much above skins from the surrounding country. Such a region is the upper Nipigon territory of Ontario westward toward the Lake of the Woods. The local climatic conditions of this rocky, saturated and densely wooded area are responsible for this. It is too local, however, to warrant a further subdivision. Respecting the cranial characters, upon which I have primarily based my examinations of this perplexing group, I begin by considering Gray's fundamental separation of the New World martens from *M. martes, foina* and *zibellina* on the size and shape of the last upper tubercular molar. In *americana* this is stated by him, and in measure amplified by Coues and Allen, to be different, in its hour-glass shape and greater size of the inner bulb as compared with the outer. In *americana* this tooth has but slight constriction, with resulting rectangular shape, owing to the relative equality in size of the inner and outer bulbs. A very careful examination of the large series of American martens shows that the specific separation from Old World forms on this basis is fully warranted. It is further emphasized by the character of the second lower true molar, which in all the exotic forms has a strongly characterized inner cusp, as asserted by Allen. In *americana,* Allen says, this is " not found," or " only in a very rudimentary condition." I have found it, however, in a more or less rudimentary condition in all typical *americana* skulls, except those so very old that it had been worn away. In rare instances this cusp is almost as well developed, proportionately to the smaller and narrower character of *americana* molars, as in *martes.* On this account its diagnostic value is less than that of the last upper molar. These remarks apply equally to all marten skulls I have examined taken east and north of the Cascade mountains, from Nulato, Alaska, to the coast of Maine. But when skulls from the Cascade mountain region and the Pacific coast are examined an intermediate condition is immediately noticeable. The shape of posterior upper molar corresponds more closely to that of the Old World forms, as also does the flat, rounded cranium and its broad, zygomatic width as compared with its length. In these combined respects it resembles the European beech marten, *M. foina,* more closely than it does the martens of the Rocky mountains and eastern Canada. Regarding the cranial relations of the Asiatic sable, *M. zibellina*, to our West American martens, nothing seems to have been published. Brandt, who made a critical monograph on these subjects, seems not to have had any skulls of *zibellina*. Neither did Baird, Coues, or Allen. Brandt (*Beitr. Kennt. Säugeth. Russl.*, 1855) finds no differences between the external characters of the Asiatic and West American martens, the "sables" of the "Nischnaja Tunguska occupying an intermediate position between the dark Asiatic and yellow American sables."

A fine series of sable skulls from Kamschatka, representing thirty-two specimens of the Old World *zibellina*, correspond exactly with the good figure of *zibellina* in Blainville's *Ostéographie*. Comparing these with American martens we find them larger than the largest skulls from Alaska, Mackenzie and Labrador, six old males averaging 82 mm. in basilar length and 53 mm. in zygomatic expansion. In the largest Alaskan example the basilar length is 80 mm. A specimen from Peel's river, Mackenzie territory, the largest in my American series, is 82 mm. long, while the largest Kamschatkan skull is 85 mm. long. In both size and proportions, however, these crania of *zibellina* are remarkably like *actuosa* of Alaska and *brumalis* of Labrador. But when the dental characters are examined there is a distinct separation between them, based, as above mentioned, on the great size and peculiar asymmetric saddle shape of the upper posterior grinder of *zibellina* as contrasted with the rectangular, transversely elongate shape of that tooth in *americana*. The distinction of relative size and the inner tuberculation of the lower sectorial in these Kamschatkan skulls is also a decided feature as contrasted with their nearest geographic allies in America. Comparing these *zibellina* skulls with three Swedish skulls, typical of *martes*, the close specific relationship between these two is emphasized in every character examined. On the other hand, *foina* specimens from Germany are very distinct in cranial features.

In *foina* we have a very short, broad and flattened skull, wholly lacking any sagittal ridge on the occipital crest, even in old age. The frontal constriction is relatively unpronounced. The posterior upper grinder is more rectangular in shape than in the *martes* group, and owing to the short rostrum the premolar teeth overlap at base instead of being separated by short diastemae. In respect of the size and shape of the cranium, *foina* is far more distinct from *martes* and *zibellina* than the latter are from any American form except *caurina*. It is interesting to note in this connection that *caurina* resembles *foina* very closely in the small size and shape of its audital bullæ and the breadth and flatness of the brain-case, but in respect of the sagittal crest, frontal constriction and character of the teeth, *caurina* is closer to *zibellina*. Its homologies connect it far more closely with the Eurasian than the American type of marten, and would indicate a closer genesis from the Old World martens than from those of the New World. As it does not appear to intergrade with the latter, I am induced to consider it an isolated member of the *martes-zibellina* group. This peculiarity is not without precedent in the Asiatic character of other animals found in the habitat of *caurina*.

Measurements.—Average of six adult males from Maine, Pennsylvania and the Adirondacks: Total length, 575 mm.; tail vertebræ, 175 mm.; hind foot, 82 mm. Skulls ditto: Basilar length (from inferior lip of foramen magnum to posterior base of upper median incisors), 70.5 mm.; postorbital constriction, 16.0 mm.; zygomatic expansion, 44 mm.

Mustela americana brumalis (Bangs). Labrador Marten.

1898. *Mustela brumalis* Bangs, American Naturalist, Vol. 32, p. 502.

Type Locality.—Okak, Labrador.

Faunal Distribution. — Humid coast region of northeastern Labrador, Ungava bay to Straits of Belle Isle. Intergrading westwardly into *actuosa*, southwardly into *americana*.

Description of Species.—Mr. Bangs' description of this race was based on three skulls, presumably of males, no skins being obtained. Since then he has obtained skins, two of which, an adult male and female, have been sent to me for examination. The character of the skull of *brumalis* as compared with that of *americana* from Maine is certainly conspicuous for greater size, but the *relative proportions* when compared with specimens from Maine of same age and sex are not so marked as described by Bangs. I note that the skulls of *brumalis* are surprisingly identical in size and proportions with those of *actuosa* from the Mackenzie river district and Alaska, as shown by the fine series loaned by the U. S. National Museum. This is referred to by Osgood in his description of *actuosa*, but the skull of *brumalis* figured by him is smaller than the largest specimen I have, so that the differences Osgood seeks to draw between the two in this regard are much less than would appear. The relative size of the audital bullæ in *actuosa* and *brumalis*, where skulls of same size are compared, is so nearly the same as to make them of no diagnostic value, and the heaviness of dentition falls under the same restrictions. Taking these two races of *americana* and contrasting them therewith, the Pennsylvania and Maine specimens show an extreme diminution of size, being about 10 mm. shorter and relatively somewhat narrower than the northern races; but we are unable to make these differences in size, great as they appear, of specific value, for the martens from the north shore of Lake Superior and from Tobique and Trousers lake, New Brunswick, are plainly intermediate and connectant in cranial characters, measuring only 5 to 6 mm. shorter than the largest skulls of *actuosa* and *brumalis*. No doubt skulls from western Labrador and Keewatin would complete the chain of gradation thus indicated. It may be remarked that the development of sagittal crest in *actuosa* and *brumalis*, and the posterior angularity and expansion of their zygomæ, are more or less in excess of any specimens of the southern animal; but an examination of the cuspidation, size and outline of the teeth in all the forms except *caurina* shows that so-called differences are confined to individual variation, as proved by the unusually large series of crania now in hand. In color, *brumalis* is separable from any other eastern interior form on account of its dark shades. In the male specimen from Okak there is a close resemblance to the specimen from Sullivan county, Penna., both in tint and pattern of coloration, the difference consisting almost solely in the greater length of the coarser long hairs of the over fur. These are also blacker and the median (subapical) shade of upper back, sides and rump is less fulvous. The color of the under fur is a shade darker ash than that of the Pennsylvania specimens. In the female Okak specimen the whole body colors are much darker than in the male, being a blackish chocolate, and the fulvous cast of under fur seen in the male is replaced by a cinnamon or bistre shade in the female. In both, the head is lighter than the body. As compared with *actuosa* the Labrador form is much darker, Mackenzie river *actuosa* being characterized from all others by the contrast of their light-hued sides and heads with the darkly contrasted brown-black of the median dorsal area. An average of the *actuosa* series would class as " pale" in the furrier's nomenclature, while *brumalis* would class as " dark." On the other hand, *actuosa* is of a very different sort of " pale" from typical *americana*, such as we find in New Brunswick and Maine. These latter are termed " canaries" by the furriers and are distinguished from the *actuosa* type by the pale-orange, buffy or ochraceous suffusion of back and sides, some of them assuming a peculiar golden hue. All these pale color conditions of the southern animal, more on account of tint than paleness, detract materially from their commercial value as compared with those pale skins which are typical of the interior Arctic martens.

Measurements of brumalis.—Total length of ♂, 680 mm.; tail vertebræ, 195 mm.; hind foot, 115 mm.: of ♀, 585, 179, 91 mm.: both specimens from Lance Au Loup. Skull measurements of four adult males average: Basilar length, 79 mm.; interorbital constriction, 16 mm.; zygomatic expansion, 52 mm.

Mustela americana actuosa Osgood. Arctic or Alaska Marten.

1900. *Mustela americana actuosa* Osgood, North American Fauna, No. 19, p. 43.

Type Locality.—Fort Yukon, Alaska.

Faunal Distribution.—British America, north of latitude 55° to Barren Grounds; east to western Labrador peninsula (Northeast Territory); west to Coast Ranges of British Columbia and Alaska; south in Rocky mountains almost to northern boundary of the United States.

Description of Species.—Osgood, the describer of this race, has correctly characterized it in his original description and figure as compared with *americana typicus*, but, as previously stated, he has emphasized too strongly the distinctions between it and *brumalis*, as now evidenced by the additional skulls of *brumalis* secured by Mr. Bangs.

Osgood's description of color characters of type may be quoted in part as follows: " Posterior half of upper parts pale ochraceous-buff, shoulders and anterior part of upper parts gradually becoming grayish; entire upper parts except head overlaid with coarse brown hairs; head, including cheeks and throat, pale grayish-white, lightly mixed with brown, especially on nose and chin; inside and edges of ears whitish; outside and bases of ears brown. Under parts similar to upper parts, but darker and more brownish on chest.'' This description is taken from a lighter individual with more ochraceous cast than the average. Several of the Peel's river specimens have scarcely any ochraceous cast, but rather a drab-brown tinge; but even in these the grayness and clearness of the brown from the "canary" shade of typical southern *americana* is very noticeable. For a fuller discussion of these differences see under *M. americana brumalis* above, where the cranial characters of both forms are also discussed at length. Also, see remarks under *M. americana typicus*.

Measurements.—Average of eight selected old adults, males, measured in flesh: Total length, 671 mm.; tail vertebræ, 204 mm.; hind-foot, 109 mm.; ear height, 49 mm. Skull measurements (average of six adult males): Basilar length, 80 mm.; interorbital constriction, 16 mm.; zygomatic expansion, 51 mm. In the type of *actuosa* the occipito-nasal length is given by Osgood as 85 mm., and the zygomatic expansion 55 mm. This is larger than any of the rest of the large series belonging to the U. S. National Museum.

Mustela americana abietinoides (Gray). British Columbia Marten.

1865. [*Martes americana*] var. 1, *abietinoides* Gray, Proc. Zool. Soc., London, p. 106.

Type Locality.—"Rocky Mountains (Drummond and Lord)," Gray. As Gray's *abietinoides* thus included two distinct species, one of which was undoubtedly *caurina* (collected by Lord), I have now restricted it to the Rocky mountain specimens taken by Drummond. Drummond's itinerary, as given by Richardson (*Fauna Boreali Americana*, Vol. I, p. xvi), shows that he did not collect specimens west of the Selkirk Range, hence not within the range of *caurina*. The description of *abietinoides* by Gray evidently refers to dark specimens characteristic of the humid environment of the Selkirks, into which Drummond says he penetrated just before his recall home. The marten of the main arid chain of the Rockies is evidently a lighter colored animal. On these considerations I have seen fit to define the restricted type locality of *abietinoides* to the edge of the humid western slope of the Rocky mountains, somewhere between Kicking Horse pass and the Columbia river. It is significant that this is also the eastern limit of the "*Abies*" *mertensiana* or Western hemlock, after which Gray named his so-called "variety" *abietinoides*, probably on account of notes made by Drummond or Lord as to the habitat of the type specimens of this marten.

Faunal Distribution.—Humid interior region of British Columbia, peculiar to the Selkirk and Gold Ranges.

Description of Species.—Gray's description reads: "Black-brown; ears pale, head grizzled with white hairs, more or less gray; throat yellow or yellow-spotted; throat spot large or broken up into small spots; the head sometimes with only a few gray hairs, and the throat with only a few distinct small spots." A specimen sent to me from Vernon, British Columbia, by W. C. Pound, a taxidermist with whom I became acquainted while in that place in 1892, is of especial interest in this connection. It was taken November 22, 1892, and no doubt was brought to Mr. Pound by an Indian trapper whom he dealt with, living in the Gold Range above Vernon. Such, at least, was the source of his supplies of larger game and furs during my residence there. The skull and skin of this specimen indicate it to be an adult, but not very aged, female. The naso-premaxillary sutures are not wholly obliterated, as in over-aged specimens, but the occipital crest is that of a fully matured marten, perhaps three or four years old. The color of this specimen answers exactly Gray's description of "*black-brown.*" In this respect it is instantly distinguished from all other of the specimens of marten I have before me, both by the quality and depth as well as the uniformity of its coloration. In terms of ***Ridgway's*** *Nomenclature of Colors,* this specimen is seal-brown throughout, both above and below, with exception of the sides of the head, the interior of ears and a small irregular throat patch. The shade of this seal-brown is blackest on tail, feet, legs and middle back. On sides, under parts, neck and head it is more of a vandyke-brown, but nowhere buffy, ochraceous or orange, as in all other martens I have examined.[1] A cheek patch between ear and eye and the insides and margins of ears are grayish-drab, but the rest of head above and below is not noticeably paler than neck as in all others of the *americana* group found east of the Rocky mountains. Scattered white hairs are noticeable among the dark body pelage above and below, being more numerous about head, neck and breast. The narrow, irregular throat patch reaches from angle of lower jaw

---

[1] The Newfoundland species, *M. atrata,* which I have not seen, is probably another exception.

to near base of neck, being about two inches long and three-quarters of an inch broad in the widest part Its color is ochraceous-buff. The fullness, density and length of pelage is noticeable, and the slight contrast in color of the basal portion of the fur with that of the apical half is unique, so far as I have examined specimens. In even the darkest Labrador skins of *brumalis*, the triple-zoned color pattern typical of marten fur is quite as marked as in lighter-hued races; but in *abietinoides*, as illustrated by this Gold Range specimen, the subapical or intermediate color zone of the individual hairs is absent and their dark apices merge insensibly into the more ashy-brown of their bases. Taken as a sample, this skin would seem to me to indicate that the Selkirk mountain animal furnishes one of the most desirable marten pelts, from the furrier's standpoint, that can be found in North America.

The skull of this specimen, as well as that of another, sexed female, from the same locality, show, in comparison with female skulls of same age from the Mackenzie river regions, that *abietinoides* is not only specifically identical with *M. a. actuosa*, but that it is only slightly smaller in size, being intermediate in the latter feature between *M. americana* of Lake Superior and Arctic examples of *actuosa*. As regards coloration, *abietinoides* is farther removed from *actuosa* than any other race of the *americana* group. It is allied most closely, as regards color pattern, with its geographic ally, *origenes* of the main Rocky mountain chain. The teeth, audital bullæ and the proportions and configuration of skull in *abietinoides* are precisely as in the *americana*, as contrasted with the *caurina* type of cranium.

Prof. Oldfield Thomas, who examined for me the Drummond and Lord specimens of *Mustela* in the British Museum which formed the basis of Gray's *abietinoides*, agrees with me that the Drummond specimens should be considered the types in a determination as to the status of this name. As the use by Gray of one or more specimens, probably taken by Lord in the habitat of *caurina*, further necessitates this division, the natural course, as already somewhat explained under remarks on "*type locality*," has been to retain *caurina* for these and restrict *abietinoides* to the very distinct race of *americana* inhabiting the hemlock and cedar (*Tsuga et Thuja*) forests of the western offshoots of the British Columbia Rockies. Prof. Thomas states that a Drummond specimen in the British

Museum is less dark than some of the Lord specimens. Unless the exact locality were given, it is not improbable that some of Drummond's specimens (if there were many) may have come from localities in the eastern Rockies, where that naturalist did most of his collecting. In such a case the question would seem to be complicated by specimens of *origenes*, which is almost undoubtedly the race found on the headwaters of the Red Deer river in the Purcell Range, where Drummond wintered. But the gist of the matter, shorn of these complications, is Gray's desire to designate by name a dark American marten found in the Rocky mountains by Drummond. As no special type from a series of British Columbia specimens was designated by Gray, and as a special type or race agreeing with his description has been found to live in the habitat designated, it is within our province here to give it fixity by restriction and elimination, rather than ignore or reject it as a nomenclatural enigma. It may be added that an examination of J. K. Lord's itinerary shows that it is very unlikely he secured any specimens from the habitat of *abietinoides* as I have restricted it. His operations with the Boundary Commission in the Rocky mountains lay entirely south of the Selkirk and Gold Ranges.

Measurements.—Made by collector from specimen No. 633, Coll. of S. N. Rhoads, ♀, Gold Range, near Vernon, B. C., by W. C. Pound; taken November 22, 1892: Total length, 584 mm.; tail vertebræ, 178 mm.; hind foot (dry measurement), 87 mm. Skull (of same specimen): Basilar length, 70 mm.; zygomatic expansion, 43 mm.; postorbital constriction of frontals, 17 mm. Measurements of the male, judging by analogy of the sexual differences in other races, would nearly equal those given for *actuosa* and *brumalis*.

Mustela atrata Bangs. Newfoundland Marten.

1897. *Mustela atrata* Bangs, American Naturalist, Vol. 31, p. 162.

Type Locality.—Bay St. George, Newfoundland.

Faunal Distribution.—Newfoundland.

Description of Species.—I have seen no specimens of this form, which seems nearly related in size and color, etc., to the dark martens of the northern Rocky mountains. As it is confined to the island, it is considered by Mr. Bangs, its describer, as a distinct species, on geographic rather than anatomical grounds. Its affinities with *americana*, however, judging by the original description, are cranially much closer than to those of *brumalis, actuosa*, etc.

In such a case it would seem preferable to make exception to the arbitrary ruling of specific recognition (as contrasted with racial separation), based primarily on geographic isolation. The subspecific differences of *atrata*, from the standpoint of coloration alone, appear to merit its separability from typical *americana*.

The color of *atrata* is said by Bangs to be "Deep chocolate, becoming black on back, head, arms, legs, rump and tail; a few white hairs scattered along back; chest and under side of neck irregularly blotched with orange; a median line of orange on belly; ears black, narrowly bordered all round with dull white." This indicates a much blacker and more orange-spotted animal than any other marten known to me except a specimen from near Vernon, British Columbia, in the interior region west of the Selkirk Range. In this last specimen, however, the orange spot is small, and does not extend below the base of neck. Bangs says further: "Skull about the size of or larger than that of *M. americana;* rostrum narrow, audital bullæ much larger and deeper than in *M. americana* . . . . ; dentition rather weaker throughout, with greater spaces between premolar teeth than that of *M. americana*. Unfortunately, the skulls as well as the type skins were from females. But as other skulls, probably from males, were examined by him, it is likely his diagnosis includes them, showing the close affinity of *atrata* to typical *americana* from New Brunswick.

Measurements.—Fide Bangs from two females, types: Average total length, 550 mm.; tail vertebræ, 185 mm.; hind foot, 88 mm.; ear from notch, 42 mm. Skull of type: Basilar length, 69.2; zygomatic expansion, 42 mm.

Mustela caurina Merriam. Pacific Marten.

1890. ***Mustela caurina*** Merriam, North American Fauna, No. 4, p. 27.
1865. ***Martes americana***, var. 1, *abietinoides* Gray (in part; referring to J. K. Lord's specimens), Proc. Zool. Soc. Lond., p. 106.

Type Locality.—Near Gray's Harbor, Chehalis county, Washington.

Faunal Distribution.—Humid coast and Cascade mountain region of western United States, British Columbia and probably southern Alaska, from northern California northward, east to summit of Cascade Range. Geographic connection with *M. c. origenes* problematic.

Description of Species.—The Cascade mountain marten, as illustrated by a very large series of skulls in my collection from Lake Kichelos, Kittitas county, Washington, taken at elevations of 8,000 to 10,000 feet, shows cranial characters so different from any of the other American martens as to suggest a distinct species. It is significant, also, to note that their departure from the *Mustela americana* type is in the direction of the Old World species, as originally observed by Brandt and Merriam and confirmed by the exceptional series in my hands.

As compared with skulls of *M. a. actuosa* from Mackenzie, B. A., and *M. americana* from north of Lake Superior (with the latter of which they correspond almost exactly in length), the following differences are prominently noticeable: The skull of *caurina* viewed from above is greatly broadened and flattened; the zygomatic breadth in an old male from Lake Kichelos is to the basilar length as 52 to 74; in a male skull of similar age and sagittal development from Lake Superior these proportions are as 47 to 74, the skulls in each case being the same length. In the largest skull from the Mackenzie river the zygomatic breadth only exceeds that of the largest Washington specimen by 1 millimeter, but its basilar length exceeds the latter by 6 mm. In conformity to this relative shortening and widening, *caurina* has a markedly wide brain-case and interorbital region, the postorbital processes being widely and bluntly developed and the frontals abruptly constricted behind them, so that while this constriction is as narrow as in *actuosa*, the greatest supraorbital width is 1 mm. greater than in the largest *actuosa* skull. The lowness or flatness of the cranium is also marked. In the skulls already alluded to, *caurina* has a maximum height from the audital bullæ to crest of occiput of 29 mm., while *actuosa* is 32 mm. high. Viewed from below, the audital bullæ of *caurina* are instantly seen to be very small as compared with *americana* of same sized skull. They are also of a different shape, being flat, shortened and squared anteriorly, forming a sort of retangular outline, whereas *americana* and *actuosa* are more triangular, tumid and elongate. The last upper molar presents differences from all *americana* forms quite as radical and strangely similar to those claimed by authors as warranting the specific separation of the *americana* group from the Old World martens. In all the adult representatives of *caurina* I have examined, this tooth is analogous in character to that of specimens labeled *martes* and *foina* in the collection of the Academy of Natural Sciences, and also to Blainville's superb figure of *zibellina* in Plate 7 of the *Ostéographie.* The character alluded to is the relatively large size of this molar and the wide expansion of its inner bulb or saddle as contrasted with the exterior section of the same, giving the tooth a rounded, emarginate, triangular shape as contrasted with the narrow, rectangular lateral elongation characteristic of the *americana* series. In the latter the ratio of greatest breadth to length of tooth is as 5 to 8, in *caurina* it is as 7 to 9. In a specimen labeled *martes* from Europe this ratio is 7½ to 9, the numbers in all three cases being actual millimeter dimensions of the teeth. Another character in this tooth common to *caurina*, *zibellina* and *martes* is the tendency to a double median tuberculation of the inner bulb, instead of the single elongate tubercle always found in *americana typicus* and its races. This is clearly resultant from the greater width of the inner bulb in *caurina* and its Old World allies, thus allowing room for subdivision of the tubercle. A further analogy between *caurina* and the Eurasian, as contrasted with the American type of dentition, is seen in the large lower sectorial. In the former this tooth is much wider and heavier than in the *americana* group and the inner median tubercle is strongly developed. In *americana* it is generally rudimentary, but not always so.

Some of these characters are pointed out by Dr. Merriam in his original description of *caurina*, but his statement that the inner cusp of the lower sectorial is wanting in male *caurina* is disproved by my large series. The skulls of Merriam's types were not fully adult, however.

In color, *caurina* is a richer brown than any of the *americana* group, more inclining to cinnamon in upper body color. This shade is more uniform throughout the entire length of upper parts to head, which is not so distinctly lighter in color as in all other average East American martens. The head is an almost uniform shade of pale Mars-brown, not lightening on cheeks and ears as in eastern *americana* types. A marked difference peculiar to *caurina* is found in the extensive area and rich tint of the dark orange-buff throat and breast patches. This area begins at the angles of the jaw, reaches up along sides of neck to and including inner base of forelegs, and stretches by spotted interruptions almost to vent, the main body of color terminating on lower breast. The rich coloring and great size of this pattern seem constant in a series of Cascade mountain skins before me. A tendency to scattered long silvery hairs through the upper pelage is noticeable as contrasted with *americana*. This feature is also in the direction of *zibellina*.

In external character the relative length of the tail of *caurina* is greater than in any other form of American marten except *origenes*. This in a comparison made with my series of Lake Kichelos skins, which were measured in the flesh by collector, Mr. Allan Rupert. It appears likely, however, that his measurements included part of the brush of tail, as the measurement of the dry specimens now seems to indicate. Allowing for this, however, the *caurina* specimens indicate a long-tailed marten, as the average below given of six old males indicates. See further discussion of cranial characters under *M. americana typicus*.

Measurements.—Total length, 675 mm.; tail, 270 mm.; hindfoot, 90 mm. Deducting from this 50 mm., the length of the body of tail pencil, leaves the total length 625 mm., and the tail vertebræ 220 mm., which is much greater relatively and absolutely than in other American martens whose size exceeds *caurina*. The length of the body, skull and hind foot are nearly identical with the medium-sized martens of southern Canada. It is to be regretted that Dr. Merriam gave no body measurements of his types of *caurina*. Skull measurements (average of six old males): Basilar length, 74 mm.; zygomatic expansion, 51; interorbital constriction, 15. For relative dimensions of teeth, see above under description of species.

Mustela caurina origenes[2] subsp. nov. Rocky Mountain Marten.

Type, No. 112,170, young adult ♀, collection of U. S. National Museum, from "Marvine Mountain" (Garfield county ?), Colo. Collected by Ernest T. Seton (E. Seton-Thompson), September 16, 1901.

Faunal Distribution.—Southern Rocky mountain region; higher ranges of New Mexico (?) northward; probably replaced in the

---

[2] From the Greek, meaning "*a mountain race*."

Canada Rockies by a race of *americana*. Geographic connection with *caurina* problematical.

Description of Subspecies.—Strikingly different from all other American martens except *caurina* in the absence of the light-colored cheek patches. Head relatively darker, as compared with upper body colors, than in *caurina;* ears lacking a white border or inner lining of white hairs. Gular and pectoral patch extensive, wide, connected by interrupted streaks along median abdominal line with well-defined narrow pre-ventral area of similar color. Color of gular patch a peculiar buffy-orange, as in *caurina*, lightening somewhat at armpits. Entire upper parts, including head, ears, legs and sides, and lightening somewhat on belly, "wood-brown," the longer, darker hairs of middle back and rump being "broccoli-brown," and the brush of tail and soles of feet "clove-brown." Ears edged with ochraceous-buff. Tail relatively long, as in *caurina*. The concolor appearance of *origenes* viewed from above is even more striking than in *caurina*, the whole of head, excepting the ear-margins, being quite as dark as the neck and shoulders and these not noticeably darker than the back. The under parts show precisely the same color and pattern characters which distinguish *caurina* from *americana*. Indeed, it was these, together with the characters of the skull, which upset my previous ideas (based on geographic reasons) that *origenes* was a race of *americana*. Fortunately there are five skins and three skulls of Colorado martens at hand, and these all show with remarkable uniformity the constancy of the characters of type as above given. It is to be regretted that no skin with skull of an adult male is available. An adult male skin, topotype, also collected by Mr. Seton the last of August, and a female collected on the Great Divide in Boulder county, fit the above description exactly. The skull of two females, one from Boulder county, the other the type, are not enough matured to give the maximum measurements, but the skull of an old adult female from North Park furnishes these, showing *origenes* to be of the same size and proportions as *caurina* of the same sex. Coming to an examination of the teeth our surmises, based on external characters, are so completely verified that any zoogeographic preconceptions we may have had as to affinity of *origenes* with *americana* are swept away. The peculiar saddle-shaped upper posterior grinder of *origenes*, with its widely flaring inner flange, and the relatively small, flattened and rectangular audital bullæ declare its affinities to be with *caurina* and not with *americana*. It is a pale race of *caurina*, seemingly out of place in its zoogeographic status, and presenting a puzzling thought as to the relationships of the animal living on the main chain of the Rockies in British Columbia, which our present knowledge of *abietinoides* certainly indicates should be an ally of *americana*. Should the marten of the northern arid Rockies prove to be an *americana* form, as we would naturally predict, at what point then shall we look for the geographic gap which separates it from *origenes* and where the bridge which connects *origenes* with its kinsman *caurina* of the Pacific slope? These are problems for the "next reviewer."

Measurements of Type.—♀ (recorded by collector): Total length, 612 mm.; tail vertebræ, 210 mm.; hind foot, 76 mm. Measurements of an adult male skin, topotype, collected by Seton (from dry specimen): Total length, 676 mm.; tail, 230 mm.; hind foot, 85 mm. Skull (of ♀ type): Basilar length, 65 mm.; zygomatic expansion, 40 mm. Measurements of an old adult ♀ skull from North Park, No. 13,985, Coll. Amer. Mus. Nat. Hist., N. Y.: Basilar length, 65 mm.; zygomatic expansion, 43 mm.; post-orbital constriction of frontals, 14 mm.

TWO FUNGOUS DISEASES OF THE WHITE CEDAR.

BY JOHN W. HARSHBERGER, PH.D.

PREFATORY REMARKS.

The white cedar is a stately tree seventy to eighty feet in height, and one to four feet in diameter. It lives in the cold sphagnum swamps of the Atlantic and Gulf coast plains, where frequently the bases of the tree are flooded with water. In New Jersey, and in the North generally, it forms an almost pure growth. It is associated in the South with the bald cypress, *Taxodium*. Extending from southern Maine along the coast to northern Florida and then westward to the Pearl river in Mississippi, it never is met with far inland, being confined almost entirely to the coastal plains.

The tree is not subject to any very serious disease. It is remarkably exempt from both insect and fungal enemies, and consequently it should be looked upon as a promising tree for future systematic forestry in the eastern United States. It gives value to lands that without it would be useless. Sydow[1] gives nineteen species of fungi living on *Cupressus thyoides*. To this number one additional fungus should be added, viz., *Gymnosporangium Ellisii* Berk. Of these, ten species are found growing on the leaves, causing no material injury to them, as the fungi are usually found on dead leaves. Five fungi are confined to the branches, one is found on the trunk, two grow on the bark, two are found on the wood and one fungus, *Gymnosporangium biseptatum*, occurs on both leaves and branches. The majority of these fungi are saprophytes living on the dead parts of the white cedar. Only two fungi may be called disease-producing, viz., *Gymnosporangium biseptatum* Ellis and *Gymnosporangium Ellisii* (Berk.) Farlow.

The latter species, *Gymnosporangium Ellisii*, was first described by

---

[1] SYDOW, *Index Universalis et Locupletissimus Nominum Plantarum Hospitium Specierumque Omnium Fungorum*, 1898, p. 375.

Berkeley[2] as *Podisoma Ellisii.* Farlow[3] transferred the species to the genus *Gymnosporangium*, and gave somewhat in detail the external appearance of the witches' brooms caused by the growth of the fungus. It causes a fasciation of the smaller branches of the white cedar, which become more or less fan-shaped brooms. The external portion of the fungus is smaller and less gelatinous than in any other species of the genus. Sargent, in the *Silva of North America*, enumerates in a footnote (X, p. 100) the more important fungi that live on the true cedars, mentioning *Gymnosporangium Ellisii* (Berk.) Farlow and the following parasitic plant, *G. biseptatum* Ellis, as of most importance from a pathological standpoint.

HISTORICAL.

The fungus *Gymnosporangium biseptatum* was first described by Ellis[4] in the following words: "On branches of white cedar. Appearing in April, bursting through the epidermis in little reddish chestnut-colored velvet-like patches which, about the middle of May, pass into the tremelloid state, swelling out into gelatinous masses the size of large peas; not so distinctly foliaceous as in *G. juniperi.* Spores long pedicellate, mostly biseptate." Ellis, also in this place, referred to the appearance of the swellings produced by the fungus. Farlow[5] studied and described the fungus in a more thorough manner, but his account has largely to do with the botanical characters of the plant, the external appearance of the swellings and the variation of the spores. He referred in a casual manner to the fact that "the mycelium is found principally in the region of the cambium." Sorauer[6] described somewhat carefully in detail the life-history of the Gymnosporangia and their corresponding Rœstelia. As the basis of his remarks, he took *Gymnosporangium fuscum* and *Rœstelia cancellata*, described the botanical characters of both the teleutosporic stage and the æcidiosporic stage, and referred briefly to the other common species of the genus, viz., *Gymnosporangium clavariæforme*, *G. conicum*, *G. macropus*, *G. biseptatum*, *G. tremelloides*, *G. Ellisii.* Wörnle[7] inves-

---

[2] BERKELEY, *Grevillea*, III, p. 56.

[3] FARLOW, *Bulletin Bussey Institute*, II, p. 226: The Gymnosporangia or Cedar Apples of the United States, 1880.

[4] ELLIS, *Bulletin Torrey Botanical Club*, 1874, V, p. 46.

[5] FARLOW, The Gymnosporangia, etc., pp. 19-20.

[6] SORAUER, *Pflanzenkrankheiten*, 1886, II, pp. 232-239, taf. X.

[7] WÖRNLE Anatomische Untersuchung der durch Gymnosporangien-Arten hervorgerufenen Missbildungen. "Inaugural Dissertation." *Botanisches Centralblatt*, 1894, LX, pp. 280-283.

tigated more particularly the pathological symptoms produced in the host plants by the European species of *Gymnosporangium*, viz., *G. juniperinum*, *G. clavariæforme*, *G. sabinæ*, and in a general way, with imperfect material at his disposal, the pathology of the American species of *Gymnosporangium*, viz., *G. Ellisii*, *G. biseptatum*, *G. clavipes*, *G. macropus*. He investigated the changes produced in the bast, the cortex and the wood of *Juniperus nana* and *J. communis* by *Gymnosporangium juniperinum* (*conicum*); of *J. communis* by *G. clavariæforme*; of *J. sabina* by *G. sabinæ*. He investigated in a most general manner the disease conditions induced by the American species of this genus of fungi. Hartig[8] described the botanical characters of the following species of *Gymnosporangium*: *G. conicum* (*juniperinum*), *G. clavariæforme*, *G. sabinæ* (*fuscum*), *G. tremelloides*. Frank[9] described in a general way the botany and pathology of *Gymnosporangium fuscum*, *G. confusum*, *G. clavariæforme*, *G. conicum*, *G. Ellisii*, *G. macropus*, *G. biseptatum*, *G. clavipes*, *G. globosum*, *G. nidus-avis*, *G. Cunninghamianum*. Plowright[10] obtained some unexpected results by cultures made with the teleutospores and æcidiospores of the three European species of Gymnosporangia, viz., *G. clavariæforme*, *G. conicum*, *G. fuscum*, enlarging materially the list of plants upon which the Rœstelia of these plants are found. Thaxter,[11] by numerous culture experiments, succeeded in most cases in working out the life-histories of the American species of the genus *Gymnosporangium*, by connecting the æcidial stage on rosaceous plants with the teleutosporic stage on various coniferous trees. Sanford[12] studied the structure of the twigs of the red cedar with reference to the formation of the cedar apple. He made a detailed microscopic study of the cedar apple swelling, the spores and the spore-bearing filaments. A brief mention of these articles is sufficient to draw attention to the fact that very little work has been done on the pathological conditions produced by the American species of *Gymnosporangium*.

---

[8] HARTIG, *The Diseases of Trees* (English translation), 1894, p. 157.

[9] FRANK, *Die Pilzparasitären Krankheiten der Pflanzen*, 1896, II, pp. 176-184.

[10] PLOWRIGHT, British Heterœcious Uredines, *Journ. Linn. Soc. Bot.*, 1888, XXIV, p. 93.

[11] THAXTER, *Bot. Gaz.*, 1889, XIV, p. 163; *Conn. State Exper. Stat. Report*, 1891, p. 161.

[12] SANFORD, *Annals of Botany*, 1887, I, p. 263.

The attention of the writer was drawn to the swellings a year or two ago, while botanizing in the coastal plain of New Jersey. Specimens of the swellings caused by the two fungi were collected in a cedar swamp at Island Heights Junction, N. J. Both the fanlike growth of the younger branches and the larger knotty growths on the older branches and the trunk of the trees were met with in this cedar swamp. The large knob-like swellings, a foot or more in diameter, girdling the trunk of large trees, were seen in a cedar swamp at Newfield, N. J.

METHODS.

Sections of the swellings caused by *Gymnosporangium biseptatum* were made by means of a plane. The smaller sections were mounted in the usual way on slides, and the larger sections were mounted on window glass with thinner pieces of white glass as covers, and these preparations were then placed over a steam radiator until the balsam was perfectly dry and hard. The covers were kept in place during the drying by spring-clip clothes pins, which suited the purpose admirably. Bismarck-brown, aniline-green and an admixture of acid-fuchsin and methyl-green were used with satisfactory results in the demarcation of the tissues.

APPEARANCE OF THE SWELLINGS.

The swellings produced by *Gymnosporangium biseptatum* Ellis are quite characteristic. The disease may appear on trees which are from five to six feet high, with stem about an inch in diameter. In these young trees the swelling surrounds the whole stem, being about three inches long and approximately spindle-shaped (Pls. XXII, XXIII, figs. 1, 2, 3, 4, 5). The bark is deeply fissured by longitudinal cracks, which are also somewhat wrinkled at the bottom (fig. 3). In a stem three-eighths inch diameter, the wood involved is quite sound, although in dried specimens of a more decided yellow color than the wood of the stem below, which is whitish in color. As the mycelium of the fungus is perennial, these club-shaped enlargements keep constantly increasing in length and diameter from year to year. In another somewhat larger specimen studied, the burl reaches a diameter of an inch and a half and is about six inches long. The fissures become much deeper, due to the abnormal formation of the cork, until on one side of the stem the barky ridge is one-half inch high, the groove being correspondingly deep. These ridges of bark covered with small lichens give to the swelling an extremely rough, cancer-like appearance (fig. 5). The wood assumes a brownish aspect and the annual rings, as seen by the naked eye, are more or less wavy. Occasionally the malformation appears as an enlarged excrescence. It would seem that this excrescence began its growth upon a young lateral branch, which afterward ceased its elongation and was covered up by the enlarging fungus-infested mass of wood. The burls are about three inches long and about two inches wide, with the bark fissured into deep grooves with rather broad corky flakes. The wood to the naked eye resembles in appearance the well-known curly or bird's-eye maple. In another specimen examined, the swelling seven inches long involves the main stem and one of its branches, so that the swelling, which is fissured in the characteristic way and two inches in diameter, may be said to have forked.

The swellings produced by *Gymnosporangium Ellisii* Berk. are confined to the smaller twigs and branches. Near the summit of young white cedar trees where the branches grow upward, and are thus more or less crowded together, all of these branches may be involved (fig. 8). The result is the formation of fan-shaped mass of swellings, which assume a fasciculate character when closely crowded. The trees attacked by it may, therefore, be recognized, even at a considerable distance by the peculiar distortions, which consist in a dense fasciculation of the smaller branches in different parts of the tree, so that, viewed from a distance, one sees closely branching tufts of a corymbose outline, which appear to terminate some of the branches (fig. 8). On one lateral branch of white cedar, one-half inch in diameter, twelve smaller branches were all massed together into a witches' broom. The external appearance of the bark on these branches is somewhat different from that described for *G. biseptatum*. Here the bark is fissured transversely. With a few longitudinally directed cracks the reddish-brown bark is thus divided into a number of plates, rectangular in shape (fig. 8). The smaller twigs are not thus affected, but instead have a somewhat rugose continuous surface. One or two of the branches involved by the fungus are dead. The swellings differ also from those formed by the preceding fungal species in tapering gradually from the basal end of the twig, where the swelling is largest, toward the distal end, where the growth merges with the normal diameter of the branch (fig. 8). The abnormalities on the lateral branches of two other young trees of white cedar are marked, because the secondary branches have increased considerably in number and have assumed a fastigiate habit, radiating upward and outward from an approximately common point. As many as twenty small branches, all about six inches long, are to be counted in a single fastigiation (fig. 8). The surface of the bark in these specimens is raised into vesicular rougheninngs, which condition seems to precede the formation of the rectangular plates of bark by some interval of time.

NORMAL STEM STRUCTURE OF WHITE CEDAR.

According to Prof. Sargent,[13] "the wood of *Cupressus thyoides* is light, soft, not strong, close-grained, easily worked, slightly fragrant, and very durable in contact with the soil. It seasons rapidly and perfectly without warping or checking; it is light-brown tinged with red, with thin lighter-colored sap-wood, but grows darker with exposure, and contains dark-colored, conspicuous narrow bands of small summer-cells, and numerous obscure medullary rays. The specific gravity of the absolutely dry wood is 0.3322, a cubic foot weighing 20.70 pounds."

The sections, made with a hand-plane, were stained with three different stains, viz., methyl-green, Bismarck-brown and a mixture of methyl-green and acid-fuchsin used as a double stain. The histological details of the stem in an undiseased state are as follows: The pith of a twenty-one-year-old stem with wood three-eighths inch diameter is almost entirely absent. Its place is filled by the closely aggregated spiral tracheæ which compose the region known as the protoxylem. From this small contracted protoxylem radiate toward the cortex the primary medullary rays and the wedges of xylem. The medullary rays are numerous, but obscure. They consist in the cross-section of but a single row of thin-walled parenchyma cells which are six times longer than broad. The wedges of wood are narrow, their radial limits being defined by the medullary rays. The following table shows the variation in the size of the annual rings, as determined by a count under the microscope

---

[13] SARGENT, *Silva of North America*, X, p. 112.

of the number of tracheids in a single radial line, proceeding from the cambium to the pith. The striking feature in this enumeration of the tracheids is the uniformity of the growth (fig. 9). The diameter of the lumen and the thickness of the cell wall in nearly all of the tracheids of the spring and summer wood is very nearly the same in all of the annual rings of wood. This, and the fact that the annual rings are not clearly delimited by the naked eye, and in some cases even with the microscope, argues for an extremely uniform rate of growth. A uniform rate of growth presupposes environmental conditions of little variation.

TABLE I.

Number of Annual Ring.	Year.	Number of Tracheids.	Number of the Tracheids in the Autumn Wood.
21	1900	6	2
20	1899	10	3
19	1898	21	5
18	1897	18	5
17	1896	18	4
16	1895	15	5
15	1894	12	3
14	1893	6	1
13	1892	16	5
12	1891	12	4
11	1890	15	4
10	1889	12	5
9	1888	9	3
8	1887	6	2
7	1886	7	2
6	1885	10	3
5	1884	9	2
4	1883	10	5
3	1882	6	3
2	1881	7	3
1	1880		

The factors which influence the growth of the tree and the formation of the wood are, therefore, fairly constant during the growing season, and it is not until near the time of the cessation of growth that a few tracheids of thick walls and narrow lumen are laid down as autumn wood. We would expect just such influencing environmental conditions in a sphagnum bog.

Conditions Influencing the Growth of White Cedar and its Parasitic Fungi.

The temperature of sphagnum bogs is well known to be low, and the expression cold bogs is frequently met with in the descriptions in the manuals. European students of bogs consider the low temperature as due to evaporation from the surface of the sphagnum which grows in the bogs, but this seems altogether inadequate to explain the phenomenon. Ganong[14] supposes it to be due rather to a persistence of the winter cold, which in such a non-conducting mass would last through the summer. In this explanation the writer entirely agrees with Prof. Ganong, although in New Jersey the winter cold does not persist throughout the entire summer. One would expect this from the more southern position of New Jersey, as compared with the northern latitude of New Brunswick, there being a difference of six degrees of latitude between the two stations. The difference in latitude hardly expresses the difference in climate, because of the exposure of New Brunswick to the descending polar currents. "It is easy to test these two hypotheses; for if the former be true there should be little change in the temperature conditions after the summer average is once attained, or even the bog might be somewhat lower in temperature when the season is hottest, and hence evaporation most active; if the latter be true the bog should steadily rise in temperature through the summer." Ganong took the temperature of the bogs studied by him and found that there was a perceptible rise of temperature during the summer, the temperature rising in two months an average of 2° at one foot under the surface. The same author found on July 1, near the centre of the bog observed by him, sheets of ice six to eight inches thick and several feet square about a foot under the surface.

All of these facts are of interest in connection with the character of growth of the white cedar. The persistence of the uniform temperature, *i.e.*, the slow heating up of the soil and water of the swamps, regulates to a remarkable degree the character of the annual rings of wood. With rapid growth in the wet spring, ordinary dicotyledonous trees, as a rule, have well-defined spring elements with usually wide open lumen. As the summer advances

---

[14] Ganong, Upon Raised Peat Bogs in the Province of New Brunswick, *Transactions of the Royal Society of Canada*, 2d Ser., III, p. 151.

and the soil becomes drier and warmer, the xylem elements become thicker walled and the lumen smaller, forming the so-called autumn xylem. Where the spring growth is delayed until growth fairly commences and where the soil and ground water temperature remain almost constant, the tracheids approach a uniform thickness and size. The annual rings are consequently not well characterized, and it requires in many cases a microscopic examination to determine the limits of the rings of wood annually laid down. We have in the white cedar, *Cupressus thyoides*, of the New Jersey bogs an exemplification of this character of ill-defined annual rings due to the influence of the uniform condition of growth. The question may be asked at this point, Why this digression ? The answer is, the whole question of growth has a very important bearing on the entrance, growth and spread of the fungi which cause the disease conditions about to be described.

It may be well here to preface the discussion of the diseases produced by the two species of Gymnosporangia by referring to a case described by Ward[15] which is apropos. The larch disease is due to the ravages of a fungus, *Dasyscypha Willkommii*, the hyphæ of which obtain access by wounds to the sieve tubes and the cambium of the stem, finally producing a cankerous malformation. The larch fungus is to be found on trees in their alpine home, but there it does very little damage and never becomes epidemic except in sheltered regions near lakes and in other damp situations. "How then are we to explain the extensive ravages of the Larch disease over the whole of Europe during the latter half of this century ?" Ward asks. "In its mountain home the Larch loses its leaves in September and remains quiescent through the intensely cold winter until May. Then come the short spring and rapid passage to summer, and the Larch buds open with remarkable celerity when they do begin—*i.e.*, when the roots are thoroughly awakened to activity. Hence the tender period of young foliage is reduced to a minimum, and any agencies which can only injure the young leaves and the shoots in the tender stage must do their work in a few days, or the opportunity is gone and the tree passes forthwith into its summer state. In the plains, on the contrary, the Larch begins to open at varying dates from March to May, and during the tardy spring encounters all kinds of vicissitudes in the way of frosts and cold

---

[15] Ward, *Diseases in Plants*, 1901, p. 152.

winds following on warm days which have started the root action—for we must bear in mind that the roots are more easily awakened after our warmer winters than is safe for the tree. It amounts to this, therefore, that in the plains the long-continued period of foliation allows insects, frost, winds, etc., some six weeks or two months in which to injure the slowly sprouting tender shoots, whereas in the mountain heights they have only a fortnight or so in which to do such damage."

May we not have a parallel case in the retarding influence of the conditions which surround the white cedar in its boggy home, and which influence is reflected in the structure of the annual rings of wood already alluded to and the development of the disease about to be described?

ADDITIONAL FACTS CONCERNING THE NORMAL STRUCTURE OF WHITE CEDAR STEMS.

Before beginning the pathological description, it may be well to say a few more words concerning the normal structure of the stem. The woody tracheids are elongated and marked with bordered pits in their radial walls. The bordered pits are large and well defined, both in the radial longitudinal section and in the transverse section. Resin canals (fig. 11) are entirely absent from the wood, and in this the general resemblance of the xylem of the white cedar to that of the pine ceases. The absence of a well-defined pith in *Cupressus thyoides* is also noteworthy. The phloem or bast region of a twenty-one-year-old stem consists of alternate concentric rings of hard and soft bast. The hard bast consists of bast fibres with thick chromophobic[16] walls and obsolete lumen. The bast fibres are arranged in a single layer of cells in each of the annual rings of bast elements. Alternating with these are the soft bast layers, the layer latest formed being found next to the wood cambium. Numerous large circular and elliptical resin canals are found in the phloem region, breaking the continuity of the rings of hard and soft bast (fig. 11).

A stem forty-one years old shows essentially the same structure with some differences in the cortical region. The same uniformity in the size of all the tracheids is noticeable, there being no sharp

---

[16] A term proposed by Montgomery to describe the walls and protoplasm of cells that are refractory to stains.

delimitation of the annual rings of wood. An enumeration of the tracheids in a single row from pith to cortex is here given, as an expression of the relative size of each annual ring. The wood of the stem from which the enumeration is made is one inch diameter.

TABLE II.

Number of Annual Ring.	Year.	Number of Tracheids.	Number of Tracheids in Autumn Wood.
41	1900	6	2
40	1899	9	2
39	1898	10	3
38	1897	14	2
37	1896	9	3
36	1895	6	2
35	1894	8	2
34	1893	8	2
33	1892	9	3
32	1891	9	3
31	1890	11	3
30	1889	13	3
29	1888	11	4
28	1887	13	3
27	1886	18	3
26	1885	15	3
25	1884	22	4
24	1883	18	5
23	1882	10	3
22	1881	10	3
21	1880	7	2
20	1879	15	3
19	1878	18	4
18	1877	14	3
17	1876	16	3
16	1875	19	3
15	1874	16	3
14	1873	17	3
13	1872	10	3
12	1871	13	2
11	1870	11	3
10	1869	11	2
9	1868	16	3
8	1867	16	3
7	1866	11	2
6	1865	21	4
5	1864	27	4
4	1863	22	3
3	1862	47	4
2	1861	22	5
1	1860	18	4

The tracheids of the first three years of growth are more rounded in contour and their walls are thicker than those of subsequent years.

The phlœm of a forty-one-year-old stem differs materially from that of a twenty-one-year-old stem in the absence of strongly marked layers of bast fibres. Bast fibres are present, but they are not in continuous layers. Even with the high power, it is difficult to trace their continuity. The resin canals occupy a definite area, viz., midway in the phlœm. The medullary rays of the phlœm are continuous with those of the xylem, running out to the active cork cambium (fig. 12). True cortical parenchyma is entirely absent from such stems. The cork is in several well-marked zones or bands. These bands are separated from each other by the several layers of cork cambium. Seven well-marked layers of cork cambium are met with in this forty-one-year-old stem. The outer one is about to be pushed off by the sixth layer of cork. The innermost cork cambium lies against the outer rows of phlœm cells. Several old functionless resin canals are included in the mass of dead exfoliating bark. They are conspicuous as rounded or elliptical holes in the mass of cork cells. The external appearance of the bark of large trees is smooth than otherwise. It is usually from three-quarters of an inch to nearly an inch in thickness, light reddish-brown, and divided irregularly into narrow, flat connected ridges, which are often spirally twisted around the stem, and separated into elongated loose or closely appressed plate-like fibrous scales.

Pathological Considerations.

The pathological conditions which are followed by the striking increase in the size of the stems are of long duration, as evidenced by a microscopic examination of the swellings. The fight for supremacy, if such it may be called, is a long-drawn-out one. A section was made across the smallest stem canker which completely girdled the whole stem. It was found upon examining the abnormality that the same annual ring is not of a uniform thickness throughout, being thinner in some parts than in others. The rings are clearly much thicker than those of the normal stem. Sixteen rings in all were counted in the region of the canker. This increased width of the rings is due to an increase in the number of tracheids produced by the cambium. These tracheids, as well as the cells of the medullary rays, are usually of a greater diameter than the normal, which also accounts for the greater width of the rings formed at the canker. These observations agree with those of Anderson[17] upon the canker growth produced by *Dasyscypha resinaria*. The medullary rays of the swollen areas of the stem seem to increase somewhat in diameter. This increase of diameter is not due to the increase in the number of parallel rows of cells, but is due to the increase in diameter of the single row of parenchyma cells which is met with in the normal cross-section. These cells stain more deeply than the normal cells because of the granular contents. Further reference to this change of content in the medullary ray cells of diseased sections of the stem will be made with a description of the longitudinal section of the diseased regions.

If a number of tracheids in the annual rings of the swollen area of the sixteen years of growth be compared with the table displaying the number of tracheids in the annual rings of twenty-one years' growth, a wide difference is at once observable. The number of tracheids in the abnormal growth is clearly greater than in the normal one.

TABLE III.

Number of Annual Ring.	Year.	Number of Tracheids.	Number of Tracheids in Autumn Wood.
16	1900	31	4
15	1899	24	6
14	1898	49	4
13	1897	54	5
12	1896	39	5
11	1895	50	7
10	1894	40	5
9	1893	29	4
8	1892	42	5
7	1891	25	4
6	1890	26	7
5	1889	21	4
4	1888	20	4
3	1887	12	2
2	1886	10	3
1	1885	10+px.	3

---

[17] ANDERSON, ALEXANDER P., Dasyscypha resinaria causing canker growth on Abies balsamea in Minnesota, *Bulletin of the Torrey Botanical Club*, XXIX, pp. 23–34.

One of the most frequent results of the action of fungi is that of a stimulus given to cell division. Mention in this connection must be made of the swellings on the stems of silver firs, whose cortical tissues are infested by *Æcidium elatinum;* the increased growth of the cowberry through the attack of *Melamspora* (*Calyptospora*) *Gœppertiana*;[18] of the larch through the influence of *Peziza* (*Helotium*) *Willkommii.*[19] Still more frequently the infested parts are stimulated to display abnormal growths. Flowers and fruits of various species of plants are transformed in a most peculiar manner by fungi belonging to the genus *Exoascus.* The disease of the silver fir, however, caused by *Æcidium* (*Peridermium*) *elatinum* is the most appropriate one to compare with the canker knobs produced on the white cedar by *Gymnosporangium biseptatum.* The mycelium of this fungus, according to Hartig, is perennial in the cortical and bast tissues of the stem, and even penetrates the cambium and the wood. With the spread of the mycelium, the swellings or canker spots increase in size, and if present on the stem of a vigorous tree, they may attain to large dimensions. At such places the tissues of the cortex and bast become fissured and dry up here and there, as far as the wood, giving the whole exterior of the swelling a rough, shaggy appearance. The swellings resemble much in external character those described by the writer as occurring on the white cedar in New Jersey. Anderson[20] describes the changes produced in the cortex of *Abies balsamea* by *Dasyscypha resinaria* in the following quotation from his paper: " In the bark of the canker, the periderm as well as the primary cortex, and outer layers of the secondary cortex, are very soon cut off by the formation of a new phellogen layer. This causes the death of the cut-off layers of the bark, which dry up sooner than in the normal. The resin canals are also cut off and disturbed, and their resin contents begin to diffuse into the surrounding tissues, but mostly collect in the resin vesicles or 'blisters,' which are also formed sooner in the primary cortex of the canker than in the normal bark. The resin of the canker vesicles is forced out by the increased pressure on the vesicle, by the shrinkage of the surrounding dead layers of the bark, cut off by

---

[18] HARTIG, *Text-Book of the Diseases of Trees,* 1894, p. 161.
[19] HARTIG, *loc. cit.,* p. 120.
[20] ANDERSON, *loc. cit.,* p. 29.

the new phellogen. The resin thus forced out runs down the trunk of the tree, the more volatile substances evaporating, leaving the solid resin, which hardens and gives the trunk a glazed appearance easily seen at some distance from the tree." *Peziza* (*Dasyscypha*) *Willkommii* and *Æcidium* (*Peridermium*) *elatinum* cause similarly an increased growth of the cortex. In summer the growth of the mycelium of the former ceases and an unusually broad layer of cork is formed, for the protection of the tree, along the boundary between the sound and diseased tissues. Year by year the canker spot enlarges and the conflict between parasite and host plant may remain long undecided. Hartig found in the Tyrol larches still alive with blisters of a hundred years' standing. The second fungus, whose mycelium stimulates growth in a very marked manner, is perennial in the cortical and bast tissues of the stem, and even penetrates the cambium and the wood. The influence of the fungus is to induce the increased formation of the wood, but especially the more vigorous development of the cortex.

This account with reference to the increased activity of the phellogen (cork cambium), due to the fungi mentioned, describes in a fairly accurate manner the method of augmented growth in the white cedar caused by *Gymnosporangium biseptatum*. Four successive cork cambial layers have been developed in this sixteen-year-old stem, with the possibility of more that have been exfoliated. The newest phellogen has developed inside the phloem, cutting off from the more internal layers three concentric layers of hard bast. Not only has the hard bast been cut off from the inside of the stem, but also the resin canals, with, however, only a slight exudation of resin, the corky flakes remaining almost quite dry. The three outer cork cambia have only affected the primary cortex, and between these layers of phellogen the resin canals have expanded to their widest diameter. The layers of cork cambium take a somewhat sinuous course in running around the stem, so that they apparently loop in and out among the rapidly dying cells.

The hyphæ of the fungus live apparently in the cells of the wood cambium and those of the phloem recently cut off from the cambium. This is evidenced by a study of the cells. The hyphæ in cross-section occupy the lumen of the cells, for, in addition to the cellulose cell wall of the host, there are rounded or elliptical rings filled with granular matter (figs. 18, 19). These rings are the transversely or obliquely cut hyphæ which, by their presence, stimulate the cambium to increased activity. With the exception of these there seems to be no other attributable cause for the formation of the swellings, because the wood at this stage of the disease is free from all appearance of disintegration. It is, however, otherwise when the disease has progressed for some years. One remarks this on studying the sections of a canker that has progressed in development for some ten or more years. In all of the larger swellings studied by the writer, the cambium had been killed in a number of places. The dead spots vary in size in different cankers, but they seldom become confluent by extending completely around the stem or branch. When they meet so as to girdle the stem, the stem dies. More often the dead area is small, remaining about the same size for a number of years. The living cambium makes an effort to repair the damage, but this it is not able completely to do on account of the presence of the mycelium in the tissues. A cavity or pocket finally results at the dead spot with the increase in number of the annual rings (fig. 14). As with the disease of *Abies balsamea* described by Anderson, often several such cavities are formed when the cambium has been killed at more than one spot, and these cavities or pockets contain hardened resin. In the white cedar a comparatively small amount of resin collects, but in *Abies balsamea* the amount is quite considerable. In stems of white cedar that have been long diseased and that are dead above the swelling the brown bark cracks off, exposing the wood, the external surface of which is ventricose (fig. 14). The sap-wood of such badly diseased swellings has become porous, partly rotten and divided up into plates by the pores, the cracks or the fissures that abound. The heart-wood is still firm. Under the microscope this breaking down of the sap-wood does not seem to follow an absorption of the middle lamella of the cell wall by ferment action, but is due to a springing free of the lignified portion of the cell wall. Later the walls seem to break across and pieces of lignified cell wall, some U-shaped, some Y-shaped, hang free along the edges of the fissures thus formed. Here the disease has progressed to its fullest extent (fig. 32).

The hyphæ from the point of infection grow through the cortex and then spread vertically up and down through the phlœm. By the second year they have established themselves in the cambium and in its immediate neighborhood (fig. 18). The pathological conditions set up by these hyphæ have been described, but in addition to the increase of the bast and the wood, we have an increase in the number of cells in the cortex and the bark. The course of the hyphæ and their distribution throughout the swellings will be described more in detail. A brief mention at this point suffices to draw attention to them.

The Plugged Tracheids.

The wood of the abnormal regions of the stem shows in addition to the hyphæ brown-colored spots which are absent in stems of normal proportions. Without discussing at this juncture the nature and significance of these brown spots, which are due to the plugging of the tracheids, it is appropriate to discuss the distribution of the spots throughout the diseased regions of the stems. Plugged tracheids are found in the swellings with sixteen rings of growth, beginning with the fourth annual ring of wood. Here they are seen in the spring wood. Counting the number of such plugged tracheids in a half-circle of the fourth annual ring of wood and in the rings of successive years of the same stem, we obtain the following numerical statement:

Table IV.

Seasonal Wood.	Year.	Number of Plugged Tracheids.
	1	
Summer.	2	18
	3	23
Spring.	4	22
Spring and Summer.	5	32
Autumn.	6	18
Summer.	7	12
Spring and Summer.	8	11
Summer and Autumn	9	16
	10	
	11	
End of Spring.	12	10
	13	
	14	
	15	
	16	

An inspection of the table shows that in small swellings the plugged tracheids are confined almost entirely to the summer wood, and occur in largest number in the first six or eight years of growth. Very few are found in the annual rings subsequent to the ninth.

Older stem cankers show these plugged tracheids more plentifully from the first annual ring of wood laid down to the last one (figs. 16, 17). The larger excrescences have them in greatest number. The smaller excrescences are without them. At the point, however, where the tissues of the swellings join the main portion of the stem, these plugged tracheids are so numerous that they form well-marked concentric bands. The following statement roughly expresses the position and abundance of the plugged tracheids in the several annual rings of a swelling with well-marked excrescences.

Second Year Wood. Summer. Abundant, forming a compact circular zone.

Third Year Wood. Spring. Abundant, forming a loose zone.

Fourth Year Wood. Summer. Sparse, except one area where the plugged tracheids are closely aggregated together. At this point the ring is much narrower, taking a U-shaped bend inward. The autumn wood here is wanting. The fourth annual ring is, therefore, continuous except at this one point, where it becomes bent inward. Instead of the fifth year wood following this indented portion of the fourth year wood, it fills up the indented area with additional tracheids, so that at the end of the fifth year the course of the autumn wood again conforms to a circular outline.

Fifth Year Wood. Autumn. Sparse.

Sixth Year Wood. Late summer. Plentiful.

Seventh Year Wood. Summer. Autumn. A few plugged tracheids are found in the summer wood. More are met with in the autumn wood.

Eighth Year Wood. Late spring. The plugged tracheids are very abundant and in a definite circular zone.—Summer. Abundant in two circular zones. Late summer. Scattered.

Ninth Year Wood. Summer. Very few, but the plugged tracheids apparently become brown lines coterminous with the medullary rays.

Tenth Year Wood. Autumn. Abundant and occupying in a circular zone the region of the autumn wood. The same brown lines are traceable running out to the cortex.

Eleventh Year Wood. Late summer. Plentiful in a definite zone. A few in the autumn wood.

Twelfth Year Wood. Spring. In a definite zonal band, two or three tracheids deep. A few in the summer wood. A ring of scattered tracheids at the beginning of the autumn wood.

Thirteenth Year Wood. Whole year. Here the small excrescence began its growth. It is limited on both sides by dead tissue. The plugged tracheids form several circular zones both in the spring and summer woods. Three well-marked circular zones of plugged tracheids are clearly distinguishable, forming with their aggregation an almost continuous area involving most of the tracheids of the spring and early summer woods. Beyond the area with the largest number of these plugged tracheids occurs the small excrescence which has grown over the adjacent bark at the dead areas, producing a characteristic fissure. The disposition of these plugged elements in concentric rings in the several annual cylinders of wood is somewhat analogous to the disposition of the resin canals in *Abies balsamea*, diseased by *Dasyscypha resinaria*, as described by Anderson. This botanist finds that these are arranged in circular rows and in all cases follow the development of the above-mentioned fungus. According to the same author, Nottberg produced these resin canals experimentally in the wood and branches of *Abies pectinata* by fracturing the branches. The characteristic canal chains were formed in the wood near the fracture three months after the wound had been made.[21]

The phloem and cortex regions of the swollen areas are remarkable for the increase in the number of elements. The cork, hard and soft bast, representing the previous activity of the cambial layers, are pushed off more rapidly than in a normal undiseased area (figs. 13, 14). New layers of hard and soft bast are formed constantly by the wood cambium, and the noteworthy features of such phloem is that the bast fibres do not form so continuous a circle of growth, but are isolated in patches. The cells of the soft bast are more irregular in outline (fig. 13). The resin canals in such cross-sections are also more inconstant in outline. Some of them are large and of irregular shape; others are circular and small. The resin canals in the normal state are, as a rule (not always), elliptical in cross-section. Where the cortex of the excrescence

---

[21] ANDERSON, *loc. cit.*, p. 31.

meets that of the unmodified stem it is much reduced in width, and there are no cortical cells where, by the folding over of the swelling, forceful compression occurs. The bast fibres in transverse section are, as a rule, rectangular with rounded corners. The lumen has almost completely disappeared. In unstained mounts these elements have the luster of German silver. These fibres are more continuous in some places than in others. Their continuity is only broken by the cortical medullary rays.

Longitudinal sections of two swellings were studied. The swellings used to make the sections may be described as follows: The first one forms a burl-like outgrowth on one of the smaller lateral branches which had grown through the activity of the fungus very considerably in size, the end being rounded and clubbed. The other swelling represents a malformation of the main stem and a branch, a section of which is in general Y-shaped. The thicker part of the swelling represents the stem of the Y. These sections were stained with methyl-green. The normal tracheids are chromophobic. The bordered pits are well marked in all of the tracheids.

The plugged tracheids mentioned in the consideration of the transverse sections are well marked. They stain in general of a dark-green color, and the lumen seems to be enlarged and filled with granular contents. The ends of such tracheids are more rounded than the ends of normal ones. The cell-lumen is larger. The wall is more wavy and the course of the elements more irregular. In some of these plugged tracheids the contents seem to be more or less granular. These become dark-green in color by the use of the methyl-green. That these longitudinally directed plugged tracheids correspond to the brown spot referred to in the description of the several cross-sections is easily demonstrated by observing their course in the sections of lateral branches found in the longitudinal sections of the swellings. It is observable that the longitudinally directed tracheids filled with granular matter take a sharp bend and run into the branch, where they are seen in transverse section. The medullary ray cells also of such sections become deeply stained when methyl-green is applied. Tangential sections of the swellings show the medullary ray cells stretching across the tracheids in a gridiron fashion. The parenchyma cells of the medullary rays are long compared to their diameter. The ratio of 5 to 1 will express in an approximate manner the relative length and diameter of such parenchyma cells.

CONTENTS OF PLUGGED TRACHEIDS AND FILLED MEDULLARY RAY CELLS.

The Unverdorben-Franchimont reaction with copper acetate was used as a special reagent to determine the presence or absence of resins and terpenes.[22] It was thought that the material plugging the tracheids and filling some of the medullary ray cells might be of a resinous nature. The reaction is indecisive as to the material in the tracheids. An emerald-green color is produced by the copper acetate in the area of wood most affected by the fungus and where the active formation of the wood and bast took place. This green color is confined to the newly formed sap-wood and to the immediate neighborhood of the most active mycelial growth. The appearance of the emerald-green color indicates the presence of resin, and, in fact, in thin longitudinal sections of the wood of the stem at the swelling there is found a granular matter which stains a malachite-green. This material, which reacts to the copper acetate, occurs as a peripheral layer about the brownish matrix in the center of the filled medullary ray cells and the plugged tracheids, and this is most pronounced where the influence of the fungous parasite seems to be most marked. In some cases the green color indicates that whole medullary ray cells contain a resinous material. The contents of the resin canal cells of the phlœm and of the cortex react to the copper acetate, and the dried resin which occurs on the surface of and in the fissures of the bark becomes of a striking malachite-green color. These latter reactions confirm the Unverdorben-Franchimont test. The green color imparted to the wood is confined to patches and is not generally distributed. The brown material in general of the plugged tracheids and medullary ray cells is not influenced by the copper acetate. That this reaction seems to indicate the presence of resin in the most diseased areas and another fundamentally different substance is indicated by the fact that adjoining cells will have their contents colored emerald-green, while others will remain uniformly uncolored. In a transverse section of the area of wood stained green, the contents of the plugged tracheids (figs. 16, 17) still retain their brownish-yellow color. Notwithstanding these facts, one point seems to be definitely settled, viz., that the presence of the mycelium in the

---

[22] ZIMMERMANN-HUMPHREY, *Botanical Microtechnique*, pp. 90, 91.

sap-wood and cambium leads to the accumulation of resin, a brownish-yellow material which appears to be fungus gamboge, as indicated by the following test: A solution of ferric-chloride colors fungus gamboge olive-green or blackish-brown, and in the sections of white cedar so treated a decidedly blackish-brown color is obtained. The material in the tracheids is, therefore, named tentatively fungus gamboge. Besides this material, which seems to form the matrix, there are numerous small rounded grains which plentifully fill the medullary ray cells. These granules stain brown when iodine solution is used, green when methyl-green is used, and brown when Bismarck-brown is applied. The substances which then collect in the diseased stems of white cedar through the metabolic changes stimulated by the fungus mycelium are tentatively the following: Proteid bodies, in small rounded granules; resin, which is confined to the areas of stem undergoing the most rapid histologic changes; fungus gamboge, which with the other materials referred to fills the medullary ray cells and plugs the tracheids. Besides these, there are amorphous masses of substance in some of the medullary ray cells. These in the natural state are yellowish in color. When the sections are stained with methyl-green, these masses become green in color. It is impossible to state at this time what these amorphous masses really are.

With strong iodine solution the walls of the tracheids color a deep brownish-yellow, and this reaction is marked in both the longitudinal and the transverse sections.

The Mycelium of Gymnosporangium biseptatum.

A study of the mycelium yields some interesting results. These results become of importance when a comparison of the mycelia of the different species of *Gymnosporangium* is made with reference to their growth and duration. Farlow[23] briefly sketches the character of the mycelium in the American species studied by him. "The mycelium does not differ much from that commonly found in the other Uredineæ. It is irregular, much branched and cross partitions are rather numerous. Unlike, however, the mycelium of some of the Pucciniæ, that of the species of the present genus is limited in extent, and is not found throughout the whole of the

---

[23] Farlow, *The Gymnosporangia or Cedar Apples of the United States*, 1880, p. 10.

plant on which it is growing, but is confined to certain portions of the stems or leaves. The mycelium of most of the species is perennial—that is, the mycelium which has produced a crop of spores (figs. 29, 30) one year, will the next year, under ordinary circumstances, produce another crop in or near the same place.'' The explanation of the difference in the character of the different abnormal growths produced by the various species of Gymnosporangia is to be sought in the amount and extent of the mycelium, the rapidity of its growth and its duration. We have in a rapidly growing annual species, viz., *G. macropus*, a large, rather spongy excrescence, which shrivels in drying. The excrescence is more dense in the perennial species of slower growth, viz., *G. globosum*. The mycelium of *G. biseptatum*, according to Farlow, is comparatively limited in amount, and does not increase rapidly, and in consequence the formation of the annual wood layers is not prevented, nor the nutrition of the branches above much interfered with. The mycelium, as described by Farlow, is found principally in the region of the cambium, and acts rather as a stimulant than as a destructive agent. There is in *G. Ellisii* a more luxuriant and rapidly growing mycelium, which extends along the smaller branches and is abundant enough to interfere with the nutrition of the infected branches. The consequence is that the branches above become short and stubby, and at length densely fasciated. The branch below the fungus remains normal in character, so that instead of a nodose swelling we have a tuft of short branches borne on the end of a normal branch.[24]

With this brief résumé of the character of the mycelium in the different species of *Gymnosporangium* living in the wood of coniferous trees, it is important to make a more detailed study of the character of the mycelium and its relation to the cells of the host in *Gymnosporangium biseptatum*. Very little of a definite character can be ascertained by a study of the transverse section of the diseased wood of the white cedar. Here and there the cut ends of the hyphæ are seen, and occasionally the knuckle-like portion of one that is bent is seen in the cross-section (figs. 18, 19). The hyphæ, which are instrumental in stimulating the production of additional wood and bast, live in the cells of the wood cambium. This is evidenced by a study of the cells. The hyphæ in cross-

---

[24] See *ante*.

section apparently occupy the lumen of the cells, for, in addition to the cellulose cell wall of the host, there are rounded or elliptical rings filled with granular matter. The difficulty of clearly tracing the hyphæ in a cross-section is almost entirely removed by careful study of longitudinal sections. Such longitudinal sections reveal the following distribution of the hyphæ and their relation to the cells of the host:

The hyphæ are of a brown color, and can easily be traced by means of the contrast which this color affords to the colorless tracheids and to the medullary ray cells which have stained a bright-green color with methyl-green. The mycelium is not abundant, and if we imagine the host cells to be macerated away, leaving the mycelium, it would form a reticulum of large open meshes much in appearance like a coarse fish-net, only not so regular (fig 22). The hyphæ are variously curved, gnarled or knuckled (fig. 22). Their course is somewhat sinuous, or an undulate one, although in many cases the larger hyphal strands are perfectly straight. They occur in all parts of the wood of the swelling, and are associated in general with the plugged tracheids and the enlarged medullary rays, which contain the yellowish granular matter to which reference has already been made. The plugging of some of the tracheids in the several annual rings of wood with yellowish granular material and the enlargement and filling up of the medullary ray cells seems to be correlated with the presence of the mycelium. The tracheids and medullary ray cells distant from the strands of the mycelium are without these evidences of nutritive changes, followed by the filling of the cell cavity by the granular waste, or reserve (?) products. The hyphæ are marked by numerous transverse partition walls, and these are sufficient to indicate that the fungus belongs to the higher series of fungal types. Some of these hyphal cells are long and cylindrical. Others are shorter and more cheese-box-like in form.

Relation of Hyphæ to Host Cells.

The hyphæ grow into and through the medullary ray cells, and it is through these cells that the mycelium maintains its continuity from annual wood ring to annual wood ring. It is this growth through the medullary rays that accounts for the perennial habit of the fungus. At best the growth of the fungus is a slow one, as the hyphæ are nowhere abundant, and where they do occur they seem to grow with the tracheids. The evidence of intracellular growth is clear.[25] In one set of medullary ray cells a hypha is found which forms an enlargement against a transverse partition wall before penetrating it by secretion of a ferment (fig. 22). Fortunately for clearness of observation, the end walls of two adjoining cells are slightly separated, leaving a lens-like intercellular space (fig. 23). Through this space the hypha, contracted to a narrow thread-like bridge, is seen to pass, enlarging again on the other side (fig. 23). The hypha which thus penetrates the cell wall passes to the other end of the same medullary cell, where it enlarges into a knob-like extremity (fig. 23). It, however, gives rise to a branch in the middle of the medullary ray cell. This branch grows out transversely by means of a bordered pit into the lumen of a wood tracheid, through which it runs to the next medullary ray lying parallel to the first. Here a new branch is found at right angles to its former course through the tracheid, which enters a medullary ray cell. This branch in turn produces another one at right angles to itself, and this again another one which runs into new medullary ray cells. The description of the course of this hypha, which is clearly traceable in the longitudinal section of the swollen stem, epitomizes the course of practically all of the hyphæ studied in the several longitudinal sections. The hyphæ enter the longitudinally directed wood tracheids through the path of least resistance, viz., through the membrane of the bordered pit (figs. 24, 24*a*, 25, 26). In several instances this mode of exit and entrance is clearly traceable in the sections. By following the course of a hypha through the lumen of a tracheid it is found suddenly to dip down at the pointed extremity of the tracheid, opposite to the last bordered pit, and after disappearing from focus it again appears in another tracheid. By carefully focusing it is demonstrated that the hypha passes through the bordered pit, and after taking a U-shaped bend it appears again on the original level in another tracheid (fig. 22).

The mycelium does not show any relationship to the nuclei of the host cells, such as has been demonstrated to be the case with the

---

[25] Farlow found in *G. macropus* the mycelium in the leaves where there are haustoria [*sic*] which enter the parenchymatous cells. The fact that the mycelium grows in the leaves and not in the stem may account for this difference in growth.

hyphæ of endotropic mycorhiza. Groom[26] and Magnus[27] have both worked upon this problem, and both botanists have shown that in the case of the hyphæ of mycorhiza fungi they enter a cell because they are attracted thither by a chemotropically active substance and grow toward the nucleus, because that substance is present there in optimum proportions. These investigators conclude that the chemotropically active substance attracts the hyphæ and is manufactured in the cell infected, and particularly in the vicinity of the nucleus of that cell. No clearly defined relationship of this kind is discoverable in the medullary ray cells of the white cedar. The hyphæ run straight through many of the cells without deviating from their course.

This distribution of the mycelium in *G. biseptatum* seems to be similar to the distribution of hyphæ in *G. Ellisii,* as described by Farlow. The mycelium of this species, according to Farlow, is of rather large size and in cross-sections of the stem is seen to follow the medullary rays, sometimes extending nearly to the center of the stem, and occasionally forming partial circles between the annual rings. The greater part of the mycelium in *G. Ellisii,* according to Farlow, is found near the cambium, it collects in masses in the bark to form the sporiferous bodies which originate at some little distance beneath the surface.

MYCELIUM OF GYMNOSPORANGIUM ELLISII.

The mycelium of *Gymnosporangium Ellisii* is more copious than that of *G. biseptatum*, and its activity seems to be more marked in producing pathological changes in the tissues of the host. It may be traced in both radial and tangential longitudinal sections to the best advantage. The development of the hyphæ of the mycelium in the sections studied by the writer is in a longitudinal rather than in a transverse direction (fig. 24). The main hyphæ of the mycelium are longitudinal ones, and these anastomose with each other by the formation of short hyphæ developed at right angles to the longitudinal ones. The course of the main hyphæ is approximately a straight one, although of necessity there is some

---

[26] GROOM, On Thismia Aseroe (Beccari) and its Mycorhiza, *Annals of Botany*, IX, pp. 327–360.

[27] MAGNUS, WERNER, Studien an der endotrophen Mycorhiza von Neottia nidus-avis L., *Jahrbücher für wissenschaftliche Bot.*, 1900, p. 205.

bending from a straight line as they run from tracheid to tracheid (fig. 25). Some annual rings are noted for the considerable number of hyphæ present. Others are marked by the small number and weak development of the hyphæ. The color of the hyphæ is an umber-brown, practically the same as that of the hyphæ of *Gymnosporangium biseptatum*. Occasionally hyphæ in *G. Ellisii* are found that are yellowish-brown in color. The hyphal strands are characterized by the well-marked transverse partitions, which are evident even under the low power of the microscope. It may be remarked here that the general course of the mycelium can be clearly followed by the low power alone. The mycelium is more abundant in the cortex and comparatively less abundant in the xylem. Some peculiarities of structure of the hyphæ of this species easily differentiate it from *G. biseptatum*. The hyphæ of *G. Ellisii* form, as revealed by the high power of the microscope, a somewhat irregular reticulum (fig. 24). These hyphæ are characterized by the presence of larger or smaller nodose or ventricose hyphal cells (figs. 25, 26, 27), which are found in considerable numbers in the length of each hyphal strand. These swollen or enlarged cells are found most frequently in the irregular intercellular spaces, filled with brownish material produced by the pathological changes induced in the host by the growth of the fungus. Occasionally these ventricose hyphal cells are found as lateral branches of the main longitudinally directed hyphæ. Their shape may be spherical, ellipsoidal, oblate-spheroidal, napiform or fusiform (figs. 25, 26, 27). They are of the same umber-brown color as the other unenlarged hyphal cells, and are most numerous in the cortical region and in the aforementioned pathological areas filled with brown material.

Relation of Hyphæ of G. Ellisii to Host Cells.

The course of the hyphæ in the stem may be briefly described as follows: The straight hypha runs through the lumen of the tracheid until it comes to a bordered pit which lies in the direction of its growth (figs. 24, 24*a*). This bordered pit is entered, and by a solution of the middle lamella of the cell wall at this point it crosses to a neighboring tracheid, when it again takes a longitudinal direction. Sometimes two or three tracheids are crossed by the hypha before it again takes an up-and-down course (fig. 24).

The hypha, as it passes through the area of the bordered pit, enlarges to fill the space formed when the middle lamella of the cell wall at this point is dissolved by ferment action (fig. 24*a*). The hypha at this point, therefore, becomes in shape like a double convex lens. Again, a hypha that runs in general longitudinally in the tracheids may leave these and enter a medullary ray cell, where it courses transversely, enlarging meanwhile in the medullary ray cell and giving off short rounded branches which may be called tentatively haustoria. A hypha that enters a tracheid in one direction may form two branches, one a short, lateral, downward-directed branch that ends in one of the large ventricose cells (fig. 27) to which reference has been made, and another branch which runs to the end of the tracheid and leaves it through a bordered pit to enter another tracheid. Another hypha runs lengthwise until it comes opposite to the pointed end of another tracheid, where a row of five bordered pits is seen in transverse section. For each of these bordered pits the longitudinal hypha gives off a branch (figs. 24, 24*a*). Each branch thus formed swells in the space of the bordered pit to form a lens like enlargement before the branch enters the contracted lumen at the pointed end of the other tracheid. All of these appearances are illustrated in the annexed figures (figs. 24, 24*a*, 25, 26, 27, 28).

The course of the hyphæ in the areas of stem that have been transformed pathologically into a broken-down mass of a brown color, forming pockets throughout the wood, is more irregular. Here the hyphæ forming the mycelium bend and twist about, now forming an enlarged ventricose hyphal cell, and again producing such a swollen cell as the termination of a short lateral branch. Short stubby branches are also formed in the course of these same hyphæ, consisting in most cases of a single short cell. The hyphæ of these brown areas have also increased considerably in diameter, being much thicker than those of the mycelium which grows in the tracheids. The larger hyphæ are found in the cleft-like intercellular spaces and grow in and out between the dead and broken-down cells, as well as through the resin-like substance which fills the pockets to which reference has been made above.

The hyphæ in the smaller transverse sections of the diseased stem are also clearly traceable. They are seen as purplish-brown rings in the lumen of the tracheids (figs. 20, 21). Several adjacent tracheids will have hyphæ coursing through them, and occasionally two or three hyphæ are met with in a single tracheidal cavity. Where these hyphæ, by branching, cross transversely other tracheids, they are observed in cross-sections of stem as short threads, or as U-shaped or V-shaped elements of a purplish-brown color. Whenever these hyphæ in their branching enter one of the brown areas with cleft-like cavities, they grow through the brown mass, enlarging meanwhile in diameter, and grow out into the cleft, where they branch and rebranch in an irregular manner, swelling here and there into the nodose or ventricose cells referred to above (fig. 27). Occasionally the hyphæ are found growing outward through the medullary ray cells, but this seems to be the exception rather than the rule. This fact affords another of the characters of the mycelium of *G. Ellisii* which differentiates it from that of *G. biseptatum*, also found on the white cedar.

The distribution of the tracheids containing the hyphæ, disposed as above described, is for a transverse section of stem seven years of age, as given in the accompanying table. The number of tracheids in which hyphæ are found is estimated for one-half of each annual ring. The widest annual ring is that of the third year, and this increased width is closely correlated with the diseased condition of the stem for that year:

TABLE V.

Number of Annual Ring.	Year.	Number of Tracheids.	Number of Tracheids in Autumn Wood.	Number of Tracheids with Hyphæ ½ Annual Ring.
1	1894	22	2	13
2	1895	16	3	6
3	1896	30	4	26
4	1897	10	3	17
5	1898	9	2	34
6	1899	5	1	21
7	1900	5 (?)		12 (?)

The brown areas are by far the largest and almost confluent in the third annual ring of wood, and therefore only four continuous radial strips of healthy xylem are to be found in the growth of the third year. The enumeration for the seventh year is incomplete, because the stem was dead along the radius of stem chosen for the computation of the tracheids.

The mycelium in the cortex is well marked. The hyphæ grow both into and through the cortical cells, and are found in the larger and smaller intercellular spaces. Their direction of growth is less definite than in the wood, and they, therefore, form a complex of twisted and curved hyphæ which run apparently through the medio-cortex in an indefinite manner. The rounded enlargements of the hyphal cells above mentioned are also found.

PATHOLOGICAL CONDITIONS OF STEM INDUCED BY THE MYCELIUM OF G. ELLISII.

The pathological condition of the stem of white cedar induced by the parasite are very different from those produced by the mycelium of *G. biseptatum.* It may be stated at the outset that the diseased conditions are much more severe when the mycelium of *G. Ellisii* is the pathological agent, although the swellings never become so large and globose as those formed by the stimulating influence of the mycelium of *G. biseptatum.* The witches' broom-like character of the malformations caused by *G. Ellisii* have already been described (figs. 6, 8). Observations in the field, after part of this paper had been written, reveal some characteristic features of the disease not mentioned then. The disease, except in young trees, seems if it attacks older trees, to be confined to the short lateral branches of the trees, as they form a pure growth in the cedar swamps of New Jersey. Sometimes all of the larger branches from the lower part of a tree to the top will be fasciated. The branches live for a long time before death finally ensues, and they consequently have a gnarled and knotted appearance which gives to a large tree badly diseased an unsightly appearance. Birds, such as the fish crow, take advantage of the flattened, closely crowded condition of the branchlets to build their nests under cover of the dense and crowded mass of leaves which forms a closely set crown of foliage (fig. 6). The photographs of diseased lateral branches (figs. 6, 8), one of which supports a nest of the fish crow, show the general appearance of the disease when it has progressed to the point of involving the whole branch.

In the seven-year-old stem above described the wood is badly broken down, and in place of the healthy tracheids there are irregular wedge-shaped masses of a rich brown color, consisting of the broken-down cells, a mass of hyphæ and a yellowish-brown matrix formed as a waste product by the host cells that are attacked by the fungal parasite. These masses of dead tissue proceed radiately outward. Their inner side is more or less evenly rounded and conforms to the general concentric arrangement of the annual rings (fig. 31). Their outer edge is more or less irregular, as the disease progresses by proceeding outward along the wedges of wood between the medullary rays (fig. 31). These diseased areas may become more or less confluent as the pathological tissue increases in amount by the spread of the fungus antagonistic to the host (fig. 31). Where these wedge-shaped brown areas touch the cortex the cortical cells become involved, assuming a darker, richer brown color with the death of the cells attacked. As these brown patches increase in size, the hyphæ which have grown out into them keep pace with the dissolution of the healthy tissues, until, as before mentioned, they form a complex of considerable extent.

The breaking down of the tracheids begins much in the same manner as in the disease of the white cedar induced by *G. biseptatum*, but the final result is different. The same springing loose of a part of the lignified cell wall is observable (fig. 32). When two adjacent tracheids have been thus affected, the middle lamella is dissolved away and a cavity, two tracheids in diameter, is formed. If three or four adjoining tracheids are involved, the space becomes larger (fig. 33). These spaces are filled with a brown residual material, and by the confluence of a number of smaller brown diseased areas the wedged-shaped diseased spots are formed, which later become fissured by the appearance of crack-like intercellular spaces. In older stems, the appearance of the diseased brown areas and the increase in width of the annual wood-rings seem to be correlated. The fifth and sixth annual rings in a stem eleven years old seem to be most involved, and here, with the exception of one small unaffected patch of tissue, the brown tissue forms a continuous band of variable thickness and pathological appearance about the stem. The spring wood of the sixth year here seems to be most involved. From this ring arms of diseased wood radiate out through the seventh, eighth, ninth, and on one side of the stem to the cortex through the eleventh and last annual ring of wood. An enumeration of the number of tracheids in a radial row from the fifth outward is presented in tabular form, as showing the variation and increase in size of the several annual rings of wood in the abnormally developed tissues of the stem. The variation in the size, shape and color of the tracheids is a peculiarity of the twelve-year-old stem studied. These variations are most marked in the fourth and the eighth annual rings. The tracheids of the fourth annual ring of wood are thicker than the normal, and of a decided yellow color. Those of the eighth annual ring are decidedly variable in shape. Some of the tracheids are circular in cross section, others are elliptical, while others are rectangular and more or less irregular. This departure from the normal structure of the tracheids is directly traceable, the writer believes, to the stimulation produced by the presence of the fungus in the tissues of the host plant.

TABLE VI.

Number of Annual Ring.	Year.	Number of Tracheids.	Number of Tracheids in Autumn Wood.
1	1889	7+px.	2
2	1890	7	1
3	1891	9	2
4	1892	29	3
5	1893	21	3
6	1894	23	5
7	1895	27	4
8	1896	32	5
9	1897	28	5
10	1898	33	5
11	1899	16	3
12	1900	22	3

A comparison, however, of the width of the several annual rings of older and younger stems shows that the increase in the number of tracheids is marked, especially in the immediate neighborhood of the hyphæ. There is, however, not that marked increase which is noted for the stems abnormally swollen by the action of the mycelium of *Gymnosporangium biseptatum*. The same brown patches of pathological tissue are seen in branches an inch and a quarter in diameter. Here, if the disease is confined more especially to the smaller branches, the brown areas are more rounded and appear as isolated brown specks when a cross-section is made. The smaller branches, if early infected, are more badly diseased, as evidenced by the larger size and confluent condition of the dead tissues, than the heavier branches, if infection takes place after the branch has reached considerable size. The writer has no evidence that the disease spreads down into the wood of the older portion of the branch from the smaller branches by the longitudinal growth of the hyphæ, although it is within the range of probability that this downward growth does take place.

Concluding Remarks.

That the metabolic activities of the cells invaded by the mycelia of the two parasites above described are changed from the normal condition is proved by the accumulation of material in the tracheids and medullary ray cells influenced by the presence of the fungi. The nature of these accumulated substances has already been discussed. Not only are the metabolic activities of the host cells altered, but the cambium in which the mycelia lives is stimulated to increased divisional activity, and this stimulation may exert itself to some distance. Townsend[28] has shown that "the influence of an irritation, due to cutting or other injury, is capable of acting through a distance of several hundred millimeters." It would seem, therefore, that plants that are victims to parasitic fungi may possibly be influenced as if they were wounded. How this increased activity of the host cells expresses itself in the increase in the amount of wood and bast has already been discussed. It appears that the fungi perennate in the wood of the canker, forming there a loose open reticulum, much like a coarse fish-net, and that they cause an alteration in the activities of the cells, obtaining for themselves thereby a sufficient amount of food for continued slow growth. The hyphæ which are instrumental in the formation of the swellings clearly reside in the wood cambium and adjacent soft bast cells, being able to draw upon the supplies of that part of the mycelium which has lived longest in the stem. It appears then that the mycelium of the wood was once as active as the mycelium of the cambium, and that as the permanent tracheids and medullary ray cells were formed the walls of the hyphæ increased

---

[28] Townsend, The Correlation of Growth Under the Influence of Injuries, *Annals of Botany*, XI, pp. 509–532 (1897).

correspondingly in thickness, and maintained for some time a slow growth through the wood and medullary ray cells.

We have these changes in the structure and metabolism of the cells of white cedar paralleled by examples recorded by other botanists. Halsted[29] states that " one of the most striking instances of starch localization is found in the leaves of ordinary corn that are infested with the smut (*Ustilago maydis* D.C.). Pieces of leaves that were more or less distorted by nodules and projections of the smut-bearing tissue . . . . were placed in the iodine, when the blue color began almost immediately to appear in the swollen tissue." Again: " An interesting study in this direction was made of the cedar galls of *Gymnosporangium macropus* Lk., where the starch is packed away in the enlarged host cells to their utmost capacity, and thin sections through the centres of the large galls display a neat fan-shaped appearance after they had been in iodine for a few minutes. The ordinary wood of the gall-bearing twigs show with the same treatment only a small amount of starch." Other cases of this influence of parasite upon host might be cited, but the illustrations mentioned above sufficiently show that in most instances the effect is a marked one, not only altering the chemical nature of the cell contents, but also the activity of the process of cell division with the formation of additional tissue elements.

TABULAR COMPARISON OF THE SEVERAL SPECIES OF THE GENUS GYMNOSPORANGIUM.

In the table on pages 498–501 an attempt is made to present the characters of the several species of the genus *Gymnosporangium*, so that a comparison of the structure of these fungi can readily be made.

SUMMARY.

1. The white cedar, *Cupressus thyoides*, is a stately tree, ranging from southern Maine to northern Florida and westward to Mississippi, and is not subject to any very serious disease.

2. There are nineteen species of fungi that live, saprophytically or parasitically, upon this tree.

---

[29] HALSTED, Starch Distribution as Affected by Fungi, *Bulletin of the Torrey Botanical Club*, XXV, p. 573.

3. Only two species of fungi, viz., *Gymnosporangium biseptatum* Ellis and *G. Ellisii* Berk., may be considered as serious parasites.

4. Historically these two funguses have been studied largely from a morphologic standpoint, and not from a physiologic or histologic point of view.

5. Wörnle and Tubeuf give the most satisfactory accounts of the several known species of *Gymnosporangium* and the diseases produced by them.

6. The two diseases are prevalent in the cedar swamps of New Jersey, where *Cupressus thyoides* makes an almost pure stand of timber.

7. Sections of the swellings caused by the fungi were made by means of a hand-plane and stained with aniline-green, Bismarck-brown, and a double stain consisting of methyl-green and acid-fuchsin.

8. The swellings produced by *Gymnosporangium biseptatum* are usually nodose, increasing year by year, until they may be brain-like in appearance and six to eight inches in diameter.

9. Those produced by *G. Ellisii* are never so thick, but the branches involved radiate out in a fan-like manner, assuming the character and appearance of witches' brooms.

10. The normal stem structure is described as a means of throwing light upon the abnormal structures produced by the fungi.

11. The stem structure in general is that common to other conifers, but the resin canals are confined to the bast and cortex.

12. The number of tracheids produced normally in a radial line are set forth in tabular form, as an expression of the variation in size of the several annual rings.

13. The environmental conditions are shown to have considerable influence in determining the spread of the diseases.

14. Sphagnum bogs are cold because the winter cold persists well on into the summer.

15. This persistence of the winter cold retards the development of the tree each year until summer is well advanced, and this retardation, it is thought, is reflected in the uniformity in size of the tracheids, there being little well-marked autumn wood.

16. The retardation of growth, with the persistence of the winter's cold in the bog, also exerts an appreciable influence on the growth of the parasitic fungi, which cause the canker-like swellings on the white cedar.

17. It is assumed that the perennial habit and slow growth of the mycelia are direct expressions of the inhibitory effect of the cold environment.

18. In considering the pathological transformations, a comparison is instituted with the disease produced by *Dasyscypha resinaria* in *Abies balsamea.*

19. By means of a table it is shown that the number of tracheids in a swelling produced by one of the fungi is vastly greater than in a normal stem of the same age.

20. The increased activity of the phellogen is also a marked feature of the disease due to *Gymnosporangium biseptatum.*

21. Several additional well-marked layers of cork are laid down as a result of this activity of the cork cambium.

22. As the disease progresses these cork layers begin to slough off.

23. The formation of the excrescences through the death of the cambium in part, and the attempt made on the part of the host to repair the damage are minutely described.

24. Pathological changes in the wood due to *G. biseptatum* result in the plugging of the tracheids and the final cracking of the sapwood when the parasitic attack has been long maintained.

25. The number of plugged tracheids is shown by an enumeration to be extremely variable in the several annual rings of wood.

26. The material filling the plugged tracheids in the disease caused by *G. biseptatum* is supposed to be fungus gamboge, from a number of chemical reactions obtained for the purpose of deciding this question.

27. Resin is also present in the most diseased areas, as determined by the copper acetate (Unverdorben-Franchimont) reaction.

28. The mycelium of *G. biseptatum* is described as a loose net. The hyphæ penetrate the wood, cambium and phlœm cells, spreading longitudinally and horizontally.

29. The hyphæ in growing from tracheid to tracheid take advantage of the bordered pits, the middle lamella of which disappears by ferment action.

30. The relation of the hyphæ to the host cells is carefully described.

31. The mycelium of *G. Ellisii* is more copious than that of *G. biseptatum*. It also grows through the cortex, bast and wood.

32. The hyphæ of this fungus are characterized by the ventricose swellings produced, and by the fact that they grow into the intercellular spaces of the brown patches of diseased tissue formed in the wood.

33. The hyphæ of *G. Ellisii* grow through the lumen of the tracheids and from tracheid to tracheid by means of the bordered pits, much as in the other fungus described.

34. The distribution of the tracheids containing hyphæ is presented in tabular form.

35. The pathological conditions induced by *G. Ellisii* are more severe at first than those caused by *G. biseptatum*.

36. Patches of diseased tissue are found in the stems of white cedar as brown spots of a wedge shape. These brown areas become more or less confluent until they may involve the circumference of the stem. Into these brown patches the hyphæ grow.

37. An enumeration of the tracheids in the diseased branches is also presented in tabular form, as a means of comparing the size of normal and diseased stems.

38. The belief is expressed, in conclusion, that the fungi cause marked metabolic changes in the stem, accompanied by the accumulation of resins and other substances, products of increased cell activity.

39. A tabular comparison of the several species of the genus *Gymnosporangium* is presented to show the relationship of the fungi studied to other species of wide distribution.

40. The bibliography details the papers consulted in the preparation of this paper by the writer.

Name of Fungus.	*Gymnosporangium conicum* D. C. (*G. juniperinum* Winter.)	*Gymnosporangium fuscum* D. C. (*G. sabinæ* Winter.)	*Gymnosporangium Ellisii* Berk.	*Gymnosporangium clavipes* Cooke and Peck.
Host Plants.	*Juniperus nana*, *Juniperus communis*, *Juniperus virginiana.*	*Juniperus virginiana*, *Juniperus communis*, *Juniperus sabinæ*, *Juniperus oxycedrus.*	*Cupressus thyoides.*	*Juniperus virginiana.*
Habit of Fungus.	Long swellings in the branches.	Causing long swellings of the branches.	Fan-shaped fasciculation distorting the smaller branches.	Leaves and branches producing nest-like distortions.
Duration of Mycelium.	Perennial.	Perennial.	Perennial.	Perennial ?
Host Tissues Infected.	Tissues of the branches.	Wood and less frequently in the medullary rays.	Medullary rays forming partial circles in the annual rings. Largely in the cambium.	Leaves. Tissues swell to twice original size.
Character of Mycelium.	Much branched, somewhat knotted or balled.	Fine hyphæ, little branched, running up and down and in toward the center of the stem.	Collected in brownish spots. Extends along the branches a distance of 18 inches.	Abundant.
Sporiferous Masses.	Subpyriform, or indefinitely expanded. Orange colored. $\frac{1}{2}$ inch high.	Numerous, approximated, brownish when dry, dark orange when swollen. $\frac{1}{4}$-$\frac{1}{2}$ inch high.	Numerous, cylindrical, filiform. Orange colored. $\frac{1}{4}$ inch high.	Subpyriform, irregularly globose, then indefinitely expanded. Orange. $\frac{1}{4}$ inch high.

Gymnosporangium nidus-avis Thaxter.	*Gymnosporangium clavariæforme* D. C.	*Gymnosporangium biseptatum* Ellis.	*Gymnosporangium globosum* Farlow.	*Gymnosporangium macropus* Lk.
Juniperus virginiana.	*Juniperus communis.*	*Cupressus thyoides,* *Libocedrus decurrens.*	*Juniperus virginiana.*	*Juniperus virginiana.*
Leaves, branches and trunks producing bird's nest distortions.	Branches causing long fusiform swellings.	Stems and branches forming large and small nodose swellings.	Smaller branches producing globose swellings.	Attacking leaves and smaller twigs and producing spherical reddish swellings.
Perennial.	Perennial.	Perennial.	Perennial.	Annual.
Tissues of leaves, branches, trunk.	Wood forming a rim in the annual growth, frequently in the medullary rays.	Cambium, wood and medullary rays.	Tissues of stem and leaves.	Cells of leaves.
	Fine hyphæ, little branched, growing up and down and inward.	Hyphæ large, brown, branched to form a reticulum.	Abundant.	Abundant, producing haustoria which grow into leaf cells.
When young cushion-like, irregularly globose or oval, small and distinct or elongate and confluent, rich red-brown; moist and swollen, orange colored.	Numerous, scattered or aggregated, bright yellow when swollen.	Flattened and brownish when dry, hemispherical, yellow and rugose when swollen.	Globose, densely aggregated, dark brown when dry, yellowish-orange when swollen. $\frac{1}{4}$–$\frac{1}{2}$ inch high.	Aggregated in globose masses, orange-yellow, cylindrical, gelatinous. $\frac{1}{2}$–1 in. long.

Name of Fungus.	*Gymnosporangium conicum* D. C. (*G. juniperinum* Winter.)	*Gymnosporangium fuscum* D. C. (*G. sabinæ* Winter.)	*Gymnosporangium Ellisii* Berk.	*Gymnosporangium clavipes* Cooke and Peck.
Teleutospores.	15–18 μ diam., 48–58 μ long, two-celled, constricted at septum.	15–22 μ diam., 38–53 μ long, two-celled, constricted at septum.	10–16 μ diam., 75–190μ long, three to four-celled, sometimes one to five-celled.	22–38 μ diam., 40–60 μ long, two-celled, constricted at septum.
Name of Rœstelia.	*Rœstelia cornuta* (Gmel). Fr.	*Rœstelia cancellata*(Jacq.) Rebent.	*Rœstelia transformans* Ell.	*Rœstelia aurantiaca* Pk.
Intermediate Hosts	*Sorbus aucuparia*, *Sorbus aria*, *Cydonia vulgaris*, *Amelanchier canadensis*, *Pirus malus*, etc.	*Cratægus oxyacantha*, *Pirus communis*.	*Pirus malus*, *Pirus arbutifolia*.	*Pirus malus*, *Pirus arbutifolia*, *Amelanchier canadensis*,
Geographic Distribution.	Massachusetts, New York, South Carolina, Northern and Central Europe.	Massachusetts, Maryland, Europe.	Massachusetts, New Jersey.	E. Massachusetts, New York, New Jersey, Pennsylvania, North and South Carolina.

Gymnosporangium nidus-avis Thaxter.	*Gymnosporangium clavariæforme* D. C.	*Gymnosporangium biseptatum* Ellis.	*Gymnosporangium globosum* Farlow.	*Gymnosporangium macropus* Lk.
.055x.025μ, two-celled.	13–19 μ diam., 55–90 μ long, two-celled.	15–20 μ diam., 50–84 μ long, two to six-celled, or three to four-celled.	19–21 μ diam., 38–45 μ long, two-celled.	15–20 μ diam., 45–60 μ long, two-celled, constricted at septum, with papilla at each end.
Ræstelia nidus-avis Thaxt.	*Ræstelia lacerata* (Sow.) Mer.	*Ræstelia botryapites* Schw.	*Ræstelia lacerata* 2 (Thaxter).	*Ræstelia pyrata* (Schw.) Thaxt.
Cydonia (quince), *Amelanchier canadensis.*	*Pirus communis,* *Cratægus oxyacantha,* *Cratægus grandiflora,* *Cratægus sanguinea,* *Cratægus nigra,* etc.	*Cratægus tomentosa,* *Amelanchier canadensis.*	*Cratægus coccinea,* *Pirus americana,* *Pirus malus,* *Cydonia* (quince; pear), *Amelanchier canadensis.*	*Cratægus tomentosa,* *Cratægus Douglasii,* *Amelanchier canadensis,* *Pirus malus,* *Pirus coronaria,* *Pirus arbutifolia.*
Connecticut.	Maine, Connecticut, Northern and Central Europe.	Massachusetts, New Jersey and California.	Massachusetts to South Carolina.	Massachusetts to South Carolina, west to Missouri, Colorado, Wisconsin.

Bibliography.

1865, Oersted. Botanische Zeitung, p. 291.

1874, Ellis. Bulletin of the Torrey Botanical Club, V, p. 46.

1874–75, Berkeley. Grevillea, III, p. 56.

1877, Körnicke. Mykologische Beiträge, Hedwigia, XVI, p. 22.

1880, Farlow. The Gymnosporangia or Cedar Apples of the United States. Anniversary Memoirs of the Boston Society of Natural History, pp. 3–38, Pls. 1 and 2.

1886, Sorauer. Handbuch der Pflanzenkrankheiten, Zweiter Theil. Die parasitären Krankheiten.

1887, Thaxter. On Certain Cultures of Gymnosporangium, with Notes on Rœsteliæ. Proc. Amer. Acad. Arts and Sci., XXII, p. 259.

1887–1888, Sanford. Microscopical Anatomy of the Common Cedar Apple (Gymnosporangium macropus). Annals of Botany, I, pp. 263–268, with Pl. XIII.

1888, Plowright. Experimental Observations on Certain British Heterœcious Uredines, The Gymnosporangia. Journal Linnæan Society of Botany, XXIV, pp. 93–100.

1888, ————. Gymnosporangium macropus. Arkansas, Report of Experiment Station, pp. 127–130, fig. 3.

1889, Thaxter. Notes on Cultures of Gymnosporangium made in 1887 and 1888. Botanical Gazette, XIV, p. 163.

1890, Thaxter. Rust of Pears. Annual Report Connecticut Agricultural Experiment Station (New Haven), 1890, p. 98.

1891, Jones. Gymnosporangium macropus on Apples. Vermont Report, 1891, p. 133.

1891, Thaxter. The Connecticut Species of Gymnosporangium. Annual Report Connecticut Agricultural Experiment Station, New Haven, pp. 161–165. Connecticut State Bulletin, 107, April, 1891, p. 6.

1892, Alwood. Gymnosporangium macropus, Nature and Treatment. Virginia Station Bulletin, 17, June, 1892, pp. 59–63.

1893, Tubeuf. Infektionen mit Gymnosporangium Arten. Forstl. Naturw. Zeitschr., p. 85.

1894, Halsted. Gymnosporangium macropus. New Jersey Station Report, 1894, p. 324.

1894, Kinney. Gymnosporangium macropus. Rhode Island Station Report, 1894, p. 187, fig. 3.

1894, Hartig, tr. Somerville. Text-Book of the Diseases of Trees, pp. 51, 117, 157–164, 179.

1894, Wörnle. Anatomische Untersuchung der durch Gymnosporangien-Arten hervorgerufenen Missbildungen. Forstl. Naturw. Zeitschr. Inaugural Dissertation. Botanisches Centralblatt, 1894, LX, pp. 280–283.

1895, Taft. Gymnosporangium macropus. Michigan Station Bulletin, 121, April, 1895, p. 22.

1895, Tubeuf. Pflanzenkrankheiten, pp. 396–415.

1896, Frank. Die Pilzparasitären Krankheiten der Pflanzen, II, pp. 176–184.

1896, Underwood and Earle. The Distribution of the Species of Gymnosporangium in the South. Botanical Gazette, XXII, p. 255.

1897, Engler und Prantl. Gymnosporangium. Die natürlichen Pflanzenfamilien, I Theil. 1 Abt.,** pp. 50–53.

1899, Czapek. Zur Biologie der holzbewohnenden Pilze. Ber. d. deutsch. bot. Gesellsch., XVII, p. 166.

1900, H. von Schrenk. A Disease of Taxodium distichum known as

Peckiness. Eleventh Annual Report Missouri Botanical Garden, pp. 23–77, with six plates.

1900, H. VON SCHRENK. Two Diseases of the Red Cedar. U. S. Division of Vegetable Physiology and Pathology, Bulletin, 21, pp. 22, with seven plates.

1900, H. VON SCHRENK. Some Diseases of New England Conifers. U. S. Division of Vegetable Physiology and Pathology, Bulletin, 25, pp. 56, with fifteen plates.

1900, H. VON SCHRENK. Fungous Diseases of Forest Trees. Year Book United States Department of Agriculture, 1900, pp. 199–210, Pls. XXI–XXV.

1900, SHIRAI. Ueber der genetischen Zusammenhang zwischen Rœstelia Koraensis P. Henn. und Gymnosporangium japonicum Sydow. Zeitschrift für Pflanzenkrankheiten, X, pp. 1-5.

1901, H. VON SCHRENK. A Disease of the Black Locust (Robinia pseudacacia, L.). Twelfth Annual Report Missouri Botanical Garden, pp. 21–31, with three plates.

1901, WARD. Disease in Plants. London.

1901, ATKINSON. Studies of Some Shade Tree and Timber Destroying Fungi. Cornell University Agricultural Experiment Station Bulletin, 193, pp. 199–235, fig. 56.

1902, ANDERSON. Dasyscypha resinaria causing Canker Growth on Abies balsamea in Minnesota. Bulletin of the Torrey Botanical Club, XXIX, pp. 23–34, with Plates 1 and 2.

EXPLANATION OF PLATES XXII AND XXIII.

Figs. 1, 2, 3, 4, 5.—Abnormal swellings on the white cedar (*Cupressus thyoides*) caused by mycelium of fungus, *Gymnosporangium biseptatum.*

Fig. 6.—Larger gnarled, diseased condition of the branches of white cedar produced by *G. Ellisii.*

Fig. 7.—Small swelling on twig of white cedar produced by the mycelium of *G. biseptatum.*

Fig. 8.—Straight witches' broom produced by the perennial mycelium of a fungus, *Gymnosporangium Ellisii.*

Fig. 9.—Normal tracheids of white cedar in transverse section.

Fig. 10.—Cambium and adjacent cells from a normal stem.

Fig. 11.—Normal resin canal from bark of white cedar, showing resin.

Fig. 12.—Medullary ray cells and tracheids from a small abnormal swelling, such as the photograph depicted in fig. 7.

Fig. 13.—Diseased wood and excrescence on a young stem of white cedar.

Fig. 14.—Same section viewed entire. The depressed areas represent spots where the cambium has been killed.

Fig. 15.—Medullary ray cell from a longitudinal section, showing appearance of brown contents.

Fig. 16.—Tracheids filled with material under the stimulation of the mycelium of *G. biseptatum.*

Fig. 17.—Tracheids situated between two medullary ray cells, showing those plugged with fungus gamboge.

Fig. 18.—Cambial cells and outer wood tracheids, showing the presence of hyphæ in cross-section.

Fig. 19.—The same much enlarged.

Fig. 22.—Tracheids and medullary ray cells from the wood of white cedar, showing the course of the horizontal and longitudinal hyphæ.

Fig. 23.—Medullary ray cells, illustrating the manner in which a hypha penetrates the cell wall.

Fig. 24.—Section of stem diseased by the presence of fungus, *Gymnosporangium Ellisii.* The course of the hyphæ from tracheid to tracheid is shown. The hyphæ in several places are seen to grow through the bordered pits.

Fig. 24*a*.—Course of a hypha which grows through the bordered pits. Notice that the hyphæ become lens-shaped in the cavity of the bordered pit. *G. Ellisii.*

Fig. 25.—Hypha enlarged, showing the nodose or ventricose enlargement of the fungal cells. *G. Ellisii.*

Fig. 26.—Details of hypha of *G. Ellisii.*

Fig. 27.—The same from the wood.

Fig. 28.—Bent and twisted hyphæ growing in the brown areas of broken-down tissue, as shown also in fig. 29.

Fig. 29.—Spores (several forms) of *Gymnosporangium biseptatum* (after Tubeuf).

Fig. 30.—Spores (uni- and multicellular) of *G. Ellisii* (after Tubeuf).

Fig. 31.—Transverse section of diseased white cedar stem, showing the diseased brown areas in the wood which have become more or less confluent.

Fig. 32.—Tracheids from diseased wood of white cedar, showing the sprung lignified cell wall.

Fig. 33.—Commencement of brown wedge-shaped areas of diseased tissue. Notice the abnormal size of the cells filled with granular matter.

JUNE 3.

Mr. ARTHUR ERWIN BROWN, Vice-President, in the Chair.

Twelve persons present.

The death of George S. Schively, M.D., a member, Sept. 28, 1901, was announced.

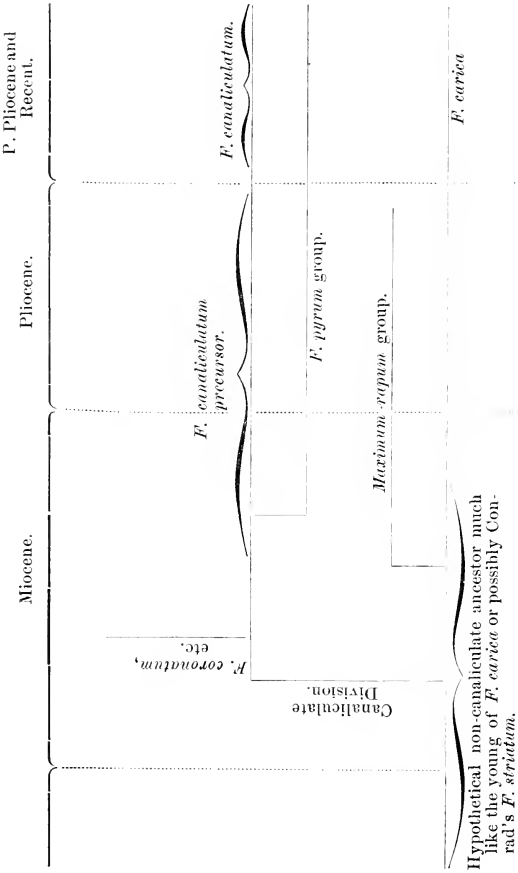
Phylogeny of the Species of Fulgur with Remarks on an Abnormal Form of Fulgur canaliculatum, and Sexual Dimorphism in Fulgur carica.—MR. BURNETT SMITH communicated some preliminary results of a phylogenetic study of the genus *Fulgur*. The ornamentation on the whorls shows that changes occur in going from the protoconch to the adult whorl. In *Fulgur* the changes in ornamentation agree in general with those observed by the Countess von Linden[1] in dealing with marine gastropods in general. As in most gastropods where the early whorls can be studied, transverse ridges occur first, except in certain forms where acceleration has taken place. These are followed by a spiral row of nodes or spines, which in old age are apt to degenerate into a shoulder keel. Modifications of these stages may occur, but they can usually be detected. In the Miocene a tendency developed which resulted in the canaliculate division of *Fulgur*. This division is probably an offshoot from the primitive non-canaliculate stock, of which *F. carica* is the modern representative. On the following page is a rough scheme showing the probable ancestry of the different races.

The *pyrum* group seems to have sprung from a *Fulgur canaliculatum* precursor which had transverse ridges on the whorl following the protoconch. In fact there is a Pliocene shell in the Academy's collection which tends toward fulfilling the requirements of this precursor. In all the young shells of the recent *F. canaliculatum* which I have examined, nodes occur on the whorl next to the protoconch and the transverse ridges are absent. This is probably a case of acceleration. In the non-canaliculate Fulgurs the recent *F. carica* shows well all the stages of ornamentation, from whorls with transverse ridges to whorls in which the spines degenerate into a shoulder keel. In the Caloosahatchie Pliocene both canaliculate and non-canaliculate divisions gave rise to smooth, bulbous var-

---

[1] *Zeit. wiss. Zool.*, LXI, pp. 261–317.

ieties. Mr. Joseph Willcox[2] seems to consider that the bulbous *F.*



contrarium is the ancestor of *F. perversum*, but from a study of

---

[2] *Tr. Wagner Free Institute*, I–II, December, 1889, p. 51.

the ornamentation it is more likely that *F. contrarium* was derived from a precursor of *F. perversum*, of which the modern spinose form of that species is the living representative. *F. contrarium* would, according to the speaker's judgment, be a side branch, and not in the direct line of ancestry. Some sinistral Miocene Fulgurs, after losing the primitive ornamentation, develop spines again on the rounded adult whorl, producing a form much like the modern typical *F. perversum*. A tendency similar to this has been noted in Miocene dextral shells of the non-canaliculate division *F. maximum*.

The abnormal specimen of *Fulgur canaliculatum* exhibited was found on the beach at Longport, New Jersey, on March 18, 1902, after a storm. Some accident occurring when the shell was young has caused it to grow so that the shoulder angle, so characteristic of the species, has disappeared, and we get a shell with a rounded whorl much like *Fulgur pyrum* in appearance. The break in the shoulder occurred on a whorl which possessed the nodes characteristic of the earlier whorls of *F. canaliculatum*. After the break there is apparently an attempt to reproduce these nodes on the rounded surface of the whorl. The faint spiral ridge which occurs well over to the left on the last whorl has evidently been caused by another accident. On examining the soft parts of this specimen it appears to be identical with the normal male specimens, except that the shoulder angle is not present on the mantle.

On examining a normal male *Fulgur canaliculatum*, it will be seen that the backward folded penis lies directly under the shoulder angle. In the abnormal specimen the penis, as well as the other organs of the mantle cavity, all seem to be intact. The absence of the shoulder angle does not seem to be connected in any way with the underlying reproductive organ. It is interesting to note that the shoulder angle occurs equally well developed in the female of *F. canaliculatum*, though in this case it corresponds with no underlying organ. No peculiarity in the mantle edge or other soft parts of this abnormal specimen, accounting for the change in shell form and ornamentation which has occurred, had been discovered.

During the past winter, while searching for the young shells of our recent New Jersey Fulgurs, a series of *F. carica* was obtained which seems to exhibit sexual dimorphism. The adult males are all smaller than the adult females. Both males and females have about 6½–7 whorls, and show the adult characters of the swelling on the branchial siphon and the degeneracy of the spines on the last whorl.

Accounting for the Depth of the Wyoming Buried Valley.—MR. BENJAMIN SMITH LYMAN spoke on certain geological features of the Wyoming valley in Pennsylvania. It has long been matter for speculation and serious practical inquiry how the ancient Susquehanna valley, buried under glacial rubbish near Wyoming and

Wilkes-Barre, could be at least 110 feet deeper than the apparently lowest possible outlet of the same valley near Bloomsburg, and ninety feet deeper than the one near Sunbury, as pointed out by State Geologist Lesley in the Pennsylvania State Geological *Report G 7*, 1883, p. xv, and by Assistant Geologist Prof. I. C. White, at p. 26. Later, in the *Summary Final Report*, Vol. III, Pt. I, 1895, p. 2019, Assistant Geologist A. D. W. Smith gives a still greater depth recently found in the buried valley, at two miles below Wilkes-Barre, namely, 220 feet below the present Bloomsburg outlet, and 200 feet below the Sunbury one. The complete understanding of the buried valley in question is of the weightiest practical importance to the operators of the Wyoming anthracite basin; for the driving of coal mines unexpectedly into the glacial rubbish full of water has repeatedly caused loss of life and property, sometimes on a large scale. The consequent consciousness of danger and uncertainty about its conditions exact great caution; and, perhaps, the guarding against unknown possibilities may occasion great losses that might to some extent be avoided if only the circumstances could be better understood. Several theories have, therefore, been devised in explanation of the observed facts; but none have proved to be at all satisfactory. It has, for example, been suggested that the glacier itself, before retreating and leaving the rubbish, may have scooped out the valley to that depth. But Lesley and others have repeatedly pointed out how insignificant is and must be the erosive action of glaciers; and, furthermore, it appears highly improbable that a glacier could not only scoop out a deep valley, but carry the vast amount of eroded material over the lip of the basin. In this case, too, that lip, near Bloomsburg, is about twenty miles beyond the nearest point ever reached by the glacier. In 1883, Lesley, in the passage just cited, was momentarily persuaded that there was no escape from admitting that the result had been accomplished by "subglacial erosion—rivers beneath the ice sheet, charged with angular drift materials, plowing deep valley-grooves in the softer coal measures." But in the *Summary Final Report*, Mr. Smith states that Lesley "now regards his theory of subglacial erosion as wholly inadequate." Indeed, it would be hard to conceive how subglacial rivers could have maintained an erosive current at such a depth below the outlet of the valley. Mr. Smith cites the opinion of "at least one prominent mining engineer," that the buried valley "has no connected channel, but that the deep places are formed by a series of pot holes." It is true, pot holes are a subordinate glacial feature of the buried valley, and extend below its bottom forty feet or more into the coal measures, as described by Ashburner in the State Geological *Report* for *1885*. But it is hardly conceivable that excavations on so grand a scale, as hundreds of bore holes have shown the buried valley to be, should have been effected, like pot holes, by rapid currents of water carrying the materials comminuted by means of swiftly whirling pebbles quite beyond the limits of such enormously large hollows. The immensity of the currents required for such tremendous action is wholly inadmissible. It is hardly necessary to discuss the extravagant idea that the waters of the now buried valley escaped to the sea through some originally deep subterranean crevice or channel, now hidden farther than ever out of sight by the glacial accumulations. The idea has been resorted to merely from the absence of any other thoroughly plausible explanation, in view of the evident impossibility of hollowing out a valley and carrying off the excavated material over a distant border two hundred feet higher than the bottom. What seems, however, to be an extremely simple, natural and probable solution of the problem has hitherto been apparently altogether overlooked. The crumpling of the rock beds into folds by the contraction of the earth's crust in cooling must necessarily have been not a mere momentary movement, but in general an extremely slow one, continuing for many ages, perhaps, to be sure, intermittently, and may probably still be going on, even in some very ancient basins. A comparatively trivial amount of such action in the couple of hundred thousand years since glacial times would be ample to effect the observed results. For, if the Wyoming basin had thereby been depressed by only the wholly insignificant average amount of half a foot in a thousand years, and the rock saddles, or anticlinals, near Bloomsburg and Sunbury elevated at the same rate, the whole observed result would by this time be accomplished, and the old glacial valley would be found, as it is, a couple of hundred feet lower than those lowest present outlets. A liberal allowance, too, can easily be made for the degree to which those outlets have been eroded since the glacial action, and for the fact that they are not at the very summit of the anticlinals. Yet the movement would be a trifling one. In fact, the observed phenomena appear to be simply corroboration of what might with the utmost reason have been expected to occur; and the explanation is not by any means an arbitrary supposition of regional elevation or depression, conveniently imagined in order to suit facts apparently difficult to elucidate.

June 10.

Mr. Arthur Erwin Brown, Vice-President, in the Chair.

Ten persons present.

Prof. Robert Collett, of the University of Christiania, was delegated to represent the Academy at the meeting commemorating the services of Niels Henrik Abel to mathematical science.

JUNE 17.

Mr. BENJAMIN SMITH LYMAN in the Chair.

Seven persons present.

JUNE 24.

Mr. ARTHUR ERWIN BROWN, Vice-President, in the Chair.

Six persons present.

Mr. Alexander MacElwee and Mr. John Vinton Dahlgren were elected members.

JULY 1.

Mr. ARTHUR ERWIN BROWN, Vice-President, in the Chair.

Seven persons present.

JULY 8.

Mr. CHARLES MORRIS in the Chair.

Nine persons present.

The deaths of R. S. McCombs, M.D., and Samuel K. Ashhurst, M.D., were announced.

JULY 15.

Mr. ARTHUR ERWIN BROWN, Vice-President, in the Chair.

Six persons present.

Southwestern Land Snails.—DR. PILSBRY spoke of the land mollusks collected by Mr. James H. Ferriss during February of this year, in Indian Territory, Texas, New Mexico and Arizona. In the Huachuca mountains, Conservatory cañon, Ariz., living specimens of *Helix levettei* of Bland were taken. They have been dissected by Mr. Vanatta, and prove to belong to the genus *Ashmunella*, having the genitalia characteristic of that group. The following species were also taken in Arizona:

Sonorella rowelli (Newc.). Patagonia mountains and Sanford.

Sonorella granulatissima Pils. Spring cañon, Ft. Huachuca, Huachuca mountains.

Pyramidula striatella (Anth.). Huachuca mountains.

Vitrea indentata (Say). Conservatory cañon, Huachuca mountains and Patagonia mountains.

"*Pyramidula*" *strigosa huachucana* n. subsp. Conservatory cañon, Huachuca mountains. Shell with the general contour of typical *strigosa*, livid, fleshy-corneous, mottled with white, which may predominate beneath; a narrow brown or purple-brown belt revolves a short distance below the subangular periphery. Nepionic whorls spirally striated. Umbilicus broadly open. Alt. 10, diam. 21½ mm., width of umbilicus 7 mm.

Four or five shells out of about twenty-five collected are nearly uniform corneous brown. The specimens were received alive, and it appeared at once that the species is no *Pyramidula*, but a member of the Helicidæ. *The P. strigosa series of Helices constitutes a new genus of Helicidæ, having no affinity to the Patuloid snails*, but apparently is a much modified member of the *Belogona Euadenia*. The Eastern *P. solitaria* (Say), with its northwestern dark race, is a true *Pyramidula*, in spite of its resemblance to some of the *strigosa* group.

In El Paso county, Tex., Mr. Ferriss found *Bulimulus dealbatus pasonis* Pils. and *Holospira roemeri* (Pfr.), and at Colorado City, Mitchell county, Tex., were found *Polygyra texasiana* (Moric.), *Polygyra texasensis* Pils. and *Succinea luteola* Gld.

A new form of *Polygyra*, intermediate between *P. indianorum* Pils. and *P. roemeri* (Pfr.), was taken in the Indian Territory:

Polygyra indianorum lioderma. Shell similar in contour to *P. roemeri*, but always imperforate, with no parietal tooth, the lip narrow, more reflexed and less thickened within, the surface more distinctly finely striate, and with only faint traces of spiral lines. It resembles *P. indianorum* in the structure of the lip, but *liodermа* is smaller, less glossy, not so regularly striate, and the umbilical region is less sunken. *P. divesta* is a much more coarsely and strongly striate shell. Alt. 18, diam. 9 mm.; whorls 4½. Alt. 17.3, diam. 8.7 mm.; whorls 4½.

Red Fork, Creek country, Indian Territory. Types No. 83,281, A. N. S. P., collected by Mr. James H. Ferriss, 1902.

The largest shell of the series taken by Mr. Ferriss measures 18½ mm. diam., and the smallest 16 mm. There is thus but little variation in size at the type locality, which is farther north than *P. roemeri* has been found. The average diameter of fourteen adult shells is 17.2 mm.

JULY 22.

Mr. ARTHUR ERWIN BROWN, Vice-President, in the Chair.

Six persons present.

AUGUST 19.

Mr. ARTHUR ERWIN BROWN, Vice-President, in the Chair.

Seven persons present.

Papers under the following titles were presented for publication:

"On Some Living and Fossil Snails of the Genus Physa found at Las Vegas, N. M.," by Ada Springer.

"Additions to the Japanese Land Snail Fauna—VII," by Henry A. Pilsbry.

"Descriptions of the Lycosidæ and Oxyopidæ of Philadelphia and its Vicinity," by Thomas H. Montgomery, Jr.

"The Development of Gonionema Murbachii," by Henry Farnham Perkins.

The deaths of Dr. James G. Cooper and of Mr. Edward B. Edwards, members, were announced.

The following were ordered to be printed:

ON SOME LIVING AND FOSSIL SNAILS OF THE GENUS PHYSA, FOUND AT LAS VEGAS, NEW MEXICO.

BY ADA SPRINGER.

In the Pleistocene beds of the Arroyo Pecos at Las Vegas, N. M., are found many fluviatile and terrestrial shells, including the genera *Physa*, *Limnæa*, *Planorbis*, *Ancylus*, *Pisidium*, *Sphærium*, *Pyramidula*, *Succinea*, *Helicodiscus*, *Zonitoides*, *Pupa*, *Bifidaria*, *Pupoides* and *Vallonia*.

None of the species, so far as known, are extinct, but some (*e.g.*, *Sphoerium magnum* Sterki MS.) do not appear to exist any longer in the vicinity; while others exhibit varietal characters which seem to distinguish them more or less from their living representatives. The genus *Physa* is represented in those beds by very numerous individuals, differing considerably in form, but apparently all pertaining to a single species. This species has been identified at the National Museum as *Physa humerosa* Gould, and there is no reason to doubt the identity. The original description of *P. humerosa*, kindly copied by Mr. C. T. Simpson, is as follows:

"Testa subrhomboidea, solidula, polita, albida; spira acuta; anfrac. 5, tabulatis; apertura $\frac{1}{2}$ ad $\frac{2}{3}$ long. testæ adequans, postice rotundata; labro expanso; columella vix plicata, callosa, fere perforata.

"Long $\frac{1}{2}$ ad $\frac{7}{10}$ poll.; lat. $\frac{3}{8}$ poll. Found by Thomas H. Webb and by W. P. Blake, in the Colorado desert and at Pecos river.

"The broadly tabulated whorls, and the acute, elevated spire and foldless pillar clearly distinguish this species. It is like *P. tabulata* Gould, and the variety figured by Haldeman as *P. ancillaria* (fig. 7), which he regards as a monstrosity; the deep suture and the simple columella distinguish it from that species."

The species was first published in *Proc. Bost. Soc. Nat. Hist.*, Vol. V, p. 126, February, 1855. The National Museum possesses two shells from Colorado lake, received originally from Blake (Lea Collection), which are supposed to be cotypes. Mr. Simpson has kindly made a drawing of one of these. Dr. R. E. C. Stearns[1] has figured a number of specimens of *Physa* from the Colorado desert; these are variously referred to *humerosa*, *mexicana*, etc.

It would appear that the original *humerosa* was described from fossil or subfossil shells, such as are common in the Southwest in certain localities; and furthermore, that the specimens taken as typical represented a rather extreme variation.

In the series from the Arroyo Pecos Pleistocene, some shells agree well with the original *humerosa*, but these pass by insensible gradations into forms which agree with what has been regarded at the National Museum and by Dr. Stearns as *P. mexicana* Philippi. Whether these latter are the genuine *mexicana* may only be determined when it is possible to study topotypes with the soft parts.

It was also found that many shells from the Arroyo Pecos could not be separated from the common *Physa* still living at Las Vegas, though there were certain average differences between the living and fossil series. The living species has recently been described by Crandall[2] as *Physa rhomboidea.* Part of Crandall's original material came from Las Vegas; he says the species "is distinguished by its robust appearance, deep sutures, constricted aperture and umbilicus, which will be found in a large part of them. It is more like *P. solida* Philippi than any other species." It has impressed spiral lines like *P. gyrina*, etc.

For purposes of comparison large numbers of *P. rhomboidea* were collected from a pool in the Gallinas river at Las Vegas. The variation in this series, all from the same place, was very great, and selected specimens would readily be taken for distinct species. However, upon close comparisons, no difference could be found in the soft parts. Externally, the animals were the same; internally, there were some variations, as in the length of the œsophagus, but these were not correlated with the differences in the shells, and were clearly not of specific value. The teeth were of the same type in all.

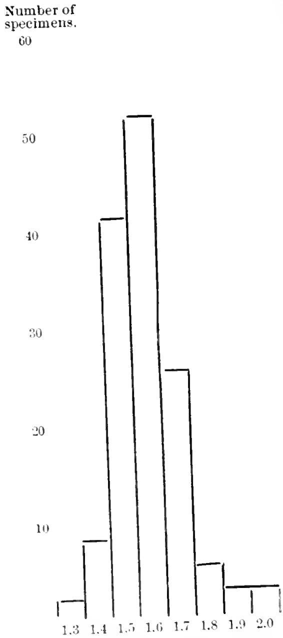
In order to determine whether the teeth could be used in distinguishing Western species of *Physa*, I examined *P. virgata* Gould, collected by Mr. Cockerell in Salt river, Tempe, Ariz., and a species identical with what has been regarded at the National Museum

---

[1] *Proc. U. S. Natl. Museum*, XXIV, Pls. XXIII, XXIV.

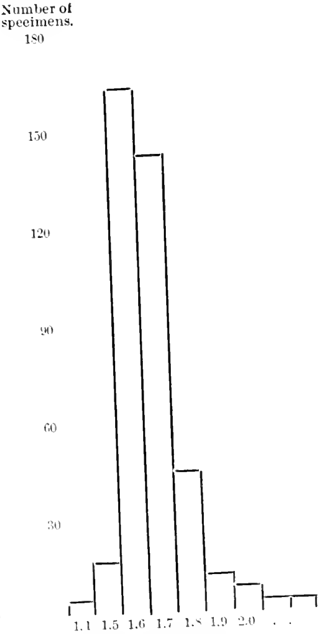
[2] *Nautilus*, August, 1901, p. 44.

as *P. lordi*, collected by Mr. C. H. T. Townsend in the Organ mountains, N. M. It was found that these differed materially from one another and from *P. rhomboidea*, and also from *P. gyrina* as



Ratio of length to breadth (average of whole series 1.5).
P. humerosa, Arroyo Pecos (fossil), 145 specimens.

Fig. 1.



Ratio of length to breadth (average of whole series 1.8).
P. rhomboidea, Gallinas river (recent), 145 specimens.

Fig. 2.

Frequency polygons.

figured by F. C. Baker. The following table indicates the nature of the differences:

Lateral teeth with denticles of two sizes, long ones alternating with short, ... 1
Lateral teeth with long denticles, not obviously of two sizes, . . 2

1. Lateral teeth with the longer denticles very long; median teeth broad, with the denticles in one transverse series, *P. "lordi"* (New Mexico).
   Lateral teeth with the larger denticles short, median teeth with the denticles in three groups, ... *P. gyrina.*
2. Lateral teeth with the denticles seven in number (counting the apical one), straight or nearly so; median teeth with the denticles in three groups, ... *P. rhomboidea.*
   Lateral teeth with the denticles five in number, very oblique; median teeth with the denticles rather long, in one group, *P. virgata.*

Individual teeth of any species may vary from the normal type, but it is easy to determine the normal character.

Figs. 1 and 2 show the frequency polygons for the fossil (Arroyo Pecos) and recent (Gallinas river) series, based on the relation of the length of the shell to the breadth—the most obviously variable character. It is found that the mode, or point of greatest frequency, is the same in both, but the skew is toward greater breadth in the fossils, toward narrowness in the recent shells. It is concluded that all the shells belong to one species, which has been evolving from a broader to a narrower form, perhaps in consequence of a decreasing salinity or flow of the water. Plate XXVI shows a series of each type, including all the recognizable variations.

The work represented by this paper has been done in the biological laboratory of the Normal University of New Mexico, under the direction of Mr. T. D. A. Cockerell, who has also revised the manuscript.

ADDITIONS TO THE JAPANESE LAND SNAIL FAUNA—NO. VII.

BY HENRY A. PILSBRY.

The description of new forms, chiefly supplied by Mr. Y. Hirase, is herein continued. The results of a critical examination of the species of *Euphædusa* and *Pseudonenia* also find place, together with a list of additions and errata to the "Catalogue of Japanese Clausiliidæ," published in these *Proceedings* for 1901.

Section HEMIPHÆDUSA Bttg.

Group of C. sublunellata.

Clausilia pachyspira n. sp. Pl. XXVII, figs. 5, 6, 7.

Shell club-shaped, the *spire very thick*, the *apex large, obtuse;* thin; yellowish corneous-white; closely and finely striate, the striation not perceptibly coarser on the last whorl. Whorls 8 to 8⅓, moderately convex, the last strongly tapering. Aperture ear-shaped, oblique, rather narrow, extending above in a *large, retracted sinulus.* Peristome free and continuous, convex, *very thick,* white, notched at the position of the superior lamella, on the right side of which there is sometimes a low tooth. Superior lamella marginal, vertical, continuous with the spiral lamella, which ascends to a position above the superior lamella. Inferior lamella deeply receding, forming a strong fold within the throat, vertically ascending, thick below, giving off *a branch in the inter-lamellar area, which curves again towards and crosses the inferior lamella* above. Subcolumellar lamella emerging, bounded by grooves. Principal plica arising near the peristome and penetrating past the middle of the right side. Upper palatal plica short, joined in the middle by a narrow, nearly straight, rather weak lunella, which becomes very weak below, but terminates in a small nodule.

Length 13, diam. 3.2 to 3.3 mm.

Clausilium (Pl. XXVII, fig. 7) narrow and parallel-sided, symmetrically tapering to the obtuse apex.

Miyai, Kii. Types No. 83,389, A. N. S. P., from No. 954 of Mr. Hirase's collection.

Very distinct by its thick, club-like shape, peculiar aperture, the curved branch of the inferior lamella, and the palatal structure. It has the pale color and fine sculpture of other members of the group.

Clausilia kurozuensis n. sp. Pl. XXVII, figs. 1, 2, 3, 4.

Shell fusiform, moderately tapering to an *unusually thick apex*, very *thin;* white or grayish-white, the specimens being wholly denuded of cuticle; for the same reason, only faint traces of fine striation are discernible on the worn surface. Whorls about 9, but slightly convex, the last tapering, somewhat compressed. Aperture somewhat oblique, piriform, with a well-defined sinulus. Peristome white, continuous, reflexed and much thickened. Superior lamella short, oblique, marginal, continuous with the spiral lamella, which penetrates to the middle of the ventral side. Inferior lamella receding, visible as a strong fold in an oblique view, giving off a branch toward the superior lamella; within it is a high, obliquely ascending plate, thickened below, penetrating inward decidedly deeper than the spiral lamella. Subcolumellar lamella emerging, bounded by grooves, but hardly extending to the lip-edge. Principal plica visible in the throat, extending inward to a lateral position, being about one-third of a whorl long. Palatal plicæ four, nearly equal, the upper one less oblique (fig. 4), or the lower two may be quite small and nodule-like (fig. 2).

Length 20, diam. 4.7 mm.

Length 17.6, diam. 4.2 mm.

Clausilium (Pl. XXVII, fig. 3) narrow and parallel-sided, evenly tapering on both sides to the apex, tapering at the filament, but not excised there.

Kurozu, Kii. Types No. 83,390, A. N. S. P., from No. 934 of Mr. Hirase's collection.

By the palatal armature of some specimens this might be placed in the group of *C. validiuscula;* the armature of others comes nearer that of *C. sublunellata.* The pale color and apparently fine striation cause me to place the species in the latter group. The specimens, though they have lost the original surface by erosion, were collected alive. Probably some other locality or station will supply unworn shells, and the color will be found to be pale yellowish or greenish. There is no evidence of coarser striation on the back of the last whorl.

The unusual thickness of the early whorls separates this form from *C. subulina* var. *leucopeas* and *C. sericina* var. *rhopalia*. *C. heteroptyx* is a much larger species with different palatal armature. The unusual thinness of the shell also distinguishes *C. kurozuensis*, though this may be partly due to the worn condition of the type specimens.

Section STEREOPHÆDUSA Bttg.

Clausilia plagioptyx n. sp. Pl. XXVII, figs. 8, 9. 10.

Shell *solid*, fusiform, much attenuated above, the first two whorls being small and of about equal diameter, giving the shell an awl-like shape; light-brown, the first whorls whitish. Somewhat glossy, closely and finely striate, the striæ perceptibly more widely spaced on the last whorl. Whorls 9½, moderately convex, the last one somewhat compressed. Aperture rhombic-piriform; peristome reflexed, thickened, white or pale-brownish. Superior lamella marginal, continuous with the spiral lamella, which penetrates to a point above the superior lamella. Inferior lamella approaching the superior, and equally long inside. Subcolumellar lamella emerging to the lip-edge. Principal plica lateral, about a half whorl long. Palatal plicæ four, the upper longest, converging inward toward the principal plica, or parallel with it; the second and third either subequal and short, parallel to the upper plica, or the third plica may be reduced to an elevated point. *Lower plica very obliquely descending*, standing almost as a short, oblique and straight lunella.

Length 17, diam. 4 mm.

Gotō, Hizen. Types No. 82,644, A. N. S. P., from No. 817 of Mr. Hirase's collection.

This species is based upon specimens which I listed under *C. brevior* as from "Goto, Uzen."[1] Upon opening specimens I find that the palatal structure differs in a very characteristic manner.

The exterior is almost exactly like *C. brevior*, but it is a less swollen shell than most specimens of that species; but while *C. brevior* has a well-developed lower palatal plica about parallel

---

[1] These *Proceedings* for 1901, p. 653.

to those above it, in the present species that plica stands obliquely, like a lunella, though not quite near enough to the vertical position to be called a lunella. In *C. addisoni* I have shown a lunella to exist, but in combination with a normally developed lower palatal plica. *C. addisoni* is distinguished externally from *C. plagioptyx* by its stronger rib-striation. *C. plagioptyx* is a more solid shell than either *brevior* or *addisoni.*

The clausilium had fallen out of the two specimens of this species sent by Mr. Hirase.

C. brevior, as I stated in a former paper, is not known from south or southwest of middle Hondo. It is a species of the region about Tokyo. At this time we have no *Stereophædusa* of the *brevior* type in southwestern Hondo, Awaji, Shikoku or northern Kyūshū. *C. addisoni* is found in Higo and Satsuma, in southern, and *C. plagioptyx* in Hizen, in western Kyushu.

Clausilia stereoma var. **hexaptyx** nov.

Shell somewhat larger than *stereoma*, and thinner, much less strong; dark reddish-brown or pale straw-yellow; palatal plicæ six, the upper and lower long, curved, the intermediate ones strong (as in *Megalophædusa*), though more or less unequal.

Length 24.4, diam. 7 mm.

Length 24, diam. 7.1 mm.

Length 22.2, diam. 6.8 mm.

Length 23, diam. 6.5 mm.

Yaku-jima, Osumi. Types No. 83,302, A. N. S. P., from No. 670*a* of Mr. Hirase's collection.

Differs from the forms of *stereoma* already known by its strong Megalophædusoid palatal folds. The clausilium is like that of *C. stereoma.* To what extent the forms of *stereoma* intergrade remains to be determined.

Clausilia oostoma Möllendorff. Pl. XXVII, figs. 15, 16, 17, 18.

C. oostoma Mlldff., Journ. Asiat. Soc. Bengal, LI, pt. 2, p. 4, Pl. I, fig. 2 (1882). Pilsbry, Proc. Acad. Nat. Sci. Phila., 1900, p. 667.
C. japonica var. *surugæ* Pils., Proc. Acad. Nat. Sci. Phila., 1900, p. 447, Pl. 14, fig. 4.
C. eurystoma var. *brachyptychia* Mlldff., Nachrichtsbl. d. d. malak. Ges., 1901, p. 41.

Shell rather solid, club-shaped, the upper three-fifths of the length tapering and somewhat attenuated, the outlines gently concave above; apex rather large; white under a yellow cuticle.

Surface glossy, densely striate, more or less worn above. Whorls 11½ to 12, somewhat convex, the penultimate widest, convex, the last whorl flattened laterally, convex below. Aperture piriform, whitish within. Peristome thickened within and reflexed, white, very shortly free, and usually a trifle notched over the superior lamella. Superior lamella oblique and submarginal, continuous with the spiral lamella, which penetrates to the middle of the ventral side. Inferior lamella forming a conspicuous, subhorizontal fold in the aperture, approaching the superior lamella, ascending within with a broad spiral trend, and penetrating deeper than the spiral lamella. Subcolumellar lamella emerging but not reaching the lip-edge. Principal plica short, arising about the middle of the dorsal side and extending past the middle of the right side, scarcely or not deeper than the inner end of the upper palatal plica. Palatal plicæ two or one, the upper plica strong, converging inward to the principal plica, the *lower plica weak and low or wanting.*

Length 26, diam. 5.8 mm.

Length 25, diam. 5 mm.

Clausilium (Pl. XXVII, figs. 15, 16) broad below the middle, the distal fourth abruptly curved, nearly at a right angle with the middle portion, tapering to a rather acute, thickened apex, the palatal margin straight near the apex, and a trifle excised close to it. Above, it tapers to the filament, and is not excised or emarginate.

Mikuriya, Suruga (Hirase; types of *C. j. surugæ* and *C. e. brachyptychia*). Hakone, Sagami (Hungerford; types of *C. oostoma*).

This species has been the subject of several notices by Dr. O. von Möllendorff and myself, but it has not hitherto been adequately illustrated. Figures are now supplied for comparison with the related forms *dactylopoma* and *goniapoma.* The above description and the figures are from the types of *C. japonica* var. *surugæ*, which is undoubtedly specifically identical with *C. oostoma.*

Clausilia oostoma var. **dactylopoma** nov. Pl. XXVII, figs. 19, 20.

Specimens from Kashio, Awaji, are a little shorter, with 11 to 11½ whorls, and have *the lower palatal plica well developed.* They have the comparatively fine, even striation of the form from Mikuriya, Suruga.

Length 22–25.5, diam. 5.2 mm.

Clausilium (Pl. XXVII, figs. 19, 20) with the apex strongly projecting, finger-like, the palatal margin near it being *strongly excised and concave;* and it is *deeply excised on the palatal side of the filament.*

This form approaches var. *goniopoma,* but differs in the fine striation, and somewhat in the shape of the clausilium.

Clausilia oostoma var. **goniopoma** n. sp. Pl. XXVII, figs. 11, 12, 13, 14.

Shell somewhat fusiform, the upper half tapering, attenuated, lower half somewhat swollen; dull light-yellow. Sculpture of *rather strong and separated folds* or ribs, the upper whorls smoother, worn. Apex small. Whorls 11 to 11½, moderately convex, latter half of the last conspicuously compressed. Aperture subvertical, piriform, the peristome white, continuous and somewhat thickened. Superior lamella marginal, oblique, continuous with the spiral lamella, which penetrates to a point above the superior lamella. Inferior lamella forming a strong, subhorizontal fold, approaching the superior lamella; inside it ascends in a broad spiral, and penetrates deeper than the spiral lamella. The subcolumellar lamella emerges. The principal plica is short, rather weak and lateral. Palatal plicæ two, the upper of moderate size or small, the lower larger.

Length 21, diam. nearly 5 mm.

Length 19.8, diam. 4.5 mm.

Clausilium (Pl. XXVII, figs. 11, 12) very broad below, the apical end bent at a right angle to the rest of the plate, thickened, narrow and mucronate, excised and thin on the palatal side; above it is a little excised on the columellar side of the filament.

Wakayama, Kii. Types No. 83,286, A. N. S. P., from No. 926 of Mr. Hirase's collection.

In general external shape, as well as in the lamellæ, this form resembles *C. oostoma* Mlldff. (*surugæ* Pils.), but it differs in the far coarser sculpture and in the peculiarly bent and attenuated distal end of the clausilium.

Whether the forms *oostoma, dactylopoma* and *goniopoma* are to be regarded as distinct species or as subspecies remains a subject for further investigation, as each is yet known from a single locality, and is constant in its characters, so far as may be judged by the material before me. The salient characteristics of the three forms may be succinctly tabulated thus:

Surface rather finely striate :	*oostoma*	Lower palatal plica weak or wanting. Palatal side of the clausilium straight distally, hardly excised, columellar side not excised near the filament.
	dactylopoma	Lower palatal plica well developed. Palatal side of the clausilium deeply excised distally, the columellar side excised near the filament.
Surface coarsely plicate :	*goniopoma*	

The shape of the clausilium is shown on the plate. In *C. oostoma* it is not quite so strongly curved as in the other forms, there is only a slight trace of the excavation on the palatal side of the distal end, and there is no excision on the columellar side of the filament. In *dactylopoma* there is a deep excision on the palatal side of the distal end, which, however, passes gradually into the broadly dilated palatal margin. The latter is but slightly thickened. The columellar side is deeply emarginate or excised at the origin of the filament. In *goniopoma* the deep distal excision terminates somewhat abruptly at the end of a wide thickened rib which strengthens the rest of the palatal margin. The excision near the filament is slightly less deep than in *dactylopoma*.

The excavation on the palatal side of the distal end of the clausilium when retracted fits over the lower palatal plica in all of these forms.

Section EUPHÆDUSA Bttg.

Euphædusa is one of the most sharply defined of the numerous sections into which Prof. Dr. Boettger divided the heterogeneous group *Phædusa*. At the time of the appearance of the classic *Clausilienstudien* but five Japanese species were known, placed by Boettger in two groups typified by Chinese species. The number of Japanese species has now been more than doubled, and requires the arrangement proposed in my *Catalogue*, p. 654. This arrangement was based upon the following characters:

I. —Superior lamella present.
  a.—Lunella perfect, ... *Group of C. jos.*
  b.—Lunella incomplete or wanting, palatal plicæ present, *Group of C. shanghaiensis.*
  c. --Lunella and palatal plicæ wanting, *Group of C. subgibbera.*

II.—Superior lamella wanting, or represented by a slight thickening of the peristome only. No lunella; 2 palatal plicæ.

a.—Aperture piriform, . . *Group of C. hungerfordiana.*

b.—Aperture oval, hardly narrower above than below, *Group of C. euholostoma.*

The groups are successively more aberrant in the order given above, this phylum having its acme in the section *Reinia.*

Two species, *C. subgibbera* and *C. expansilabris*, described by Boettger from Rein's collection, are not known to me by specimens, and their exact localities in Japan are unknown. All of the other species are represented in the collection of the Academy, and are described and figured in this paper and preceding ones of the series.

Group of C. shanghaiensis.

Key to Species.

I.—*Superior lamella high;* inferior lamella forming a *conspicuous convex fold in a front view* of the aperture; subcolumellar lamella emerging; short upper and lower palatal plicæ, but no trace of a lunella. Shell *glossy, dark purplish-brown.* 11.5 by 3 mm. Hachijo Island, Izu, . *C. tryoni.*

II.—*Superior lamella moderately developed;* inferior lamella forming a low, convex fold in a front view, *approaching close to the superior;* shell *rib-striate.*

a.—Brown; length 13–14 mm., ... *C. digonoptyx.*

a'.—Greenish-corneous; palatal plicæ short, lunella inconspicuous, almost wanting; length 10 mm., *C. comes.*

III.—Superior lamella small or reduced to a low cord; inferior lamella showing in front as a low fold, *not* converging strongly toward the superior lamella; shell dull brownish, finely striate.

a.—Superior lamella small but distinct; spiral lamella high; upper palatal plica long, connected in the middle with a J-shaped lunella, which is weak in the middle, and strengthened below into a nodule, ... *C. tau.*

a'.—Superior and spiral lamellæ reduced to a low cord; palatal plicæ short.

b.—Length 13–16, diam. 3–3.5 mm.; upper and lower palatal plicæ weakly connected by a low, imperfect lunella, visible as a whitish streak externally. Kyushu, ... *C. subaculus.*

b'.—Length 13.5, diam. 2.7 mm.; small upper and lower palatal plicæ, but no lunella. Yesso, *C. rowlandi.*

Clausilia subaculus n. sp. Pl. XXVIII, 38, 39, 40.

Clausilia aculus Benson, Boettger, Jahrbücher d. deutschen malak. Ges., V, 1878, p. 49, Pl. 3, fig. 3*a*, *b*. Kobelt, Fauna moll. extramar. Jap., p. 71, Pl. 8, fig. 19. Not *C. aculus* Benson, *cf.* Boettger, Jahrbücher, VI, 1879, p. 108.
Clausilia proba A. Ad., Boettger, Jahrbücher, VI, 1879, p. 108. Not *C. proba* A. Ad., Ann. Mag. N. H. (4), I, 1868, p. 471.

Shell long-fusiform, the penultimate whorl widest, those above regularly tapering, the spire slender above, lateral outlines straight, apex rather acute; color varying from yellowish-brown to pale olive-brown. Surface glossy, distinctly and somewhat coarsely striate, the last whorl more strongly so. Whorls about 10, rather convex, the last shortly free in front. Aperture wide-piriform, the upper margin a little sinuate. Peristome white, somewhat thickened, expanded and narrowly reflexed. Superior lamella merely a low cord terminating in a small thickening of the peristome, continuous within with the spiral lamella, which penetrates nearly to the middle of the ventral side. Inferior lamella receding, becoming high within, only moderately approaching the superior lamella, and decidedly shorter inside than the spiral lamella. Subcolumellar lamella barely emerging. Principal plica chiefly dorsal, being visible in the throat and extending to but hardly past the middle of the right side. Upper palatal plica moderately long, oblique, connected near its lower end with an arcuate lunella, which is very low or almost interrupted in the middle, becomes distinct again below, where it is recurved in a short lower palatal plica.

Length 16, diam. 3.5 mm.

Length 13, diam. 3 mm.

Clausilium (Pl. XXVIII, figs. 41, 42) strongly curved, wide below, rounded and somewhat thickened at the apex, the margins converging somewhat upward, rather deeply excised on the columellar side of the filament.

Nagasaki, in western Kyūshū. Types No. 60,372, A. N. S. P., received from Mr. B. Schmacker.

Prof. Dr. Boettger has already pointed out the differences between this species and *C. tau*. The superior lamella in the former is lower, a mere cord; the striation is stronger, and the upper palatal plica smaller. The palatal structures do not shine white through the shell so conspicuously as in *C. tau*. Inside, the spiral lamella is seen in *C. subaculus* to be much lower than in *C. tau*. This is well shown in the views of the interior from behind, fig. 39 (*subaculus*) and fig. 43 (*tau*). In both species the subcolumellar lamella is noticeably dilated where it passes the lower palatal plica, shown in the same figures. *C. digonoptyx* is a more strongly striate shell, with the inferior lamella much more closely approaching the superior.

This species was collected at Nagasaki in numbers by Prof. Dr. J. J. Rein, and at first (1878) identified by Prof. Boettger as *C. aculus* of Benson, a species originally described from Chusan. Subsequently (1879) Boettger recognized that the Japanese form was distinct from Benson's Chinese species, but trusting to supposedly authentic specimens labeled *C. proba* A. Ad. in Dohrn's collection, he substituted this name for the Nagasaki species. This determination, however, cannot stand, being contradicted by the terms of A. Adams' diagnosis of *C. proba*. He describes that shell as 5½ lines (11 mm.) long, with eight whorls, "*lamella supera valida, compressa*," whereas the Nagasaki species under discussion is larger, with about 10 whorls, and a *remarkably low, weak and inconspicuous superior lamella*. Moreover, the locality of *C. proba* is far removed from Nagasaki, being in Awa province, east of the entrance of the Bay of Yeddo. Whatever *C. proba* may prove to be, it is surely not closely related to *C. aculus*.

Under these circumstances it becomes necessary to rename the Nagasaki species; and in so doing I have considered it best to give a new description, in order that there may be in future no uncertainty about the exact form intended.

Clausilia rowlandi n. sp. Pl. XXVIII, figs. 28, 29, 30.

Shell fusiform-turrite, the spire slender, nearly straight-sided, tapering to a small apex; light-brown. Surface finely and rather sharply striate. Whorls 10, rather strongly convex, especially just below the suture, the last shortly free in front. Aperture *narrowly piriform*, the upper margin slightly sinuate at the position of the superior lamella, the well-marked sinulus a little retracted. Peristome white, thickened, expanded and reflexed. Superior lamella merely a small cord, terminating in a rather wide thickening of the margin of the peristome, continuous inside with the spiral lamella, which penetrates nearly to the middle of the ventral side. Inferior lamella receding, becoming high within, approaching the superior lamella, shorter within than the spiral lamella.

Subcolumellar lamella immersed, visible in an oblique view in the aperture. Principal plica visible in the throat, extending past the middle of the right side. *Upper and lower palatal plicæ quite small,* no lunella between them.

Length 13.5, diam. 2.7 mm.

Clausilium wide below, somewhat thickened at the apex, but angular there, almost mucronate, by reason of an excavation of the palatal side near the apex. The margins converge somewhat upward, and it is excised on the columellar side of the filament.

Garukawa, 10 miles from Sapporo, Ishikari, island of Yesso; collected by Mr. Paul Rowland, and communicated to me by Mr. Addison Gulick.

Similar to *C. subaculus* in the low, cord-like superior lamella continuous with the spiral lamella, but conspicuously distinct by its narrowly pear-shaped aperture, more slender contour, the reduction of the palatal plicæ and the angular apex of the clausilium. *C. monelasmus*, of Ojima province, Yesso, is a smaller species with no superior lamella, there being only a marginal thickening of the peristome in its place.

The shape of the mouth readily distinguishes this from all Japanese *Euphædusæ.* The clausilium is also characteristic, no other Japanese *Euphædusa* having it subangular at the apex. It is named for Mr. Paul Rowland, who found the specimens and sent them to Mr. Addison Gulick.

Clausilia tau Boettger. Pl. XXVIII, figs. 36, 37, 43, 44, 45.

> Boettger, Clausilienstudien, p. 58, footnote (1877); Jahrb. d. d. malak. Ges., V, p. 46, Pl. 3, fig. 2. Kobelt, Fauna moll. extramar. Jap., p. 70, Pl. 8, fig. 18.

The shell is finely striate, becoming costulate-striate on the back of the last whorl, as in *C. subaculus.* The aperture is widely piriform, the upper margin distinctly sinuate at the position of the superior lamella. The superior lamella is small, but decidedly higher than in *C. subaculus.* The principal plica is long, extending inward beyond the lunella. The upper palatal plica is quite long, united in the middle with the lunella, which is low or interrupted in the middle, and curves inward below, terminating in a nodular lower palatal plica. The whole structure, as seen from the inside, has been aptly compared by Boettger to the Greek letter τ. The palatal folds show whitish on the outside.

Length 12½–15½ mm., diam. 3–3½ mm.

Kyoto (Rein, Hirase; type locality); Shirono, Buzen; Gojo and Nohara, Yamato; Takasaki, Kozuke (Y. Hirase); Yokohama and Tokyo (F. Stearns, purchased).

Clausilia digonoptyx Boettger. Pl. XXVIII, figs. 31, 32, 33, 34, 35.

Boettger, Clausilienstudien, p. 58, footnote (1877); Jahrb., V, p. 45, Pl. 3, fig. 1; Pl. 4, fig. *a*. Kobelt, Fauna, p. 69, Pl. 8, fig. 17.

A more glossy shell than *C. tau*, finely *rib-striate*, the superior lamella higher than in *C. tau*, the inferior *strongly converging toward it* in the throat. The upper palatal plica is shorter than in *C. tau*, and united with a very low lunella, interrupted in the middle, and curving inward below in a short lower palatal plica. The plicæ and lamella together form an arch or bow rather than a τ-shaped figure. It does not attain quite the size of *C. tau*, but is larger than *C. comes*. The conspicuous approximation of the lamellæ and the rib-striation are its most striking features. The conspicuous striation unfortunately did not come out well in the reproduction of my figure 32.

The types were collected by Rein, exact locality unknown. Mr. Hirase has sent specimens from the following localities: Manabe, Hitachi; Takasaki, Kozuke; Yamagachi, Tajima; Nishigo, Uzen.

Section REINIA Kobelt.

Clausilia variegata var. **nakadai** nov.

Shell very much smaller than *variegata* or *nesiotica*, length 7, diam. 2 mm.; brownish, the upper whorls whitish or somewhat buff-streaked; whorls 6½. Superior lamella short, widely separated from the spiral lamella, the other lamellæ as in var. *nesiotica*.

Hachijo-jima, Izu. Types No. 83,299, A. N. S. P., from No. 942 of Mr. Hirase's collection.

Section PSEUDONENIA Bttg.

So far as the Japanese species are concerned, it is difficult to see any important difference between *Pseudonenia* and *Euphædusa*. Each has a clausilium of the broad type, either rounded or somewhat acuminate at the apex, and the lamellæ and plicæ are of the same type in both sections. The Japanese forms referred to *Pseudonenia* I would therefore place under *Euphædusa*, but pending a general revision of the groups in question, the generally accepted arrangement is here retained.

Clausilia sieboldi Pfr.

C. sieboldtii Pfr., Proc. Zool. Soc., 1848, p. 111; Monographia Hel. Viv., II, p. 165; Conchylien Cabinet, *Clausilia*, p. 100, Pl. 11, figs. 10, 11.

C. sieboldi Pfr., Monogr., VIII, p. 520. Kobelt, Fauna moll. extramar. Jap., p. 73, Pl. 9, fig. 1.

A species collected by Siebold, and described by Pfeiffer as corneous-brown, with 10 whorls, a deep, arcuate lunella, visible outside through the shell, and one moderate palatal plica. The type measures 18 mm. long, 4 wide in the middle.

Kobelt described and figured specimens taken by Dr. Rein at Amakusa, and between Hiugo and Bugo (Bungo ?). He gives the color as "dunkel hornbraun." "Die Principalfalte ist klein, häufig gar nicht zu erkennen, die Mondfalte ist klein oder breit, fast gerade, von der Principalfalte getrennt, und schicht unten einen Ast nach hinten; die Gaumenfalten fehlen oder es ist eine ganz kleine vorhanden, welche mit der Mondfalte zusammenhängt."

The relation of this form to the next is a matter for further investigation, with more material than is at present available.

Clausilia sieboldi var. **diptyx** nov. Pl. XXVIII, figs. 19, 20, 21.

Shell fusiform or turreted, the greatest width being either near the middle or at the last whorl; the spire rapidly tapering above to a rather small, acute apex, the outlines of the terminal portion straight. Dark purple-brown, fading to pale or yellowish-brown above. Surface glossy, sculptured with strong, close rib-striæ, narrower than their intervals. Whorls 9½, convex, the last somewhat flattened laterally, convex beneath, showing a pale or yellowish curved streak in the position of the lunella. Aperture ovate, dark within; peristome white, thickened within, rather widely reflexed, continuous, a little excavated at the sinulus. Superior lamella rather small, thin, and *short*, not reaching to the lip-edge; widely separated from the spiral lamella, which is a half whorl long, penetrating to the middle of the ventral side. Inferior lamella subhorizontal, thin, not extending upon the expanded lip, ascending in a wide spiral within, penetrating as deeply as the superior lamella. Subcolumellar lamella very deeply immersed. Principal plica about a third of a whorl long, latero-dorsal. Upper and lower palatal plicæ rather short, subparallel, the upper one curved; they are connected by a very low lunella, scarcely noticeable, except for the absence of dark pigment in the shell wall at its position.

Length 19, diam. 4–4.3 mm.
Length 18, diam. 4.3 mm.
Length 16.3, diam. 4 mm.

Clausilium (Pl. XXVIII, figs. 22, 23) rather wide below, strongly curved, the apex somewhat acuminate, a little thickened; dilated on the palatal side; deeply excised on the columellar side of the filament.

Nippon or Hondo Island: Toyomshikami, Nagato, type locality. Shikoku Island: Kashiwashima, Tosa. Kyushu Island: Yatsushiro, prov. Higo, and Sasebo, Hizen (Y. Hirase).

This widely distributed form apparently differs from *C. sieboldi* as defined by Pfeiffer and Kobelt by its dark color, *well developed principal plica, two distinct palatal plicæ*, and the very low lunella. It differs from *C. neniopsis* by the less approaching superior and inferior lamellæ, the former widely separated from the spiral lamella, the very deeply immersed subcolumellar lamella, and other characters.

The specimens figured (No. 79,137, A. N. S. P.) are from the type locality in Nagato province, southwestern Nippon. Those sent by Mr. Hirase from Kashiwashima, Tosa, and Sasebo, Hizen, are similar. Specimens from Yatsushiro, Higo, are quite thin, somewhat smaller, with 9 whorls and the spiral lamella approaches near the superior lamella. Length 15–16½, diam. 4 mm.

Clausilia neniopsis n. sp. Pl. XXVIII, figs. 24, 25, 26, 27.

Shell fusiform, the penultimate whorl widest, the spire much attenuated above, the apex minute, first two whorls of about the same diameter, weakly convex, following whorls convex and rather rapidly increasing, the last two whorls forming more than half the total length, last whorl compressed laterally. The last two whorls are blackish purple-brown or dull red, spire reddish, the earlier two whorls nearly white. Surface somewhat glossy, sharply and closely rib-striate. Aperture ovate-piriform, dark within. Peristome continuous and free, rather broadly reflexed, somewhat thickened, white on both face and reverse. Superior lamella marginal, vertical, thin, continuous with the spiral lamella which penetrates past the ventral side. Inferior lamella prominent, strongly spiral, *approaching close to the superior lamella*, and penetrating as far. Subcolumellar lamella either barely visible from in front or wholly immersed. Principal plica rather small, lateral. Palatal plicæ two, lateral, the upper curved a little further inward than the straight, oblique lower one. No lunella.

Clausilium (Pl. XXVIII, figs. 26, 27) very strongly curved, almost in a semicircle, wide, broadly rounded below, tapering above, not excised at the filament.

Length 18, diam. 4 mm.; length of aperture 4.6 mm.

Oshima, Osumi. Types No. 83,305, A. N. S. P., from No. 932 of Mr. Hirase's collection.

This species is somewhat more slender and graceful than *C. sieboldi* var. *diptyx* of Kyushu, with more attenuated early whorls; but it differs chiefly in the much closer approach of the inferior to the superior lamellæ in the aperture, the continuity of the superior with the spiral lamella, and the deeper penetration of both spiral and inferior lamellæ. As in *C. sieboldi*, the position of the wanting lunella is indicated by a pale area in the shell. The clausilium differs, being broadly rounded at the apex in *C. neniopsis*, and without excision near the filament, while in *C. sieboldi* var. *diptyx* the apex is angular and there is an abrupt excision on the palatal side of the filament.

The converging lamellæ in the mouth remind one of *Nenia* or the allied genus *Garnieria*.

ADDITIONS TO AND CORRECTIONS OF THE CATALOGUE OF JAPANESE CLAUSILIIDÆ.[2]

Section MEGALOPHÆDUSA Bttg.

C. DUCALIS var. DECAPITATA Pils. Kashima, Harima.

Section HEMIPHÆDUSA Bttg.

C. INTERLAMELLARIS v. Mart. (*Catal.*, p. 648). The locality Kirishima, Kyushu, is given by Boettger, *Syst. Verz.*, p. 57.

C. PLATYDERA v. Mart. A var. *elongata* from Kobe is mentioned by Bttg., *Syst. Verz.*, p. 57.

C. STRICTALUNA var. EMERSA Ancey. Hitozashi.

C. AGNA Pils. Yakushima, Osumi.

---

[2] See these *Proceedings* for 1901, pp. 647-653.

C. CALOPTYX Pils. Yakushima, Osumi.

C. PACHYSPIRA Pils. Miyai, Kii.

C. KUROZUENSIS Pils. Kurozu, Kii.

Section TYRANNOPHÆDUSA Pils.

C. AURANTIACA var. PLICILABRIS A. Ad., Pils. Kashima, an island near Tanabe, Kii. (Syn.: *C. a.* var. *hypoptychia* Pils., *Catal.*, p. 652; *C. plicilabris* A. Ad.)

C. BILABRATA Sm. Forms *minor* and *integra* are listed by Dr. Boettger from Kyushu. A synonym is *C. bilabiata* Sowerby, *Conch. Icon.*, XX, Pl. 14, fig. 135.

Section STEREOPHÆDUSA Bttg.

C. PLAGIOPTYX Pils. Gōtō, Hizen. The locality "Gōtō, Uzen," is to be deleted from the range given to *C. brevior*, p. 653.

C. OOSTOMA var. GONIOPOMA Pils. Wakayama, Kii.

C. OOSTOMA var. DACTYLOPOMA Pils. Kashio, Awaji.

C. STEREOMA var. HEXAPTYX Pils. Yakushima, Osumi.

C. DÆMONORUM Pils. Kikaiga-shima, Osumi.

Section PSEUDONENIA Bttg.

C. SIEBOLDI var. DIPTYX Pils. Southwestern Nippon, Shikoku and Kyushu.

C. NENIOPSIS Pils. Oshima, Osumi.

Section EUPHÆDUSA Bttg.

C. SUBACULUS Pils. Nagasaki. This name replaces that of *C. aculus* Bens., *Catal.*, p. 654, for the Kyushu form.

C. ROWLANDI Pils. Garukawa, near Sapporo, Yesso.

Section REINIA Kobelt.

C. VARIEGATA var. NAKADAI Pils. Hachijo-jima, Izu.

Species incertæ sedis.

C. LEWISII Ancey. Japan.

EXPLANATION OF PLATES XXVII AND XXVIII.

[NOTE.—All figures of corresponding parts are drawn to the same scale.]

PLATE XXVII, Figs. 1–3.—*Clausilia kurozuensis.* Kurozu, Kii.
Fig. 4.—Diagram of palatal armature of another specimen.
Figs. 5–7.—*Clausilia pachyspira.* Miyai, Kii.
Figs. 8, 9.—*Clausilia plagioptyx.* Gōtō Hizen.
Fig. 10.—*Clausilia plagioptyx.* Palatal armature of another specimen.
Figs. 11–14.—*Clausilia oostoma* var. *goniopoma.* Wakayama, Kii.
Figs. 15–18.—*Clausilia oostoma* Mlldff. (Type of *C. japonica* var. *surugæ* Pils.) Mikuriya, Suruga.
Figs. 19, 20.—*Clausilia oostoma* var. *dactylopoma.* Kashio, Awaji.

PLATE XXVIII, Figs. 19–23.—*Clausilia sieboldi* var. *diptyx.* Toyonishikami, Nagato.
Figs. 24–27.—*Clausilia neniopsis.* Oshima, Osumi.
Figs. 28–30.—*Clausilia rowlandi.* Garukawa, near Sapporo, Yesso.
Figs. 31–35.—*Clausilia digonoptyx.* Manabe, Hitachi.
Figs. 36, 37.—*Clausilia tau.* Clausilium of a specimen from Kyoto.
Figs. 38–42.—*Clausilia subaculus.* Nagasaki.
Figs. 43–45.—*Clausilia tau.* Nohara, Yamato.

DESCRIPTIONS OF LYCOSIDÆ AND OXYOPIDÆ OF PHILADELPHIA AND ITS VICINITY.

BY THOMAS H. MONTGOMERY, JR.[1]

The present paper is based on a study of the following collections: that in the Academy of Natural Sciences of Philadelphia, a rich collection made by Mr. Witmer Stone, which was the basis of the first contribution on Pennsylvania *Lycosidæ*, Mr. Stone's "Pennsylvania and New Jersey Spiders of the Family Lycosidæ," a small collection made by the Rev. Dr. H. C. McCook; and the author's own collection, specimens mainly from West Chester, Pa., from Philadelphia and its close vicinity. I would express my indebtedness to the Academy of Natural Sciences, and to my friend Mr. Stone in particular, for the use of its collections. The greater number of the specimens examined are from Philadelphia and from Chester county, Pa., others from various parts of Pennsylvania, from New Jersey, New York State and one from Maryland. The present contribution probably does not include all the species around Philadelphia, and much less all of Pennsylvania and New Jersey.

The figures represent the copulatory organs, drawn with great care in regard to the details, for these organs are undoubtedly of first diagnostic importance. The epigyna are frequently difficult to see clearly in all their parts; it is always necessary to denude them of the hairs to make them more discernible, and in some cases to dissect them away from the body and study them by transmitted light. The other characters of importance are the arrangement of the eyes (including the relative extent of the dorsal eye area), the relative proportions of the dimensions of the cephalothorax and its form, the relative length of the legs, and the relative length of the superior and inferior spinnerets. Form and dimensions of the abdomen are of little value. Color is quite constant in some species, but highly variable in others, and sometimes there is quite a

---

[1] Contributions from the Zoological Laboratory of the University of Pennsylvania.

marked sexual difference in the coloration. Only sexually mature individuals have been considered.

It is very difficult to recognize the American species described by C. Koch and Walckenaer. I have examined Walckenaer's descriptions very carefully, and believe that with the exception of a very few forms, *e.g.*, *Lycosa carolinensis*, his species must be regarded as unrecognizable. Walckenaer based his descriptions on the manuscript notes and drawings of Bosc and Abbot; these drawings have never been edited, and until they are published they cannot rightly be granted any more priority rights than an unpublished description, unless we should grant manuscript drawings the value of type specimens. It would be as incorrect, in face of the generally accepted rules of nomenclature, to name species on the basis of unedited drawings as upon unedited descriptions. Hence these drawings are of no decisive importance at all until they are published, and Walckenaer's meagre verbal descriptions comprise all we know of his species. Hentz's descriptions are on the whole still less ample than Koch's and Walckenaer's, but Hentz has given figures which, in the main, are good, so that a considerable number of his species may be regarded as recognizable. It is right to be very thorough in endeavoring to recognize the species of a previous author, even when his descriptions are very scant; but when the description is so inprecise as to apply to any one of several species occurring in the locality of the specimens described, then the species based upon such a description must be considered unrecognizable and no further attention paid to it. If this rule is not followed, our nomenclature would be based upon a tissue of guesswork probabilities, and but for the date of the tenth edition of the *Systema Naturæ*, we should logically seek in some early source the names given by Adam.

The works of the writers cited are arranged together in a list at the end of the paper.

Family LYCOSIDÆ

Characters of the Family.—*Araneæ* with one pair of lung books and unpaired tracheal spiracle; with three claws on the feet, and legs in order of length generally 4, 1, 3, 2, or 4, 1, 2, 3; eyes in three rows, the first (most anterior) row of four small eyes, the second and third each of two larger eyes.

Key to the Herein Described Genera of Lycosidæ.

A.—Third eye-row nearly on a line with the second.
  I.—Lateral eyes of the first row about equidistant from the second row and the anterior edge of the cephalothorax, *Ocyale.*
  II.—Lateral eyes of the first row at least twice as far from the anterior edge of the cephalothorax as from the second row, ... *Dolomedes.*
B.—Third eye-row not nearly on a line with the second.
  I.—Superior spinnerets not longer than the inferior, dorsal eye area usually considerably less than one-quarter the length of the cephalothorax, legs usually well clothed with hair, chelicera usually fully 1½ times the length of the head in front, ... *Lycosa.*
  II.—Superior spinnerets slightly longer than the inferior, dorsal eye area fully or nearly one-quarter the length of the cephalothorax, legs slender with long spines and few hairs, chelicera not longer than 1½ times the height of the head in front, ... *Pardosa.*
  III.—Superior spinnerets at least 1½ times as long as the inferior, dorsal eye area less than one-quarter the length of the cephalothorax, legs well clothed with hairs, chelicera comparatively small, ... *Pirata.*

Genus **LYCOSA** Latr.

Following Simon, I have included in *Lycosa,* and not granted separate rank, the genera *Trochosa* Koch, *Arctosa* Koch and *Tarentula* Ohl. and Thor. In the species here described it is impracticable to distinguish these genera, the interrelation of them is so close and intermediate forms so difficult to classify. When genera become more difficult to distinguish than the species which compose them, it is clearest to adopt one comprehensive genus for all. The following key will aid in distinguishing the species here described:

A.—Cephalothorax not more than 2.5 mm. in length, without a distinct median light band.
  I.—Sternum nearly twice as long as broad, ... *nigra.*
  II.—Sternum nearly round, ... *sublata.*
B.—Cephalothorax 2.7–4.6 mm. in length, with a distinct median light band.
  I.—Sides of cephalothorax brownish or yellowish, sternum not darker than legs.

1.—Submarginal light band of cephalothorax very distinct, generally a dark annular mark on sternum, *ocreata pulchra.*

2.—Submarginal light band of cephalothorax indistinct, no dark markings on sternum, . . . *relucens.*

II.—Sides of cephalothorax blackish or dark-brown, sternum darker than legs.

1.—Sternum without hairs, under surface of coxæ and abdomen black, ... *sepulchralis.*

2.—Sternum with hairs, under surface of coxæ and abdomen not black.

(*a*)—Legs comparatively thick, fourth leg not four times the length of the cephalothorax, labium deep black its entire length, . *charonoides.*

(*b*)—Legs very slender, the fourth leg at least four times the length of the cephalothorax, labium lighter at its distal end.

(1)—Legs distinctly banded, dorso-median band of cephalothorax constricted at its middle, ... *stonei.*

(2)—Legs not distinctly banded, dorso-median band of cephalothorax not constricted at its middle, ... *verisimilis.*

C.—Length of cephalothorax 5 mm. or more.

I.—Abdomen with a distinct broad dorso-median dark band along its entire length.

1.—First leg thickest, not 2½ times the length of the cephalothorax, ... *arenicola.*

2.—First leg not thicker than the others, more than three times the length of the cephalothorax.

(*a*)—Sternum black, ... *punctulata.*

(*b*)—Sternum yellow, ... *scutulata.*

II.—Abdomen above without a distinct broad dorso-median dark band along its entire length.

1.—Venter light without dark markings, middle eyes of first row considerably larger than the lateral, *cinerea.*

2.—Venter dark or with dark markings, middle eyes of first row usually not larger than the lateral.

(*a*)—Cephalothorax not distinctly banded, or with a median band much narrower than the eye area.

(1)—Middle eyes of the first row smaller than the lateral, ... *carolinensis.*

(2)—Middle eyes of the first row larger than the lateral.

(2*a*)—Three dark bands on the venter converging toward the spinnerets, ... *inhonesta.*
(2*b*)—Small dark spots on the venter, no dark bands, . . . *nidicola.*
(2*c*)—A broad transverse dark band on the venter behind the lung books, . . . *baltimoriana.*
(*b*)—Cephalothorax with a median light band as broad anteriorly as the eye area.
(1)—Abdomen with a light dorso-median band enclosing a shorter dark band anteriorly, ... *lepida.*
(2)—Abdomen above with a large black spot or stripe at each antero-lateral margin.
(2*a*)—Posterior eyes largest, cephalothorax with a pair of black longitudinal bands, *nigraurata.*
(2*b*)—Eyes of second row largest, cephalothorax without black bands.
(*α*)—Abdomen below with a large blackish mark, first leg not more than 2½ times the length of the cephalothorax, . . *frondicola.*
(*β*)—Abdomen below usually without a distinct blackish mark, first leg 2.9 times the length of the cephalothorax, *purcelli.*

1. Lycosa nigra (Stone). (Pl. XXIX, fig. 1.)

Pardosa nigra Stone, 1890.
nec *Lycosa funerea* Hentz, Banks, 1891.

(2 ♀♀, types, Stone Coll., from Chester county, Pa.)

Eyes.—First row shorter than the second, its middle eyes higher and larger than the lateral; eyes of second row largest, less than their diameter apart; the third row widest, its eyes considerably nearer to the second row than to each other and placed upon tubercles. Dorsal eye area about one-fifth the length of the cephalothorax. All eyes relatively small.

Form.—Sternum about double as long as wide in one specimen, not quite so long in the other. Cephalothorax highest at the level of the dorsal groove. Chelicera fully 1⅓ times as long as the head is high in front. Maxillæ comparatively long and slender. Legs stout and short, without very long spines.

Dimensions.—Length of cephalothorax 25 mm.

Length of first leg 5.5 mm.

Length of fourth leg 9 mm.

Color.—"Cephalothorax smooth and shining, uniform black with a reddish-brown luster, no stripes whatever. Sternum and coxæ similar, somewhat lighter. Abdomen black, indistinctly mottled with olive brown or gray, without any distinct pattern, though there is a more or less distinct light median stripe on the anterior part reaching nearly to the middle. The sides of the abdomen are black, thickly speckled with small gray dots. Beneath brownish, with no distinct markings. Mandibles and palpi shining dark reddish brown, front edge of cephalothorax, just below the first row of eyes, yellowish. Legs, femur dark shining like the cephalothorax, patella white; the first and second pairs have the other joints entirely yellowish white, the third pair are similar but with prominent black spines while the fourth pair have the tarsus banded with brown at the ends" (Stone).

Comparisons.—A typical *Lycosa* in form of legs, small space occupied by the eye area, and shortness of the superior spinnerets; quite distinct from any other American species.

2. Lycosa sublata n. sp. (Pl. XXIX, fig. 2.)

(1 ♀, type, Stone Coll., Sand Barrens, Pt. Pleasant, N. J.)

Eyes.—First row fully as broad as the second, lateral eyes slightly higher. Eyes of second row not quite their diameter apart. Third row slightly wider than second, its eyes about the same size as those of the second row, and about equidistant from each other and from the second row. Dorsal eye area not one-fifth the length of the cephalothorax, and the eyes relatively small.

Form.—Head low and sloping on the sides, length of chelicera more than twice the height of the head in front. Sternum very slightly longer than broad, nearly round. Legs stout and relatively short.

Dimensions.—Length of cephalothorax, 2.5 mm.

Length of abdomen, 2.5 mm.

Length of first leg, 6.3 mm.

Length of second leg, 5.9 mm.

Length of third leg, 5.9 mm.

Length of fourth leg, 9 mm.

Color in Alcohol.—*Cephalothorax* clear reddish-brown, shining and without hairs, a little lighter on the antero-dorsal portion but with no distinct median stripe; a narrow black marginal line; forehead yellowish; the second and third eyes on black tubercles. *Sternum* with a brown margin, otherwise yellow like the inferior surface of the coxæ. *Abdomen* above dark greenish-b own, a narrow yellow median stripe pointed at each end on the anterior half of the dorsum, and on either side of it two rows of large yellow spots converging toward the spinnerets; sides dark greenish-brown with numerous small yellow spots; venter yellow in front of and around the lung books, this yellow area ending posteriorly in a point anterior to the spinnerets, and to either side of it greenish-brown marbled with yellow. *Epigynum* reddish-brown. *Chelicera* reddish-brown; *labium* black with yellow distal end; *maxillæ* yellow. *Legs* yellow, with distinct broad brown rings on all the joints except the metatarsi.

Comparisons.—This species has some resemblance to *L. nigra* (Stone), but differs from the latter in epigynum, form of sternum, and coloration of abdomen and legs. The epigynum is comparatively small and simple, but evidently mature since it is distinctly elevated and dark colored.

3. **Lycosa ocreata pulchra** n. subsp. (Pl. XXIX, figs. 3, 4.)

Lycosa ocreata Hentz, Keyserling, 1876.
? *Lycosa ocreata* Hentz, Emerton, 1888.
Lycosa ocreata Hentz, Stone, 1890.
? *Lycosa ocreata* Hentz, Banks, 1892.

(Specimens from Philadelphia, York Furnace and Luzerne county, Pa.)

Eyes.—First row narrower than the second, lateral eyes slightly larger and lower, middle eyes nearer to each other than to the lateral. Eyes of second row largest, less than their diameter apart. Eyes of third row circular, nearly as far from second row as from each other. Dorsal eye area less than one-quarter the length of the cephalothorax.

Form.—Cephalothorax rather narrow in outline. Length of chelicera about 1½ times the height of the head in front. Sternum considerably longer than broad, pointed behind. Legs slender, rather scantily covered with hairs.

Dimensions.—Length of cephalothorax, ♂, 2.7 mm.; ♀, 3.3 mm.

Length of abdomen, ♂, 2.8 mm.; ♀, 5.3 mm.
Length of first leg, ♂, 8.9 mm.; ♀, 9 mm.
Length of second leg, ♂, 8 mm.; ♀, 8.5 mm.
Length of third leg, ♂, 7.3 mm.; ♀, 8 mm.
Length of fourth leg, ♂, 10 mm.; ♀, 12.5 mm.

Color in Life.—*Cephalothorax* in the ♀ with a broad buff median band widest at the middle and extending from the anterior eyes backward the whole length of the dorsum, and in it a short, very narrow darker line between the posterior eyes and a similar line at the dorsal groove; on each side of this band a broad dark-brown band, next a narrow buff line, then a submarginal band, composed of a single row of dark-brown spots, finally a narrow buff marginal line. *Sternum* pale yellow-brown with a darker marking in the form of a closed curve, rounded anteriorly and pointed posteriorly, the extreme margin of sternum being brownish-black. *Abdomen* above a grayish-buff, with, on the anterior half, a median brown band pointed behind, there ending at about the middle, and including a lighter band; to each side of this a rather indistinct brown band extending about to the middle, and continued toward the spinnerets as a row of about five black spots with pale spots between them; sides of abdomen a lighter ground color, with numerous short brown stripes pointing caudad and a few dark-brown spots; venter grayish-white, with two pairs of longitudinal rows of small brown spots converging toward spinnerets, the inner rows more pronounced in their anterior portions, the outer rows in their posterior portions. *Legs* yellowish, darker above, the *palpi* and *maxillæ* the same color, the *chelicera* darker, and the *labium* black. Superior *spinnerets* pale gray, the inferior brown.

In some females the dark stripes are lacking on the venter.

The males are very similar in coloration, but darker, particularly on the abdomen, and the tibia of the first leg is densely covered with long black hairs, resembling the arrangement of bristles on a test-tube cleaner.

Comparisons.—I have made a new subspecies of this Pennsylvania form on the ground of the absence, in all the numerous specimens examined, of dark annulations on the legs. Hentz both described and figured for his *L. ocreata* dark markings on the legs. His specimens were from North Carolina. *L. rufa* Keyserling is not the ♀ of this species, as Keyserling suggested it might be.

4. **Lycosa relucens** n. sp. (Pl. XXIX, figs. 5, 6.)

(1 ♀, 2 ♂♂, types, Stone Coll., Germantown, Philadelphia.)

Eyes.—First row straight, its eyes of equal size, narrower than the second row. Eyes of second row largest, more than their diameter apart. Third row widest, its eyes on black tubercles and slightly nearer second row than each other. Dorsal eye area about one-fifth the length of the cephalothorax.

Form.—Cephalothorax pointed in front and rounded behind. Chelicera not quite 1½ times as long as the head is high in front. Sternum a little longer than broad. Maxillæ more than twice as long as the labium. Legs stout.

Dimensions.—Length of cephalothorax, ♂, 3.5 mm.; ♀, 3.4 mm.

Length of abdomen, ♂, 3 mm.; ♀, 3.2 mm.
Length of first leg, ♂, 12.2 mm.; ♀, 11 mm.
Length of second leg, ♂, 11.8 mm.; ♀, 10.5 mm.
Length of third leg, ♂, 10.1 mm.; ♀, 10.3 mm.
Length of fourth leg, ♂, 16 mm.; ♀, 14.5 mm.

Color in Alcohol.—*Cephalothorax* in the ♀ light yellowish-brown, eyes surrounded by black; a yellow median band, as broad as the space between the posterior eyes, extending from the second eyes to the posterior end of the thorax; extreme margin black. *Sternum* yellowish. *Abdomen* above brownish and darker than the cephalothorax, an indistinct black mark at each antero-lateral angle, a black spot at the middle point of dorsum, and indistinct blackish spots on the margins of the posterior dorsum; sides yellowish-brown with darker spots posteriorly; venter lighter, yellow, with obscure dark markings on the margins near the spinnerets. *Spinnerets* yellow. *Epigynum* very pale reddish-brown. *Chelicera* reddish-brown, with a darker line formed of blackish hairs on the anterior aspect of each. *Labium* and *maxillæ* yellow. *Legs* pale yellowish-brown without darker markings, *palpi* similarly colored.

In the ♂ the coloration is darker. *Cephalothorax* chocolate-brown; in one individual there pass from near the middle of each side of the median light band two radiating bands of the same color to the more indistinct submarginal band, one of these radiating bands following the line of the cephalo-thoracic groove, the other passing latero-caudad. *Abdomen* above in the brighter individual (type) with a large black spot at each antero-lateral margin, a black spot at the centre of the dorsum from which two very narrow black lines pass forward and diverge, and on each margin of the dorsum a row of about six smaller black spots, the most posterior incompletely connected with those of the opposite side by cross lines of minute black dots; in the other ♂ these markings are very indistinct. Sides and venter as in ♀. *Legs* and *palpi* darker than in ♀.

Comparisons.—This form is quite similar in general appearance to *L. verisimilis* n. sp.; both have also the line of hairs on the anterior surface of the chelicera; but the genitalia of the two are quite different, and *relucens* has much stouter legs.

5. Lycosa sepulchralis n. sp. (Pl. XXIX, fig. 7.)

(1 ♀, type, author's collection, Woodland Cemetery, Philadelphia.)

Eyes.—First row very slightly broader than the second, its middle eyes slightly higher and larger than the lateral. Eyes of second row largest, more than their diameter apart. Third row slightly wider than second, its eyes nearer to the second row than to each other. Dorsal eye area only about one-sixth the length of the cephalothorax. All eyes relatively small.

Form.—Head rather low in front and its sides oblique. Cephalothorax very broad in front, more than three-fifths its greatest diameter, highest just behind the posterior eyes. Sternum longer than broad. Chelicera massive, their length about twice the height of the head in front. Legs short, tapering in diameter from proximal to distal end.

Dimensions.—Length of cephalothorax, 4.6 mm.

Length of abdomen, 6.2 mm.

Length of first leg, 12 mm.

Length of second leg, 10.8 mm.

Length of third leg, 10.4 mm.

Length of fourth leg, 15 mm.

Color in Life.—*Cephalothorax* black, a brown area surrounding the eye region and superior part of sides of head and forehead, this brown passing backward as a median band as broad as the eye area, constricted just anterior to the dorsal groove and forming a narrow line on each side of this grove; a narrow marginal line of brown. *Sternum* jet-black and shining, without hairs. ***Abdomen*** above brown, a slightly darker indistinct median band on the anterior half, a deep-black spot at each antero-lateral margin, and on each margin of the posterior half of the dorsum a row of five small spots of white hairs, the corresponding ones of opposite sides connected by transverse lines of black; sides finely marbled with brown and gray; venter deep black including the epigynum and the region in front of the lung slits, this black area converging behind to the spinnerets and its lateral margins somewhat racemose. *Chelicera, labium* and *maxillæ* deep black and glistening as also the under surface of the *coxæ;* the chelicera with few hairs and with a reddish prominence at the supero-lateral angle. *Legs* shining reddish-brown except the coxæ which are black above and below, femora unbanded; first legs unbanded and darker than the others; distinct annulations of brown and black on the patellæ, tibiæ and tarsi of the third and fourth legs, less distinct annulations on the second legs. *Palpi* blackish-brown.

In alcohol the black on the venter shows indistinct lines of minute brown spots converging toward the spinnerets.

Comparisons.—This species in the form of the head is somewhat intermediate between *Trochosa* and *Tarentula.* It is very close to *Lycosa* (*Tarentula*) *modesta* (Keys.), from which it differs: (1) slightly in the form of the epigynum; (2) in the middle eyes of the first row being much less than twice as large as the lateral, and in that the eyes of the second row are separated from each other by nearly their full diameter; (3) in the black color of the sternum and coxæ and in different coloration of the dorsum of the abdomen. It shows also close resemblances to *L. charonoides* n. sp., particularly in the shape of the legs and the coloration of the superior surface of the abdomen; but the head is much narrower and its sides steeper in *charonoides*, and the two species differ in the form of the epigynum and in the coloration of the lower parts.

6. Lycosa charonoides n. sp. (Pl. XXIX, fig. 8.)

(1 ♀, type, author's collection, Woodland Cemetery, Philadelphia.)

Eyes.—First row narrower than the second, its lateral eyes very slightly lower and a little smaller. Eyes of the second row about 1½ times their diameter apart. Third row widest, its eyes as larg as those of the second row, and about as far from them as from each other. Dorsal eye area less than one-fifth the length of the cephalothorax.

Form.—Chelicera not $1\frac{1}{2}$ times the length of the head in front, sides of head comparatively steep. Sternum longer than broad. Legs stout and tapering.

Dimensions.—Length of cephalothorax, 4.2 mm.

Length of abdomen, 7 mm.

Length of first leg, 12.5 mm.

Length of second leg, 12 mm.

Length of third leg, 12 mm.

Length of fourth leg, 16 mm.

Color in Life.—Cephalothorax with a narrow median stripe of long buff hairs extending from the second row of eyes to the posterior end of the thorax, its anterior two-fifths divided into two by a black line; the remainder of the cephalothorax black with short brown hairs, and a few scattered long buff hairs on the posterior aspects of the sides. *Sternum* black with scattered long white hairs. *Abdomen* above lighter than cephalothorax, very dark chocolate-brown, a tuft of long buff hairs at the anterior dorso-median edge and two very short stripes of similar hairs diverging backward from this tuft, between them a median blackish mark shaped like a spearhead and terminating in a point anterior to the middle, and on the outer side of each buff stripe an indistinct blackish band; to either side of the mid-line a row of 4–5 minute spots, each composed of a few thick snow-white hairs; sides paler chocolate-brown, with numerous small white spots; venter buff with two lines of blackish color, converging from the lung books to the spinnerets, and two less distinct dark lines converging from epigynum not as far back as the spinnerets, and numerous dark small spots on the remainder of the venter. *Lung books* yellow, *epigynal* margins blackish, area around epigynum brown, *spinnerets* blackish-brown. *Chelicera* deep black, a nearly white knoblike projection at the supero-lateral angle of each. *Labium* deep black. *Maxillæ* rufous-black like the under surface of the *coxæ*. *Legs* deep rufous-brown with white hairs and black spines, femora a little lighter than the other joints.

In alcohol the black of the thorax and sternum becomes a brownish-black, and an indistinct broad, paler marginal band becomes apparent on the thorax.

Comparisons.—Cf. *L. sepulchralis* n. sp.

7. **Lycosa stonei** n. sp. (Pl. XXIX, figs. 9, 10.)

(Types of ♂ and ♀ in author's collection, from Philadelphia; numerous specimens from Philadelphia and its vicinity, and from West Chester, Pa.)

Eyes.—First row shorter than the second, its middle eyes slightly higher than the lateral. Eyes of second row largest, a little more than their diameter apart. Third row widest, its eyes nearly equidistant from each other and from the second row. Dorsal eye area nearly one-quarter the length of the cephalothorax.

Form.—Chelicera fully $1\frac{1}{2}$ times as long as the head is high in front. Sternum longer than wide, rather pointed behind. Superior spinnerets longer than the inferior. Legs long and slender, with short hairs and long spines. Labium barely half the length of the maxillæ and rather conically pointed at its distal end. Cephalothorax narrow, in front less than half its greatest transverse diameter, highest at third pair of eyes. Sides of head steep.

Dimensions. — Length of cephalothorax, ♂, 3.1 mm.; ♀, 3.1 mm.

Length of abdomen, ♂, 3 mm.; ♀, 3.5 mm.
Length of first leg, ♂, 12.3 mm ; ♀, 10.1 mm.
Length of second leg, ♂, 11 mm.; ♀, 9.8 mm.
Length of third leg, ♂, 10.5 mm.; ♀, 9 mm.
Length of fourth leg, ♂, 14.5 mm.; ♀, 14 mm.
An unusually large ♀ has a total length of 9.5 mm.

♂. *Color in Life.*—*Cephalothorax* above glistening black, a median gray stripe (composed of long gray hairs which readily rub off) commencing anteriorly between the posterior eyes, where its width equals the distance between these eyes, and extending backward, usually with more or less of a middle constriction, to the posterior end of the thorax, where it is somewhat narrower; a few similar light hairs around the middle eyes, and a narrow line of them at the extreme margin of the thorax. *Sternum* deep black with a narrow marginal line of short gray hairs. *Abdomen* above black with a broad median band, almost the width of the dorsum and broader than the thoracal band, composed of long grayish hairs and extending to the spinnerets; sides black; venter black but with grayish hairs, these most densely grouped on the margins of the posterior half where they compose two grayish bands. *Lung books* pale yellowish-white. *Spinnerets* dark at base and light at tips. *Chelicera* and *labium* deep black, *maxillæ* brownish-black. *Legs:* First leg with the coxa, femur, patella and tibia deep black, tarsus and metatarsus yellowish-brown, the tarsus with a black ring at its proximal end, short black hairs hide the claws of the metatarsus, the tibia thickly covered with long black thick hairs implanted on all sides, but most numerous dorsally and ventrally, each tibia thus resembling a black brush (but the hairs relatively not as long as in *L. ocreata pulchra*); second leg with the coxa, femur, patella and tibia black, tarsus yellowish-brown, with dark rings at the ends and one in the middle, metatarsus yellowish-brown; third and fourth legs with the coxa and femur deep black, the patella rufous-black, the tibia, tarsus and metatarsus yellowish-brown with dark rings; the distal ends of all metatarsi black. *Palpi* black, except the tarsus, which is brownish-black.

In alcohol the dorso-median thoracic appears red, that of the abdomen brownish.

♀. *Color in Life.—Cephalothorax* black, a broad median band composed of long gray-buff hairs (not nearly white as in the ♂) extending from the posterior eyes to the posterior end of the thorax, broadest anteriorly where it occupies the whole space between the second and even extends a little lateral to them, filling the space between the third eyes and with a slight constriction at this point, enlarging slightly at middle and here more or less distinctly notched, narrower behind. To each side of this band the black color is hairless, but on the lower sides with rather sparsely scattered white hairs, such hairs forming also a very narrow marginal band. Sides of head, forehead and clypeus rusty black. *Sternum* a rusty dark-brown with a narrow pale margin. *Abdomen* above at base, next to pedicel, with a transverse band of black, and when the abdomen is viewed strictly from the dorsum each end of this band appears as a large black spot at an antero-lateral margin, and in some individuals these spots are continuous with those placed posteriorly; ground color of dorsum buff-brown, with large irregular spots of black on the margins converging toward the spinnerets, two pairs of these spots on the anterior half being particularly prominent, corresponding spots of opposite sides transversely connected by angular black lines each margined posteriorly with a narrow line of white hairs, and at the middle point of each black transverse line a black spot; on the anterior half of the dorsum two small round spots, each black medially and white laterally, placed close together near the mid-line. Sides of abdomen brownish with numerous small white spots. Venter pale gray, with small black spots converging more or less as curved lines toward the spinnerets and variable in number and size. *Lung books* pale yellowish-white and very distinct. *Epigynum* rusty brown. *Labium* deep ferruginous, almost black; *chelicera* the same color on their anterior but a little paler on their posterior surface. *Maxillæ* pale yellowish-brown like the ventral surface of the *coxæ*. All the *legs* distinctly banded with buff and black above and below on all the joints except the metatarsi, which are yellowish-brown. *Palpi* similarly colored.

In alcohol the buff markings and thoracal stripe in the ♀ change to reddish, and the black of the cephalothorax, except around the eyes, to a deep reddish-brown.

Comparisons. — This beautiful small woodland species I take pleasure in naming for my friend, Mr. Witmer Stone, who was the first to monograph the Lycosids of this vicinity.

L. stonei shows a marked sexual difference in coloration, more than any other of the local forms, but as I have observed the copulation and mating, tnere is no doubt of the specific identity of the males and females here described.

It is a very well-marked species, the thick brush of hairs on the first tibia of the ♂ being shared only by the ♂ of *L. ocreata*, while the epigynum is easily distinguished by the great breadth of its median piece. In the slenderness and great length of the legs, as well as in the size of the dorsal eye area, it resembles *Pardosa*, but in all other characters is a typical *Lycosa*.

8. **Lycosa verisimilis** n. sp. (Pl. XXIX, figs. 11, 12.)

(1 ♀, type, West Chester, Pa. 1 ♂, type, Philadelphia; author's collection).

Eyes.—First row shorter than second, the middle eyes slightly larger and higher and closer together than to the lateral eyes. Eyes of second row circular and fully their diameter apart. Eyes of third row oval and nearer the narrower second row than each other. Eyes not black but clear in color. Dorsal eye area a little more than one-sixth the length of the cephalothorax.

Form.—Length of chelicera fully twice the height of the head in front, a line of black hairs on the anterior face of each. Sternum distinctly longer than broad. Legs long and slender with numerous fine hairs. Cephalothorax in front almost half its greatest transverse diameter, highest at middle, sides of head rather steep.

Dimensions.—Length of cephalothorax, ♂, 3.2 mm.; ♀, 4.2 mm.

Length of abdomen, ♂, 2.8 mm.; ♀, 4.1 mm.
Length of first leg, ♂, 9.9 mm.; ♀, 12.5 mm.
Length of second leg, ♂, 9 mm.; ♀, 11.8 mm.
Length of third leg, ♂, 9 mm.; ♀, 12.1 mm.
Length of fourth leg, ♂, 12.5 mm.; ♀, 16.7 mm.

♀, *Color in Alcohol.*—*Cephalothorax* very dark reddish-brown, eye region black, a broad buff median stripe arising between the posterior eyes, widest in its anterior third and most anteriorly containing a narrow black line, and extending caudad to the end of the thorax; and there is a much narrower, interrupted submarginal stripe. *Sternum* dark reddish-brown, with a median lighter line anteriorly. *Abdomen* above considerably lighter than cephalothorax, brown and buff as follows: a dark-brown spot at each antero-lateral margin continued backward along the lateral margin of the dorsum as a brown line anteriorly and a row of brown dots posteriorly, between these brown margins a broad dark-buff band which, on the posterior half, is broken into 4–5 transverse buff arches separated by dark-brown dots, and in the anterior half contains a spearhead-shaped black mark terminating in a black spot just behind the middle of the dorsum; sides dark-buff with numerous brown spots; venter light buff with small black spots arranged in a U-shape, the opening of the U directed cephalad and its curve just anterior to the spinnerets, while the space enclosed by it contains a few minute black dots. *Epigynum* and *spinnerets* dark reddish-brown; *lung book* and region anterior to epigynum pale brownish. *Chelicera* dark reddish-brown, almost black; *labium* blackish at base and yellow at tip; *maxillæ* reddish-brown, a little lighter at the distal end. *Legs* with black spines and short white hairs, reddish-brown and much lighter than the sides of the cephalothorax, with distinct annulations on all joints except the metatarsi, the coxæ beneath pale yellowish-brown. *Palpi* colored like the legs.

♂. *Color in Alcohol.*—Much like the ♀. *Cephalothorax* a very dark reddish-brown, median band clear reddish and broadest in its anterior third, extending from middle eyes to posterior end of thorax, in its anterior third divided by a median dark line broadest anteriorly, long whitish hairs being present on each side of this dark line; the median thoracal band is widest a little anterior to the middle of the cephalothorax (where it is not quite as wide as the distance between the eyes of the third row), is there constricted and narrower posterior to this constriction; there is also a rather indistinct broad submarginal band of reddish; black bands connect the eyes of the second and third rows. *Sternum* as in ♀. *Abdomen* above dull brown with a broad pattern of lighter yellowish-brown, this pattern broadest anteriorly, narrowing toward the spinnerets and enclosing in its anterior half a darker oval mark with narrow black border; sides dull brown with paler stripings ventrally; venter light reddish-brown, a line of indistinct small dark spots on each margin, a median dark band extending from the anterior edges of the lung books anteriorly to a distance of one-fifth the length of the abdomen from the spinnerets posteriorly, this median band concave anteriorly where it has a width equaling the distance between the yellow *lung books*, and narrowed posteriorly where it ends bluntly, and to either side of this band minute yellowish spots. *Chelicera* reddish-brown, *labium* a little lighter at tip, *maxillæ* yellowish-brown like the *coxæ*. *Legs* clear reddish-brown, without darker rings, metatarsi a little lighter. *Palpi* colored like legs.

Comparisons.—A quite distinct species, resembling superficially the young of *L. frondicola* Em.

9. **Lycosa arenicola** Scudder. (Pl. XXIX, fig. 13.)

Lycosa arenicola Scudder, 1877.
Lycosa nidifex Marx, 1881.
Lycosa nidifex Marx, Everton, 1885.
Lycosa arenicola Scudder, McCook, 1888.
Lycosa arenicola Scudder, Marx, 1889.
Lycosa arenicola Scudder, Stone, 1890.
Lycosa domifex Hancock, 1899.

(Specimens from Cape May and Pt. Pleasant, N. J., in Stone Coll., but no mature ♂.)

Eyes.—First row almost as broad as the second, the centres of the lateral eyes of the first row lateral to the centres of the lateral eyes of the second rows, middle eyes larger and slightly higher. Eyes of second row largest, more than their diameter apart. Third row widest, its eyes nearer to the second row than to each other. Dorsal eye area a little more than one-sixth the length of the cephalothorax.

Form.—Cephalothorax very high in front, its posterior declivity very gradual and beginning anteriorly close to the posterior eyes, moderately sloping on the sides. Chelicera more than twice as long as the head is high in front, and with an elongate protuberance at the supero-lateral angle. Sternum longer than broad. First leg much thicker and stouter than the others.

Dimensions of ♀.—Length of cephalothorax, 10 mm.

Length of abdomen, 11 mm.

Length of first leg, 24 mm.

Length of second leg, 23 mm.

Length of third leg, 21 mm.

Length of fourth leg, 27 mm.

Colors in Alcohol, ♀♀.—*Cephalothorax* above reddish-brown to almost black, a lighter median band as broad anteriorly as the eye area extending backward and constricted just anterior to the dorsal groove, narrow around this groove, constricted more deeply just behind it and enlarging again to the posterior edge of the thorax; sides of the head sometimes as light as this band; extreme margin of thorax black. *Sternum* light-brown to blackish-brown. *Abdomen* above light to dark-brown, a median darker band extending the whole length of the dorsum, but most distinct on the posterior part, its margins posteriorly deeply pectinate; sides yellowish-brown dorso-posteriorly and with a black longitudinal band ventro-anteriorly; venter yellowish-brown to blackish with a more or less distinct darker area from epigynum to spinnerets, and a dark semicircle around the spinnerets anteriorly. *Epigynum* reddish-brown. Superior *spinnerets* lighter than the inferior. *Chelicera* deep reddish-brown to black, a reddish prominence at the supero-lateral angle. *Labium* and *maxillæ* reddish-brown with lighter distal ends, labium somewhat darker than the maxillæ. *Legs:* First leg darker than second, black in some individuals; second pair darker above than third and fourth, without annulations, distal ends of tarsi and metatarsi black. *Palpi* of the same color as the posterior legs.

Comparisons.—Easily distinguished from all others of the genus by the great thickness of the first legs. This is a character, united with that of the great height of the cephalothorax in front, which would seem to warrant the establishment of a new genus for it.

10. Lycosa punctulata Hentz. (Pl. XXIX, fig. 14.)

Lycosa punctulata Hentz, 1841.
Lycosa punctulata Hentz, Emerton, 1885.
nec *Lycosa punctulata* Hentz, Stone, 1890.
Lycosa punctulata Hentz, Marx, 1889.

(2 mature ♀♀, Philadelphia, author's collection.)

Eyes.—First row shorter than the second, lateral eyes slightly larger and slightly lower. Second eyes almost their diameter apart, slightly larger than third eyes. Third row slightly wider than second, its eyes nearer second row than each other. Dorsal eye area not one-fifth the length of the cephalothorax.

Form.—Cephalothorax comparatively slender, in front highest and not quite one-half as wide as the greatest transverse diameter. Sides of head steep. Length of chelicera about 1⅓ times the height of head in front. *Sternum* a little longer than broad. Legs rather stout, thickly covered with short hairs. A prominence on the supero-lateral angle of the chelicera. Superior spinnerets about as long as the inferior.

Dimensions.—Length of cephalothorax, 6.8 mm
Length of abdomen, 9 mm.
Length of first leg, 19 mm.
Length of second leg, 17.2 mm.
Length of third leg, 16 mm.
Length of fourth leg, 23 mm.

Color in Life.—*Cephalothorax* above pale chocolate-brown, two broad, parallel black stripes on the dorsum, separated from each other by about their own width, and extending from (and embracing) the second and third eyes to the posterior margin of the thorax; a narrow buff line between the second eyes; a narrow black submarginal and a black marginal line on the thorax; region between the eyes blackish, and a narrow, short black line on each side just ventral to the dorsal eyes. *Sternum* black with pale hairs. *Abdomen* above with a broad dark-brown median band extending the whole length of the dorsum, widest at the middle and anteriorly with a black edging on each margin of it, on each side of this median band paler grayish-brown with a rather indistinct large brownish spot at each antero-lateral margin; sides mottled with gray and reddish-brown; venter with a transverse row of three large black spots just behind the plane of the epigynum, and a blackish area extending from them and converging toward but not reaching the spinnerets, this black area bordered on each side by a line of contiguous buff dots; in the other ♀ the venter shows this blackish area in the same position, and scattered assymmetrically upon and around it about 16 deep black spots of varying size. *Epigynum* black, region about it yellowish. *Spinnerets* brown. *Chelicera* black, *maxillæ* and *labium* dark reddish-brown like the ventral surface of the *coxæ*. *Legs* light chocolate-brown without darker markings, the dorsal surface of the coxæ black.

Comparisons.—A well-defined species, agreeing with Hentz's description and figures. The specimens labeled by Stone "*punctulata*" and described as such by him are individuals of *L. scutulata* in which the dorso-median band of the abdomen is not notched posteriorly.

11. **Lycosa scutulata** Hentz. (Pl. XXIX, figs. 15, 16.)

Lycosa scutulata Hentz, 1841.
Lycosa scutulata Hentz, Emerton, 1885.
Lycosa scutulata Hentz, Marx, 1889.
Lycosa scutulata Hentz, Stone, 1890.
Lycosa punctulata Hentz, Stone, 1890.
Lycosa scutulata Hentz, Banks, 1892.

(Numerous specimens from Philadelphia, Chester county, York Furnace, Pa.; Pt. Pleasant, N. J.)

Eyes.—First row shorter than the second, the lateral eyes considerably lower than the middle. Eyes of second row largest, less than their diameter apart. Third row widest, its eyes nearer second row than each other. Dorsal eye area about one-fifth the length of the cephalothorax.

Form.—Cephalothorax narrow, in front not quite half its greatest transverse diameter, highest at the posterior eyes. Sides of head rather steep. Chelicera slightly more than $1\frac{1}{2}$ times as long as the head is high in front. Sternum longer than broad. Legs long and rather slender.

Dimensions.—Length of cephalothorax, ♂, 7 mm.; ♀, 7.5 mm.
Length of abdomen, ♂, 8 mm.; ♀, 13 mm.
Length of first leg, ♂, 28 mm.; ♀, 25 mm.
Length of second leg, ♂, 25 mm.; ♀, 23 mm.
Length of third leg, ♂, 23 mm.; ♀, 20 mm.
Length of fourth leg, ♂, 33 mm.; ♀, 31 mm.

Color in Life, ♀. *Cephalothorax* pale grayish-buff, a brown-black broad band on each side of the mid-line enclosing in front the eyes of the corresponding side and passing back to the end of the thorax, the buff line enclosed by these stripes much narrower than them and widest posteriorly; a narrow brown-black submarginal line, and a black vertical stripe from each lateral eye of the first row to the ventral margin of the head in front. *Sternum* pale yellowish with a darker margin. *Abdomen* above with a black-brown broad median band extending its whole length and widest at the middle, this band generally enclosing two or three oblique brown spots anteriorly and its margins indented by brown more posteriorly (though in some individuals such indentations are not present), and margined on each side by a narrower buff band; sides streaked black-brown and buff above, paler yellow with a few dark spots below; venter grayish-white with one or two pairs of narrow, longitudinal, slightly darker lines converging from the lung books to the spinnerets. *Spinnerets* dark, *epigynum* blackish, *lung books* grayish-white. *Chelicera* pale-brown with a reddish prominence at the supero-lateral angle, and a line of darker hairs anteriorly. *Labium* a paler brown, and *maxillæ* yellowish. *Legs* pale-brown, darker below than above, metatarsi of all a little darker, as also the distal ends of the tibia and tarsus of the fourth pair. *Palpi* colored like legs.

In alcohol the dark-colored stripes appear dark reddish-brown, the legs reddish, and the buff and brown of the abdomen yellowish.

Color in Life, ♂.—Similar to the ♀ except in following points: The anterior half of the medio-dorsal stripe of the abdomen a deep black; the first leg black on femur (almost whole extent ventrally, the distal half dorsally), patella, tibia and proximal two-thirds of the tarsus.

Comparisons.—A clearly marked species, easily distinguished from *L. punctulata*, with which it has sometimes been confounded, in both form and coloration.

12. Lycosa cinerea (Fabr.) (Pl. XXIX, figs. 17, 18).

Araneus cinereus Fabricius, 1793.
Lycosa cinerea Fabr., Emerton, 1885.
Lycosa lynx Hahn, 1831.
Lycosa halodroma C. Koch, 1848.
Arctosa cinerea Idem.
Arctosa lynx Idem.
Trochosa cinerea Fabr., Marx, 1889.
Trochosa cinerea (Fab.) Stone, 1890.
Lycosa maritima Hentz, 1841.

(Pt. Pleasant, Sea Isle, N. J.)

Eyes.—First row as broad as the second, or the centres of its lateral eyes more lateral than the centres of the lateral eyes of the second row, its middle eyes from $1\frac{1}{3}$ to $1\frac{1}{2}$ times as large as the lateral. Eyes of second row largest, not quite their diameter apart, separated from the first row by the diameter of a lateral eye of the latter. Third row widest, its eyes a little nearer second row than each other. Dorsal eye area about one-fifth the length of the cephalothorax.

Form.—Cephalothorax comparatively wide, its highest point a little anterior to the dorsal groove. Head low in front, height of forehead from the dorsal margins of the second eyes less than one-half the length of the chelicera. Legs slender. Sternum longer than wide. Epigynum very small, as also the tarsal joint of the ♂ palpus. Spinnerets long.

Dimensions (specimens from Pt. Pleasant).--Length of cephalothorax, ♂, 6.5 mm.; ♀, 6.5 mm.

Length of abdomen, ♂, 6.6 mm.; ♀, 9.5 mm.
Length of first leg, ♂, 19 mm.; ♀, 20 mm.
Length of second leg, ♂, 18.8 mm.; ♀, 18 mm.
Length of third leg, ♂, 18.6 mm.; ♀, 18.8 mm.
Length of fourth leg, ♂, 25.7 mm.; ♀, 25.5 mm.

Dimensions of ♂ from Sea Isle.—Length of cephalothorax, 5 mm.

Length of abdomen, 5 mm.
Length of first leg, 15 mm.
Length of second leg, 14.8 mm.
Lenth of third leg, 13.9 mm.
Length of fourth leg, 20 mm.

Color in Life (♂ from Sea Isle).—*Cephalothorax* marked intricately with white, gray-brown and black, as follows: Head white with a short black line passing downward and backward from each posterior eye; a broad dorsal area of white margined with grayish-brown and black in interdigitating patches; sides mainly white interrupted with grayish-brown lines, the extreme margin blackish. *Sternum* pale green. *Abdomen* with a medio-dorsal stripe of gray on the anterior half interruptedly margined with black, and on each side of the mid-line extending back to the spinnerets a row of 6–7 white spots margined with black and brownish; sides above white with black spots, below entirely white; venter immaculate white, *lung books* faint yellow, *spinnerets* greenish-brown. *Chelicera* black with long white hairs on the anterior surface, and a pale prominence at the supero-lateral angle. *Labium* black. *Maxillæ* pale brownish. *Legs* white with distinct brownish annulations and blotches on all joints except upon the brownish metatarsi, and more distinct above than below. *Palpi* colored like the legs, but the tarsi blackish. The females are colored like the males.

Comparisons.—The form here described is very probably the same as Hentz's *Lycosa maritima*. Whether it exactly agrees with the European *L. cinerea* I cannot decide from the descriptions of the authors, and have not had opportunity to see for myself specimens from Europe. If they should eventually prove not to be the same then Hentz's name would be applicable. Banks (1891) regards *maritima* Hentz as a synonym of *cinerea* (Fabr.).

The single ♂ I obtained at Sea Isle differs from the ♂♂ in the Stone collection from Pt. Pleasant in its much smaller size, and in that the first row of eyes is placed exactly upon the front edge of the head and not removed from it by a distance equaling the diameter of its smaller eyes. It is possible there may be two geographical varieties on the New Jersey coast.

13. Lycosa carolinensis Walck. (Pl. XXIX, figs. 19, 20.)

Lycosa tarentula carolinensis Walckenaer (Bosc. MSS.), 1837.
Lycosa (*Tarentula*) *Carolinensis*? Bosc. M.S., Hentz, 1841.
Lycosa carolinensis Hentz, Emerton, 1885.
Lycosa carolinensis Walck., Marx, 1889.
Lycosa carolinensis Walck., Stone, 1890.

(Specimens from Chester county, Pa., and Essex county, N. J.)

Eyes.—First row almost as broad as the second, the lateral larger than the middle eyes and slightly lower. Eyes of second row largest, circular, not quite their diameter apart. Third row wider than the second, the distance between its eyes considerably greater than the distance separating them from the second row. Dorsal eye area not more than one-sixth the length of the cephalothorax.

Form.—Cephalothorax highest at the posterior eyes, in front a little more than one-half its greatest transverse diameter. Sides of the head steep. Chelicera less than twice the height of the head in front, massive. Sternum longer than broad. Legs stout, thickly covered with short hairs

Dimensions.—Length of cephalothorax, ♂, 11 mm.; ♀, 12.5 mm.

Length of abdomen, ♂, 9 mm.; ♀, 11 mm.
Length of first leg, ♂, 36 mm.; ♀, 35 mm.
Length of second leg, ♂, 33 mm.; ♀, 32 mm.
Length of third leg, ♂, 29 mm.; ♀, 30 mm.
Length of fourth leg, ♂, 40 mm.; ♀, 40 mm.

Color in Alcohol, ♀.—*Cephalothorax* above dark reddish-brown without distinct markings, blackish around the eyes. *Sternum* black. *Abdomen* above dull brown, a median darker (sometimes indistinct) broad band on the anterior half, this band widest anteriorly and terminating bluntly at the middle; sides above like the dorsum, below yellowish-brown; whole venter behind the lung books black, *epigynum* reddish-brown as the spinnerets. *Chelicera* reddish-brown with black and orange hairs anteriorly and a bright red prominence at the supero-lateral angle. *Labium* and *maxillæ* black or deep reddish-brown with lighter tips. *Legs* dull reddish-brown, ventral surface of the coxæ black, and each joint with darker ends. *Palpi* reddish-brown.

Comparisons.—This is one of the few of Walckenaer's species which can be recognized with some certainty.

14. **Lycosa inhonesta** (Keys.). (Pl. XXIX, figs. 21, 22.)

Tarentula inhonesta Keyserling, 1876.
Tarentula tigrina McCook, 1878. (Not valid as a diagnosis.)
Lycosa vulpina Emerton, 1885.
Lycosa tigrina (McCook), Stone, 1890.
Lycosa vulpina Emerton, Banks, 1892.

(Several specimens of both sexes from Chester county, Pa.; 1 ♀ from Vineland, N. J., labeled in the handwriting of Dr. McCook, "Tarentula tigrina," may be his type.)

Eyes.—First row slightly wider than the second, the lateral eyes slightly lower and slightly smaller. Eyes of the second row largest, not quite their diameter apart. Third row widest, its eyes circular and farther from each other than from the second row. All eyes very small for the size of the spider. Dorsal eye area less than one-seventh the length of the cephalothorax.

Form.—Massive. Cephalothorax highest at the posterior eyes, in front slightly more than one-half its greatest diameter. Sides of head moderately oblique. Length of the chelicera more than twice the height of the head in front. Sternum about as broad as long. Legs stout, thickly covered with hairs.

Dimensions.—Length of cephalothorax, ♂, 9.2 mm.; ♀, 12.8 mm.

Length of abdomen, ♂, 8.8 mm.; ♀, 12 mm.

Length of first leg, ♂, 33 mm.; ♀, 32 mm.

Length of second leg, ♂, 31 mm.; ♀, 30.5 mm.

Length of third leg, ♂, 29 mm.; ♀, 28 mm.

Length of fourth leg, ♂, 35 mm.; ♀, 37 mm.

Color in Alcohol, ♀.—*Cephalothorax* above deep blackish-brown, in smaller individuals reddish-brown, a more or less distinct paler, very narrow median stripe from the middle eyes to the dorsal groove, a similar line on each side of the dorsal groove joining with its fellow to form an unpaired one posteriorly; there is also an indistinct and broader light submarginal band. *Sternum* blackish or deep brown. *Abdomen* above black in dark individuals, in light ones with a pale spot at the anterior end of the dorsum; sides somewhat lighter; venter blackish in very dark individuals, yellowish-brown in lighter ones, with generally three longitudinal black bands converging backward toward the spinnerets (each line sometimes a row of spots) and with small black spots. *Chelicera* thickly covered with black hairs. *Labium* and *maxillæ* black. *Legs* deep reddish-brown, blackish in dark individuals, in lighter ones clearly annulated on all the joints except the metatarsi, these annulations indistinct but discernible in dark individuals; ventral surface of coxæ black in dark individuals. *Palpi* colored like the legs.

The ♂♂ are colored like the lighter ♀♀. In one ♂ the black stripes on the venter are very distinct, in another the venter shows only small black spots on a yellowish-brown ground.

Comparisons.—These specimens agree so closely with Keyserling's description that I have no hesitation in regarding McCook's *tigrina* and Emerton's *vulpina* as synonyms of *inhonesta.* My specimens do not agree with Keyserling's description exactly in the form of the epigynum, but that organ shows considerable variation; Keyserling also states the length of the cephalothorax to be only 8.7 mm., and does not describe any light median thoracal band. But he adds: "In meiner Sammlung besitze ich mehrere Exemplare, die angeblich aus Brasilien stammen, ober vollständig mit dieser Art übereinstimmen, sie sind nur beträchtlich grösser und haben ein ganz schmales Mittelband über den vorderen Theil des Cephalothorax, das von hellen Härchen gebildet wird und bis zur zweiten Augenreihe reicht."

This species is similar in general appearance to *L. carolinensis,* its dark individuals particularly so, but they may be readily distinguished by the relative sizes of the eyes of the first row.

15. Lycosa nidicola Emerton. (Pl. XXIX, figs. 23, 24.)

Lycosa nidicola Emerton, 1885.
Lycosa nidicola Emerton, Marx, 1889.
Lycosa nidicola Emerton, Stone, 1890.
Lycosa nidicola Emerton, Banks, 1892.
Lycosa babingtoni Blackw., Banks, 1891.

(Numerous specimens from Chester county, Lancaster county, York county, Pa.; Pt. Pleasant, N. J.)

Eyes.—First row nearly as broad as the second, straight or the lateral eyes slightly higher, middle eyes decidedly larger. Eyes of the second row largest, fully their diameter apart. Third row broadest, its eyes farther from each other than from the second row. Dorsal eye area about one-sixth the length of the cephalothorax.

Form.—Cephalothorax in front not quite one-half its greatest transverse diameter, highest at posterior eyes. Head oblique on the sides. Length of chelicera about 1½ times the height of the head in front. Sternum longer than broad. Legs stout, well clothed with short hairs.

Dimensions of specimens from Chester county, Pa.—Length of cephalothorax, ♂, 6.8 mm.; ♀, 8.6 mm.

Length of abdomen, ♂, 5 mm.; ♀, 11 mm.

Length of first leg, ♂, 24 mm.; ♀, 24 mm.

Length of second leg, ♂, 21.5 mm.; ♀, 21.5 mm.

Length of the third leg, ♂, 20 mm.; ♀, 21.5 mm.

Length of fourth leg, ♂, 27 mm.; ♀, 29 mm.

Dimensions of the largest of several ♀♀ in the McCook collection, from an unknown locality in Pennsylvania.—Length of cephalothorax, 9.2 mm.

Length of abdomen, 10.5 mm.

Length of first leg, 24 mm.

Length of second leg, 23 mm.

Length of third leg, 22.5 mm.

Length of fourth leg, 31 mm.

Color in Life, ♀.—*Cephalothorax* above black, a very narrow brownish-buff median band extending from the anterior to the posterior eye-row, and continued as a somewhat broader band backward to the end of the thorax; a broader submarginal band of the same color, and some scattered buff hairs on the sides. *Sternum* deep black. *Abdomen* above deep dusky-brown, but not as dark as the cephalothorax, a black spot at each antero-lateral margin, between these and bounding them a light V-shaped mark with its apex directed cephalad, and diverging backward from the limbs of this mark a series of indistinct small light spots, some of them connected by transverse lines of the same color; sides deep blackish with numerous short streaks of buff-brown; venter pale brown anterior to lung slits, margins of the latter and a spot at the posterior edge of the epigynum black, behind the gill slits buff-brown with numerous small black spots that become confluent at the spinnerets, the larger of them arranged mainly in three narrow lines converging toward spinnerets. Margins of *epigynum* black. *Spinnerets* reddish-brown. *Chelicera* brownish-black, a red prominence at the supero-lateral angle. *Labium* and *maxillæ* black. *Legs* brown with indistinct buff annulations on the femora, patellæ and *tibiæ*; ventral surface of coxæ black. *Palpi* brown like the legs, with very indistinct annulations.

The ♂♂ are colored very much like the ♀♀, but are somewhat more distinctly marked. The *cephalothorax* of one alcoholic specimen has a short narrow buff band on each side parallel to the median stripe and extending from the posterior eyes to the middle of the cephalothorax. The *sternum* has sometimes a pale median line. The *abdomen* above dark brown with a broad black median band extending to behind the middle, and a pair of marginal bands of the same color extending to the spinnerets; the spots on the venter are often arranged very irregularly.

Comparisons.—A well-marked species. Banks (1891) considers it to be synonymic with *L. babingtoni* Blackw. I cannot agree with this conclusion, for though the coloration of the two is quite similar, *babingtoni* is described as having a thoracal length of two-fifths of an inch (a little more than 10 mm.), whereas the largest specimen I have seen of *nidicola* has a thoracal length of only 9.2 mm.; and in *babingtoni* the fourth leg is actually and proportionately shorter. Emerton mentions 9 mm. as the length of the cephalothorax in his specimens of *nidicola*, and presumably this is the measurement of his largest specimen. These are not great differences, but it is necessary to examine Canadian specimens of *babingtoni* before the identity of the two may be regarded as well established.

16. Lycosa baltimoriana (Keys.) (Pl. XXIX, fig. 25).

Tarentula Baltimoriana Keyserling, 1876.
Tarentula baltimoriana Keys., Marx, 1889.

(1 ♂, Maryland, McCook Coll.)

Eyes.—First row slightly broader than the second, its lateral eyes lower and less than half as large as its middle eyes. Eyes of second row largest, not quite their diameter apart. Third row broadest, its eyes farther from each other than from the second row. Dorsal eye area less than one-sixth the length of the cephalothorax.

Form.—Cephalothorax low for its diameter, head broad in front, and its sides rather oblique. Length of chelicera more than double the height of the head in front. Sternum longer than broad. Legs stout and hairy.

Dimensions.—Length of cephalothorax, 9 mm.

Length of abdomen, 7.5 mm.

Length of first leg, 31 mm.

Length of second leg, 28.5 mm.

Length of third leg, 26 mm.

Length of fourth leg, 33 mm.

Color in Alcohol.—*Cephalothorax* reddish-brown, a narrow white median line in the eye area, a lighter reddish area from the eyes to the dorsal groove and from the latter in radiations to the sides, the reddish and the darker reddish-brown there intergrading, extreme margin black. *Sternum* black. *Abdomen* above light-brown with grayish-white markings that form a large spot at each antero-lateral angle, a pair of large spots just anterior to the middle, and a series of four broad, zigzag arches across the posterior dorsum; the brown forms on the anterior half of the dorsum a median band that ends posteriorly notched. Sides gray, streaked posteriorly with oblique brown stripes. Venter yellowish-gray, with a broad transverse band of deep chocolate-brown extending across its entire width and from the lung slits in front almost to the spinnerets behind. *Spinnerets* yellowish-brown. *Chelicera* deep reddish-brown with pale yellow hairs superiorly, the supero-lateral prominence also deep reddish-brown. *Labium* black, *maxillæ* a little lighter. *Legs* clear reddish-brown, tarsi and metatarsi of the first and second darker, patellæ of all legs dark-brown beneath, coxæ below nearly as dark as the patellæ, indistinct dark rings on the femora.

Comparisons.—This specimen agrees perfectly with Keyserling's description, except that it is a little larger.

17. **Lycosa lepida** (Keys.). (Pl. XXIX, figs. 26, 27.)

Tarentula lepida Keyserling, 1876.
Lycosa communis Emerton, 1885.
Lycosa communis Emerton, Marx, 1889.
Tarentula lepida Keys., Marx, 1889.
Lycosa communis Emerton, Stone, 1890.
Lycosa communis Emerton, Banks, 1892.
? *Lycosa lenta* Hentz, 1841.
? *Lycosa erratica* Hentz, 1841.

(Numerous specimens from Philadelphia, Chester county, York Furnace, Pa.; Pt. Pleasant, N. J.)

Eyes.—First row much shorter than the second, its lateral eyes slightly lower. Eyes of the second row more than their diameter apart, not larger than those of the third row. Third row widest, its eyes nearer the second row than each other. Dorsal eye area not more than one-fifth the length of the cephalothorax.

Form.—*Cephalothorax* narrow, in front less than one-half its greatest transverse diameter, equally high at the middle and at the third pair of eyes. Sternum longer than broad. Chelicera massive, their length nearly twice the height of the head in front. Legs rather slender.

Dimensions. — Length of cephalothorax, ♂, 5.2 mm.; ♀, 7 mm.

Length of abdomen, ♂, 5.2 mm. ; ♀, 8.5 mm.
Length of first leg, ♂, 19 mm. ; ♀, 19 mm.
Length of second leg, ♂, 17 mm. ; ♀, 18 mm.
Length of third leg, ♂, 16.5 mm. ; ♀, 17.2 mm.
Length of fourth leg, ♂, 23 mm. ; ♀, 23.3 mm.

These are dimensions of unusually large individuals. In the same locality occur mature ♀♀ with a cephalothoracal length of only 5.5 mm.

Color in Life, ♂.—*Cephalothorax* above black, a grayish-brown median band from the posterior eyes to the end of the cephalothorax, a broader marginal band of the same color divided longitudinally in its anterior half by a black stripe, the ventral margin of the forehead and the space between the second eyes also gray; all these grayish markings are due to long hairs. *Sternum* nearly black, covered with grayish-brown hairs. *Abdomen* black on its anterior declivity, a broad light band extends on the dorsum from the anterior end nearly to the spinnerets where it ends in a point, this band buff-brown anteriorly and nearly white at its posterior end; in the anterior half of this band is a dark-brown mark edged with black and terminating bluntly at the middle of the dorsum, and on each side of the median light band is a row of large black spots; the sides are buff above and gray below; the venter nearly white with two black stripes diverging from the spinnerets forward, and each at its anterior end (just behind the lung slits) deflected mediad at a right angle so as almost to meet its fellow of the opposite side. *Spinnerets* reddish-brown, blackish at base. *Chelicera* almost black, with buff hairs anteriorly and a light prominence at the supero-lateral angle. *Labium* black. *Maxillæ* brown. *Legs* yellowish-brown with buff hairs on the femora, shorter white hairs elsewhere, the latter thickly grouped on the tarsi and metatarsi of the first and second legs. *Palpi* colored like legs.

The ♀♀ are colored somewhat less brightly than the ♂♂. The coloration is quite variable in this species. Sometimes the dark stripe included in the pale median band of the abdomen is lacking. The coloration of the venter is particularly variable; in four specimens the venter from the epigynum to the spinnerets is entirely black with no buff markings; in four others there is a pair of buff spots in the black; two others have one large buff spot in the venter; others have the black in the shape of a U on a light ground. All these colorations are found in the same locality.

Comparisons.—There are two of Hentz's species which may be referred with considerable uncertainty to this one, namely *lenta* and *erratica ;* but in my opinion his figures, and still more his descriptions, give too inadequate a diagnosis (compare Banks, 1891).

18. Lycosa nigraurata n. sp. (Pl. XXX, fig. 53.)

(1 ♂, type, Medford, Burlington county, N. J., Stone Coll.)

Eyes.—First row shorter than the second, straight, its middle eyes slightly larger. Eyes of second row fully their diameter apart. Third row broadest, its eyes largest and considerably nearer the second row than each other. Dorsal eye area less than one-sixth the length of the cephalothorax.

Form.—Cephalothorax in front not quite one-half its greatest transverse diameter, highest behind the middle, rather low and flat. Sides of head rather oblique. Chelicera about twice the length of the height of the head in front. Sternum distinctly longer than broad. Legs rather stout.

Dimensions.—Length of cephalothorax, 5.3 mm.
Length of abdomen, 5.3 mm.
Length of first leg, 18 mm.
Length of second leg, 16.6 mm
Length of third leg, 16 mm.
Length of fourth leg, 22 mm.

Color in Alcohol.—*Cephalothorax* with a dull orange, broad median stripe extending from the second row of eyes to the posterior end of the thorax, constricted slightly just anterior to dorsal groove, widest around and narrowed behind this groove, and containing anteriorly a pair of elongate black spots; on each side of this median band a black stripe extending from the posterior eye to the end of the thorax, narrowest anteriorly and its greater diameter not equaling that of the median band; a broad submarginal band of dull orange, interrupted by bands of black radiating from the black stripe; extreme margin of thorax with alternating orange and black; forehead dull orange, a large black spot at the ventral margin of each side of the head. *Sternum* pale yellowish-brown with a narrow blackish margin. *Abdomen* above dark yellowish-brown, a deep black band arises at each antero-lateral margin and is continued back to about the middle, and behind each of these bands some small black spots, one pair of which, about the middle of the posterior half of the dorsum, is particularly prominent;

sides lighter than the dorsum, finely mottled with buff and brown; venter with a broad blackish area (its lateral margins deep black) extending from just behind the lung books to the spinnerets, the region of the genital orifice deep brown, the *lung books* yellow. *Chelicera* almost black, with a pale prominence at the supero-lateral angle, and covered anteriorly with both black and yellow hairs. *Labium* black proximally, yellow distally; *maxillæ* yellowish. *Legs* above pale reddish-brown, indistinct mottlings of blackish on all the femora and on the fourth tibiæ, coxæ and femora of all much paler below. *Palpi* like the legs, except that the tarsus is almost black.

Comparisons.—This species differs from *purcelli* n. sp., *frondicola* Emerton, and *kochii* (Keyserling), to all of which it shows resemblances, in the posterior eyes being the largest, in the proportionately and absolutely larger size of the palpal organ, and in the black stripes on the cephalothorax.

19. **Lycosa frondicola** Emerton. (Pl. XXX, figs. 28, 29.)

Lycosa frondicola Emerton, 1885.
Lycosa frondicola Emerton, Marx, 1889.
Lycosa frondicola Emerton, Stone, 1890.
Lycosa frondicola Emerton, Banks, 1892.

(Specimens from Philadelphia, Pa; Pt. Pleasant, N. J.)

Eyes.—First row fully as broad as the second, the lateral eyes slightly higher than the middle, the middle eyes approximated. Eyes of second row largest, their diameter apart. Third row broadest, its eyes nearer the second row than each other. Dorsal eye area less than one-sixth the length of the cephalothorax.

Form.—Cephalothorax rather narrow, in front more than one-half its greatest transverse diameter, flat above, highest between the posterior eyes and the dorsal groove. Sides of head moderately oblique. Chelicera massive, their length more than twice the height of the head in front. Sternum longer than broad. Legs stout, thickly covered with short hairs.

Dimensions.—Length of cephalothorax, ♂, 6.1 mm.; ♀, 6.2 mm.

Length of abdomen, ♂, 5.5 mm.; ♀, 8.5 mm.
Length of first leg, ♂, 20 mm.; ♀, 15.5 mm.
Length of second leg, ♂, 17 mm.; ♀, 14 mm.
Length of third leg, ♂, 16 mm.; ♀, 15 mm.
Length of fourth leg, ♂, 23 mm.; ♀, 18 mm.

Color in Alcohol, ♀.—*Cephalothorax* dark reddish-brown, a broad median band of yellowish-brown (with white hairs) from the posterior eyes to the posterior end of the thorax, a narrow marginal line of white hairs, posterior eyes surrounded by black, sometimes an indistinct light submarginal band. *Abdomen* above brown or yellowish-brown, a pair of small black spots on the anterior third of the dorsum near the mid-line, a large black spot at each antero-lateral margin of the dorsum continued caudad as an indistinct blackish band; sides lighter brown; venter yellowish with a broad blackish area extending from the epigynum to the spinnerets and not sharply bounded laterally, and indistinct blackish spots in the lateral yellow area. *Sternum* reddish-brown with black hairs. *Chelicera* black or reddish-black, with a black prominence at the supero-lateral angle. *Labium* blackish. *Maxillæ* blackish with yellow distal ends. *Legs* reddish-brown, with no distinct darker markings. *Palpi* colored like legs.

The ♂♂ are colored similarly, but darker. The abdomen above is more grayish, with the black markings more distinct. The legs also are darker than in the ♀, and with darker markings on the femora.

Comparison.—Compare *Lycosa purcelli* n. sp.

20. Lycosa Purcelli n. sp. (Pl. XXX, figs. 30, 31.)

? *Lycosa kochii* Keyserling, Emerton, 1885.
Lycosa kochii Keyserling, Stone, 1890.
Tarentula kochii Keys., Marx, 1889 (*in parte*).
? *Lycosa kochi* Keys., Banks, 1892.
nec *Tarentula Kochii* Keyserling, 1876.

(Types in Stone Coll., ♀ from Philadelphia, ♂ from Pt. Pleasant, N. J.; other specimens from Philadelphia and Chester county, Pa.; Waterford, N. J.)

Eyes.—First row shorter than the second, lateral eyes slightly lower, middle eyes nearer the lateral than each other; eyes of the second row largest, about their diameter apart; third row broadest, its eyes a little farther from each other than from the eyes of the second row. Dorsal eye area about one-sixth the length of the cephalothorax.

Form.—Cephalothorax flattened above, highest behind the middle, in front nearly one-half its greatest transverse diameter. Head low in front and its sides rather oblique Chelicera massive, their length more than twice the height of the head in front. Sternum distinctly longer than broad. Legs comparatively stout.

Dimensions of types.—Length of cephalothorax, ♂, 6 mm.; ♀, 7 mm.

Length of abdomen, ♂, 5 mm.; ♀, 6.5 mm.
Length of first leg, ♂, 18 mm.; ♀, 20 mm.
Length of second leg, ♂, 17.3 mm.; ♀, 18 mm.
Length of third leg, ♂, 15 mm.; ♀, 17.5 mm.
Length of fourth leg, ♂, 21 mm.; ♀, 24.5 mm.

The smallest mature ♀ has the following dimensions: Cephalothorax, 5.6 mm.; abdomen, 6 mm.; first leg, 16 mm.; second leg, 14.5 mm.; third leg, 14 mm.; fourth leg, 20 mm.

Color in Life, dark ♀.—*Cephalothorax* blackish-brown, with paler brown hairs, these forming a broad median brown band which becomes narrower posteriorly and extends from the eyes of the second row to the posterior end of the thorax, at each side of its posterior portion (on the posterior declivity of the thorax) a large triangular black spot; all the hairs are short except those between the eyes. *Sternum* nearly black, with brownish hairs. *Abdomen* above buff-brown with no distinct pattern except a pair of black spots at the anterior margin, and an indistinct blackish line along the margins of the dorsum; sides paler, yellowish-buff; venter rich buff with numerous small black spots, most abundant at each lateral margin where they form an indistinct longitudinal stripe. *Epigynum* black. *Lung books* yellowish. *Chelicera, labium* and *maxillæ* almost black with lighter tips. *Legs* ferruginous, the femora with buff annulations, and all joints sparsely covered with pale brownish hairs; ventral surface of the tarsi and metatarsi of the first and second pairs, and to less degree the metatarsi of the third and fourth pairs, paler owing to scopulæ of very short, whitish hairs. *Palpi* colored like legs.

Color in Alcohol, ♀♀.—*Cephalothorax* light to dark brownish-yellow, the median band pale orange. *Sternum* and *coxæ* yellowish. *Abdomen* above yellowish-brown, darker than the cephalothorax, the black markings quite distinct; sides mottled yellow and brown; venter brownish-yellow, a row of small brown spots on either side, and in the middle either a dark area or a pair of rows of small brown spots converging from the epigynum to the spinnerets. *Epigynum* dark-brown. *Chelicera* reddish-brown, *max-*

illæ and *labium* lighter. *Legs* yellowish-brown, without darker markings or with them on the femora only.

Color in Alcohol, ♂♂.—*Cephalothorax* reddish-brown, the extreme margin black, a broad reddish median band of the same shape as in the ♀, and in the region of the median groove radiations of the same color from it to a broad submarginal band composed of whitish hairs. *Sternum* reddish-brown, with darker margin and black hairs. *Abdomen* above brown, a black stripe on either margin extending from the anterior end to behind the middle, and behind each of these stripes one or two dark spots; sides brownish; venter darker brown, lighter anterior to the lung slits. *Chelicera* black. *Labium* black at base only. *Maxillæ* clear reddish-brown, like the *coxæ*. *Legs* reddish-brown. *Palpi* colored like the legs, the tarsus darker.

Comparisons.—This species is very similar to *Lycosa kochii* Keys. in general coloration, dimensions and form. I have decided to separate them on the ground of the differences in the form of the epigynum. Keyserling's figure shows the epigynum rounded anteriorly, the swollen portion of the median piece very large, and this median portion with a deep groove on each side of it. In all the specimens of *purcelli*, on the other hand, the epigynum is conically pointed anteriorly, the swollen portion of the median piece is less than half the length of this piece, there is not a deep groove all around the median piece, and the marginal pieces are quite different in form from those represented in Keyserling's figure. Emerton has figured only a portion of the epigynum, so that I cannot decide whether he described *kochii* or *purcelli*; and Banks has not given any description.

In general coloration this species is very similar to *L. frondicola* Emerton, and some males of *purcelli* are as dark on the venter as the males of *frondicola*. The epigyna and ♂ palpi offer good diagnostic differences, and the cephalothorax is more slender in *frondicola*.

I dedicate this species to my old friend, Dr. W. F. Purcell, of the South African Museum, Capetown, who has written much of importance on the morphology and classification of different groups of the *Arachnida*.

Genus **PARDOSA** C. Koch.

The following key will aid in determining the species here described:

A.—Sternum darker than the coxæ.
  I.—Light markings on the posterior half of the dorsum of the abdomen usually distinct, ♂ palpus black on all the joints, ... *nigropalpis.*
  II.—Light markings on the posterior half of the dorsum of the abdomen indistinct, the patella of the ♂ palpus white, ... *minima.*
B.—Sternum not darker than the coxæ.
  I.—Median light band of the cephalothorax bordered by black bands, ... *scita.*
  II.—Median light band of the cephalothorax not bordered by black bands, ... *solivaga*

21. **Pardosa nigropalpis** Emerton. (Pl. XXX, figs. 32-34.)

Pardosa nigropalpis Emerton, 1885.
Pardosa nigropalpis Emerton, Marx, 1889.
Pardosa nigropalpis Emerton, Stone, 1890.
Pardosa nigropalpis Emerton, Banks, 1892.

(Numerous specimens from Philadelphia, Chester county, Lancaster county, Pa.; Pt. Pleasant, N. J.)

Eyes.—First row shorter than second, its lateral eyes slightly higher. Eyes of the second row more than their diameter apart. Third row broadest, its eyes slightly smaller than those of the second row, and almost as far from each other as from the second row. Dorsal eye area fully one-quarter the length of the cephalothorax.

Form.—Cephalothorax in front less than one-half its greatest transverse diameter, highest at the third pair of eyes, sides of the head vertical. Chelicera barely as long as the head is high in front, weak. Sternum distinctly longer than broad. Legs slender with long spines and few hairs. Superior spinnerets longer than the inferior.

Dimensions. — Length of cephalothorax, ♂, 2.2 mm.; ♀, 2.4 mm.

Length of abdomen, ♂, 2.2 mm.; ♀, 2.5 mm.
Length of first leg, ♂, 7 mm.; ♀, 8.2 mm.
Length of second leg, ♂, 6.6 mm.; ♀, 7.2 mm.
Length of third leg, ♂, 6.2 mm.; ♀, 7.2 mm.
Length of fourth leg, ♂, 10 mm.; ♀, 12.1 mm.

Color in Life. ♀.—*Cephalothorax* black, with a median brown band that commences anteriorly at the posterior eyes and there is nearly as broad as the eye area, is constricted a little before the middle, enlarges again around the dorsal groove but is narrowed behind it; there is a less distinct narrow submarginal brown band on the sides posteriorly, and brown on the sides of the head. *Sternum* black with white hairs and a lighter median line. *Abdomen* above with a large black spot at each antero-lateral margin, a yellowish-brown broad median band on the anterior third continued back to the spinnerets as a narrower and less distinct brown band, and on the sides of it black and brown mottlings; sides brown and whitish; venter blackish-brown behind the epigynum. *Lung books* bright yellow, *epigynum* black. Inferior *spinnerets* darker than the superior. *Cheliceræ* and *labium* black with a brownish tinge, *maxillæ* lighter. *Legs* distinctly annulated brown and blackish on all joints, except the metatarsi. *Palpi* colored like the legs.

Color in Alcohol. ♀ ♀.—*Cephalothorax* blackish, a broad submarginal yellow band continuous posteriorly with that of the other side, median band yellow; eye area dark, but forehead light. *Sternum* in dark individuals black, in others black with yellow spots, or dark-brown with a yellow median line. *Abdomen* above blackish-brown mottled with minute yellowish dots, a yellow median stripe (margined by black) on the anterior half and ending in a point anterior to the middle, and behind it a series of 5–6 transverse, broad yellowish arches extending to the spinnerets, each edged broadly with black anteriorly, and each containing a pair of small black dots; in some individuals these arches are very distinct, in others barely apparent, and they are clearer on alcoholic than on living specimens; sides streaked with brownish-yellow and blackish; venter yellowish or brownish, sometimes with an indistinct darker longitudinal band (or a pair of darker lines) behind the epigynum. *Lung books* yellow. *Epigynum* yellowish with brownish-red margins. *Spinnerets* yellow. *Legs* yellow, banded more or less distinctly with brown.

Color in Alcohol. ♂ ♂.—Like the ♀, but darker. *Cephalothorax* black, the yellowish median band extending forward, sometimes little farther than the dorsal groove, sometimes nearly as far as the posterior eyes; it is widest at its anterior end and constricted as in the ♀; an indistinct yellowish submarginal band is sometimes present; forehead below the first row of eyes yellowish, or black with two or three yellow spots. *Sternum* black. *Abdomen* above blackish, patterned as in the ♀; sides blackish; venter as in the ♀. *Legs* as in the ♀, except that the femora of the first pair are blackish proximally on the anterior edge. *Palpi* black on all the joints.

Comparisons.—A distinctly variable form, particularly in the coloration of the abdomen and in the form of the epigynum, two types of which I have figured. Females with the abdominal markings obscure are often difficult to distinguish from females of *L. minima*, though the males of the two are readily separated. It is the most abundant local species of the family.

22. Pardosa minima Keys. Pl. XXX, figs. 2, 3.

Lycosa minima Keyserling, 1876.
Pardosa albopatella Emerton, 1885.
Lycosa minima Keyserling, Marx, 1889.
Pardosa albopatella Emerton, Marx, 1889.
Pardosa albopatella Emerton, Stone, 1890.
Pardosa albopatella Emerton, Banks, 1892
Pardosa minima Keys., Banks, 1891.

A few specimens from Philadelphia and Luzerne county, Pa.

Eyes.—First row shorter than the second, its lateral eyes slightly higher. Eyes of second row largest, more than 1½ times their diameter apart. Third row a little broader than the second, its eyes farther from each other than from the second row. Dorsal eye area one-quarter the length of the cephalothorax

Form.—Cephalothorax flattened above, highest at third pair of eyes, in front not quite one-half its greatest transverse diameter, sides of head steep. Chelicera weak, little longer than the head is high in front. Sternum longer than broad. Legs slender with rather long spines and few hairs.

Dimensions. — Length of cephalothorax, ♂, 2.3 mm.; ♀, 2.4 mm.

Length of abdomen, ♂, 2.3 mm.; ♀, 2.5 mm.

Length of first leg, ♂, 7 mm.; ♀, 7.5 mm.

Length of second leg, ♂, 6.5 mm.; ♀, 6.6 mm.

Length of third leg, ♂, 6.5 mm.; ♀, 6.7 mm.

Length of fourth leg, ♂, 10 mm.; ♀, 10.5 mm.

Color in Alcohol. ♂♂.—*Cephalothorax* black, a rather narrow, pale median stripe arising behind the posterior eyes, broadest in front of and narrowed behind the median groove; a submarginal broad band of the same color, not extending to the head; forehead below the anterior eyes pale, with a black mark above each of the chelicera. *Sternum* black, sometimes with a narrow median pale stripe. *Abdomen* above gray, a yellow median band ending in a point anterior to the middle, and very indistinct yellowish transverse stripes behind it; sides gray; venter yellowish-brown, region of genital orifice black and a black median line continuing back from it to about the middle of the venter, and on each margin a row of small black dots. *Lung books* and *spinnerets* yellow. *Chelicera* mainly black, *labium* black, *maxillæ* yellow. *Legs:* First leg with the femur blackish above and below and with yellow distal end, the other joints yellow; second leg with the femur reddish-brown and blackish on its anterior edge only, the other joints yellow; third and fourth legs with the femora reddish-brown and the other joints yellowish; there is a dark spot on the upper surface of each coxa, but no annulations on the legs. *Palpi* black, except that the patella is white, and the distal end of the tarsus yellowish above.

Color in Alcohol, ♀♀.—*Cephalothorax* very dark reddish-brown, black between the eyes, a yellowish median stripe arising between the posterior eyes (where it is broadest), constricted anterior to and narrowed behind the dorsal groove, and dentate laterally on the sides of this groove; marginal line black, a broad submarginal band of yellowish, forehead yellowish with a black spot above each cheliceron. *Sternum* brownish-yellow with a pair of parallel longitudinal black stripes on its anterior half, and a single median one on the posterior half. *Abdomen* above dark greenish-gray with minute yellow spots, a median band of yellow (margined on each side by a narrow line of black) terminating in a point at or before the middle, and behind it about four indistinct yellow transverse arches; sides streaked with dark greenish and yellowish; venter in one individual yellow with a marginal narrow line of black on each side and an interrupted median line of black, while in another individual the venter is blackish behind the lung slits. *Spinnerets* yellow, *epigynum* orange with black margins. *Chelicera* yellowish, *maxillæ* dark-brown, *labium* black. *Legs* reddish-brown, distinctly annulated with brown on all the joints except the metatarsi. *Palpi* annulated like the legs.

Comparisons.—Compare *P. nigropalpis* Emerton.

23. Pardosa scita n. sp. (Pl. XXX, figs. 37, 38.)

(Types of ♂ and ♀ in author's collection, from Philadelphia; other specimens from the vicinity.)

Eyes.—The arrangement as in *P. nigropalpis.*

Form.—Cephalothorax highest at the posterior eyes, flattened above, in front not half its greatest transverse diameter. Sides of head steep. Chelicera about 1¼ times as long as the head is high in front. Sternum distinctly longer than broad. Legs slender, with long spines and few hairs.

Dimensions of ♂.—Length of cephalothorax, 2 mm.
Length of abdomen, 2 mm.
Length of first leg, 7.8 mm.
Length of second leg, 7.2 mm.
Length of third leg, 7 mm.
Length of fourth leg, 10.3 mm.

Color in Life, ♂. — *Cephalothorax* black, with gray hairs arranged as follows: A broad median band extending from the eye area to the posterior end of the thorax and as broad anteriorly as the eye area, constricted just anterior to the dorsal groove and narrowed behind it; quite a distinct broad marginal stripe of these hairs; the hairs on the forehead almost white. *Sternum* densely covered with long whitish hairs. *Abdomen* above with a black spot at each antero-lateral margin and two smaller spots posteriorly on a line with each of these, the remainder of the dorsum grayish; sides and venter nearly white. *Chelicera* brownish, *maxillæ* and *labium* lighter. *Legs* pale grayish-brown with indistinct annulations on the femora. *Palpi* with femur, patella and tibia black with whitish hairs, tarsus black with black hairs.

Color in Alcohol, ♂.—The sides and venter of the *abdomen* are clear yellow. The *sternum* clear yellow with a pair of indistinct darker longitudinal lines. *Palpi* with femur and patella greenish-yellow, tibia the same color but with black hairs, tarsus black.

Color in Alcohol, ♀.—*Cephalothorax* as in ♂. *Sternum* clear yellow with black spots on the lateral margins. *Abdomen* above grayish-green with a yellow pattern very similar to that of *P. nigropalpis,* except that the median band is very broad anteriorly and the yellow transverse arches relatively larger and distincter, and that on each margin of the yellow pattern are two or three large black spots; venter yellow. Margins of *epigynum* reddish. *Che-*

licera yellow like the forehead, *maxillæ* yellow, *labium* brownish with yellow tip. *Legs* pale greenish-yellow, with indistinct annulations. *Palpi* colored like the legs.

Comparisons.—This species is very similar to *P. nigropalpis;* the differences in the copulatory organs of the two are slight, but *scita* is much lighter colored, is smaller, and the cephalothorax relatively wider and shorter.

It also closely resembles *P. pallida* Emerton, but differs from it in the epigynum and in the coloration (*e.g.*, the shape of the median cephalothoracic stripe, and the coloration of the abdominal venter).

24. Pardosa solivaga n. sp. (Pl. XXX, fig. 39.)

(2 ♀♀, types, Stone Coll., York Furnace, Pa.)

Eyes.—First row not as broad as the second, the lateral eyes barely two-thirds the diameter of the middle ones, and placed a little lower, eyes equidistant. Eyes of second row largest, about their diameter apart, placed on brownish prominences. Third row widest, its eyes also on brownish prominences and placed closer to the second row than to each other. All eyes relatively large and of a light color. Dorsal eye area a little less than one-quarter the length of the cephalothorax.

Form.—Cephalothorax in front fully one-half its greatest transverse diameter, highest just behind the middle. Head rather low in front, its sides moderately oblique. Length of chelicera about 1½ times the height of the head in front. Sternum nearly as broad as long. Legs rather slender, with moderately long spines and few hairs. Superior spinnerets slightly longer than the inferior.

Dimensions.—Length of cephalothorax, 3.9 mm.
Length of abdomen, 4 mm.
Length of first leg, 12 mm.
Length of second leg, 11.5 mm.
Length of third leg, 11.3 mm.
Length of fourth leg, 16 mm.

Color in Alcohol.—*Cephalothorax* clear reddish-brown, the only dark color being the prominences which bear the second and third eyes; a broad yellowish median stripe arises from the second row of eyes, is constricted in front of the median groove and narrowed posterior to this groove; an indistinct submarginal broad yellowish stripe is also present, and radiating areas of yellowish from it to the middle of the median band. *Sternum* yellowish with black hairs. *Abdomen* dull orange yellow above, with a brownish mark at each antero-lateral margin prolonged backward as an indistinct stripe, transverse lines of brown across the posterior half of the dorsum, and two longitudinal lines of brown on the anterior half meeting at a point in the middle; the sides streaked with dull orange and buff; venter paler yellow with small dark spots most distinct and numerous laterally and posteriorly. *Epigynum* reddish-brown, *spinnerets* pale yellow. *Chelicera* reddish-brown, *maxillæ* and *labium* yellow like the sternum. *Legs* clear reddish-brown, with indistinct buff annulations on the femora and tibia. *Palpi* colored like the legs.

Comparisons.—This form resembles a *Lycosa* in relative stoutness of the legs, in the comparative shortness of their spines, and in the amount of hair upon them, and in comparative stoutness of the chelicera; the middle eyes of the first row are also decidedly larger than the lateral. Apparently, however, it should be considered a *Pardosa* on account of the length of the legs, the greater length of the superior spinnerets, and the comparatively long extent of the dorsal eye area.

Genus **PIRATA** Sund.

The following key will help to distinguish the species here described:

A.—Cephalothorax not more than 1.8 mm. long, . . *humicolus.*
B.—Cephalothorax 2.2–2.8 mm. in length.
  I.—Femora usually annulated, submarginal light stripe of cephalothorax very distinct, venter usually with longitudinal rows of dark spots, ... *liber.*
  II.—Femora not banded, submarginal light stripe of cephalothorax indistinct, venter without rows of dark spots.
    1.—A large dark mark on the sides near the spinnerets, *nigromaculatus.*
    2.—No large dark mark on the sides near the spinnerets, *elegans.*
C.—Cephalothorax more than 3 mm. long.
  I.—Eyes of second row separated from the third row by about their diameter, ... *marxi.*
  II.—Eyes of second row separated from the third row by twice their diameter, ... *procursus.*

25. Pirata humicolus n. sp. (Pl. XXX, figs. 10, 11.)

(Types of ♂ and ♀, and other specimens, author's collection, Woodland Cemetery, Philadelphia.)

Eyes.—First row a little shorter than the second, the lateral eyes slightly lower. Eyes of second row largest, nearly their diameter apart. Third row widest, its eyes a little nearer the second row than each other. Dorsal eye area about one-fifth the length of the cephalothorax.

Form.—Superior spinnerets twice the length of the inferior. Cephalothorax in front one-third its greatest transverse diameter, highest at the dorsal groove. Sides of head vertical. Chelicera about $1\frac{1}{3}$ times as long as the head is high in front. Sternum longer than broad. Legs rather stout.

Dimensions. — Length of cephalothorax, ♂, 1.7 mm., ♀, 1.8 mm.

Length of abdomen, ♂, 1.2 mm.; ♀, 2.3 mm.

Length of first leg, ♀, 4.8 mm.

Length of second leg, ♀, 4.3 mm.

Length of third leg, ♀, 4.2 mm.

Length of fourth leg, ♀, 6 1 mm.

Color in Life, ♀.—*Cephalothorax* black, a narrow white marginal line not extending as far forward as the plane of the posterior eyes; from the posterior eyes two brownish lines pass caudad, unite at the dorsal groove, and are continued backward to the posterior end of the thorax as one median band. *Sternum* shining brownish-black. *Abdomen* above black, a rather irregular line of 5–6 white spots (the foremost two largest) on either side, and indistinct transverse lines of white on the posterior dorsum; venter dark-gray owing to scattered white hairs on a black ground, a narrow white semicircle around the anterior edge of the spinneret prominence. *Chelicera, maxillæ* and *labium* almost black. *Legs* pale-brownish, paler below, a black ring at the distal ends of the first and second femora. *Palpi* colored like the legs.

Color in Alcohol, ♀♀.—*Cephalothorax* greenish-brown, at the anterior end of the median groove a dark triangular mark from the anterior end of which a narrow yellowish line, bordered on each side by a brown line, passes to the second eye row; a narrow yellow line arises on the lateral margin of the second eye row, passes around the lateral margin of the third eye row, and it and corresponding line of the opposite side converge caudad, border the triangular dark spot, and unite behind the latter as a narrow yellow line which passes to the posterior end of the cephalothorax;

eye region black; a narrow marginal black line on the thorax, and above it a broader submarginal yellow band which is not continued along the head; there are also indistinct brownish-yellow markings radiating from the median groove. *Sternum* pale yellowish-brown, with a narrow dark margin and a median yellow stripe. *Abdomen* above greenish or grayish-brown, a more or less distinct median yellow band terminating in a point anterior to the middle, on each side of it two lines of white spots extending to the spinnerets, the more median line with 6–7 spots of which the most anterior is largest and the more posterior connected by faint yellow cross lines with those of the opposite side, while the more lateral line is placed on the margin of the dorsum, sometimes only posteriorly, and the white spots which compose it somewhat elongate. The sides are greenish-brown or yellowish-brown. The venter from the lung slits to a short distance in front of the spinnerets yellow, this yellow sharply outlined laterally and posteriorly by the greenish-brown of the sides; sometimes there are one or more transverse lines of minute dots just anterior to the spinnerets. *Epigynum* reddish-brown. *Spinnerets* greenish or yellowish, the superior ones darker. *Chelicera* dark reddish-brown, *labium* blackish-brown, *maxillæ* yellowish. *Legs* greenish-brown with the coxæ and proximal portions of the femora yellow. *Palpi* greenish-brown, the proximal joint yellow.

Color in Alcohol, ♂. — Considerably darker than the ♀. *Cephalothorax* almost black, extreme marginal line yellow, no submarginal light band. *Sternum* as in the ♀. *Abdomen* also as in the ♀, except that the venter is very dark by reason of closely approximated, transverse dark lines. *Chelicera* black. *Legs* yellow, the femora of the first and second blackish above and below, the other joints of these legs lighter than the third and fourth legs. *Palpi* with the femur blackish, the other joints yellowish-brown.

Comparisons.—This species seems closely related to *P. minutus* Emerton; but the palpal organ of the ♂ is proportionately larger in *humicolus* and shows some differences in details of structure, and in *humicolus* the cephalothorax is not "gray, with a light line near the edge of the thorax and several radiating lines," but in the ♂ (and Emerton describes only the ♂ of *minutus*) is nearly black in alcohol (probably deep black in life), the extreme margin yellow, and with a pair of yellow lines on the dorsum.

It differs also from another closely related species, *P. exigua* (correctly *exiguus*) Banks, in slightly greater size, in the structure of the epigynum, and to some extent in coloration.

26. Pirata liber n. sp. (Pl. XXX, figs. 42, 43.)

? *Pirata piratica* Clerck., Stone, 1890.

(♂, ♀, types, Philadelphia, author's collection; numerous specimens from Philadelphia and vicinity.)

Eyes.—First row nearly as broad as the second, its lateral eyes slightly higher. Eyes of second row largest, about half their diameter apart. Third row broadest, its eyes much nearer the second row than each other. Dorsal eye area less than one-fifth the length of the cephalothorax.

Form.—Superior spinnerets nearly twice the length of the inferior. Cephalothorax in front almost one-half its greatest transverse diameter, flattened above and highest at middle. Sides of head vertical. Chelicera about 1⅓ times the height of the head in front. Sternum longer than broad, its anterior margin straight. Legs rather slender.

Dimensions. — Length of cephalothorax, ♂, 2.2 mm.; ♀, 2.8 mm.

Length of abdomen, ♂, 2.2 mm.; ♀, 2.8 mm.

Length of first leg, ♀, 7.5 mm.

Length of second leg, ♀, 6.6 mm.

Length of third leg, ♀, 7 mm.

Length of fourth leg, ♀, 9.3 mm.

Color in Life, ♀, type.—*Cephalothorax* longitudinally banded brown and yellowish, as follows: A narrow yellow median band extending from between the second eyes in front to not quite the middle of the cephalothorax behind, and bordered on each side by brown; two yellow lines starting at the lateral borders of the first and second eye rows, and becoming thicker converging backward to the sides of the dorsal groove, from whence they are continued back as one median line to the end of the thorax, and each of these bordered laterally by a brown band, the widest of all the bands, and with deeply scalloped lateral margin; lateral from the latter a yellow band, then a narrower and shorter brown band, then a still narrower yellow submarginal line, finally a narrow black marginal line. The eye region black. *Sternum* yellowish-brown with a narrow brown margin, and a brown spearhead-shaped mark (composed of two converging dark lines) with the point directed caudad. *Abdomen* above blackish, a narrow brown median band terminating in a point before the middle, a white line at each antero-lateral margin of the dorsum, and small white spots on the posterior two-thirds of the dorsum arranged in two lines of 5–6 spots each, the most posterior in each line largest; sides brown above, below yellowish-brown streaked with white hairs; venter with a broad brownish band extending the whole length and containing indistinct darker dots. *Lung books* yellow. *Spinnerets* brown. *Chelicera, maxillæ* and *labium* reddish-brown, the last nearly black at the base. *Epigynum* reddish-brown. *Legs* pale yellowish-brown with indistinct darker annulations on the femora, patellæ and tibiæ.

Color in Alcohol, ♀♀.—The ground color of the dorsum of the *abdomen* greenish-brown, a yellow median band ending in a point at the middle, on each side a row of about five elongated yellow spots, becoming confluent at the spinnerets with its fellow of the opposite side, and more laterally on each side a row of 4–5 minute yellow spots; venter yellowish with a median and two pairs of lateral confluent dark spots which do not extend to the spinnerets, the more median rows longer and curved. *Legs* more or less distinctly banded.

Color in Alcohol, ♂♂.—*Cephalothorax* as in the ♀, but *sternum* sometimes without dark lines. *Abdomen* as in the ♀. *Legs* clear reddish-brown, femora yellowish proximally and ventrally, femora and tibiæ indistinctly banded. *Palpi* reddish-brown, tarsi darker. Coloration otherwise as in the ♀.

Comparisons.—This species differs from *P. elegans* Stone markedly in the structure of the epigynum and in the annulations of the legs. From the other most nearly related form, *P. insularis* Emerton, it differs in smaller size, in the coloration of the abdomen, and in the structure of the epigynum.

27. **Pirata nigromaculatus** n. sp. (Pl. XXX, figs. 11, 45.)

(♂, ♀, types, Harvey's Lake, Luzerne county, Pa., Stone Coll. everal other specimens collected at the same place.)

Eyes.—First row nearly as broad as the second, its lateral eyes slightly larger and very slightly higher. Eyes of second row largest, their diameter apart. Third row widest, its eyes nearer the second row than each other. Dorsal eye area less than one-quarter the length of the cephalothorax.

Form.—Superior spinnerets about 1$\frac{3}{4}$ times the length of the inferior. Cephalothorax in front less than one-third its greatest transverse diameter, highest at the anterior edge of the median groove. Chelicera about 1$\frac{1}{3}$ times the height of the head in front. Sternum little longer than broad. Legs rather stout.

Dimensions.—Length of cephalothorax, ♂, 2.2 mm.; ♀, 2.8 mm.

Length of abdomen, ♂, 1.8 mm.; ♀, 3.3 mm.
Length of first leg, ♀, 7 mm.
Length of second leg, ♀, 6.5 mm.
Length of third leg, ♀, 6.4 mm.
Length of fourth leg, ♀, 9.2 mm.

Color in Alcohol, ♀♀.—*Cephalothorax* reddish-brown, a narrow buff band from between the second pair of eyes to the dorsal groove, a broader buff band on each side arising at the posterior eye, with its fellow of the opposite side converging back to the sides of the median groove, where the three buff bands unite and pass caudad as one median band to the end of the thorax; a broader submarginal buff line is present in some specimens, but in most there is no trace of it; eye region black. *Sternum* yellowish, its margins darker, usually a median broad light band bordered by narrow lines of darker. *Abdomen* pale yellowish-brown, a little darker above; on the dorsum a lancet-shaped yellowish mark bordered on each side by a brown line and ending in a point at the middle, and with more or less distinctness about five transverse brown arches behind it and extending to the spinnerets where they are smallest, and in some specimens lighter spots at the lateral ends of these transverse markings; on each side, close to the spinnerets, a dark mark, sometimes black and very distinct, sometimes very indistinct, and sometimes ventrally connected with its fellow by a transverse dark band just anterior to the spinnerets; venter pale yellowish-brown, lightest in the mid-line but without markings. *Epigynum* blackish-red, *spinnerets* like the venter. *Chelicera* pale reddish-brown; *maxillæ* and *labium* like the sternum. *Legs* yellow without darker annulations, as are the *palpi.*

Color in Alcohol, ♂.—*Cephalothorax* as in the ♀, but darker and without a submarginal light stripe. *Sternum* darker than in ♀, brownish with a narrow median light stripe. *Abdomen* also darker above, with the same general pattern but the light spots larger and more conspicuous; sides brownish streaked with yellow, no dark spots near the spinnerets; venter brownish-yellow. *Legs* yellow, femora of the first and second pairs deep brown above and below. *Palpi* yellow, femora deep brown.

Comparisons.—Quite closely related to *P. elegans* Stone, but the *epigyna* are quite different. The ♀♀ also show considerable resemblance to those of *P. liber*, while the ♂♂ are readily distinguished both by color and by the structure of the palpus; but there is a difference in the epigynum, the submarginal light thoracal stripe is distinct in *liber*, which has generally dark markings on the abdominal venter and lacks the large dark spot near the spinnerets.

28. Pirata elegans Stone. (Pl. XXX, fig. 46.)

Pirata elegans Stone, 1890.

(4 ♀♀, types, York county, Pa., Stone Coll.)

Eyes.—First row shorter than the second, its lateral eyes lower and slightly larger, its middle eyes approximated. Eyes of second row largest, their diameter apart. Third row widest, its eyes on slight tubercles (as are the second eyes) and nearer the second row than each other. Dorsal eye area a little more than one-fifth the length of the cephalothorax.

Form.—Superior spinnerets double the length of the inferior. Cephalothorax flattened above, highest at the posterior eyes, in front not more than one-third its greatest transverse diameter. Chelicera rather weak, their length not much more than 1⅓ times the height of the head in front. Sternum distinctly longer than broad. Legs rather stout.

Dimensions.—Length of cephalothorax, 2.5 mm.

Length of abdomen, 3 mm.

Length of first leg, 6 mm.

Length of second leg, 5.5 mm.

Length of third leg, 6 mm.

Length of fourth leg, 9.3 mm.

Color in Alcohol.—*Cephalothorax* clear reddish-brown, an interrupted narrow blackish submarginal stripe just above the yellow margin, and fine black lines radiating from the dorsal groove; a buff median band, narrowest at the posterior edge of the thorax, enlarging from the median groove forward, and reaching anteriorly in the mid-line to in front of the posterior eyes and on the sides to the first eye row, this buff band divided into three anteriorly by two darker lines which converge from the posterior eyes to the dorsal groove; on each side is a black line from the second to the third eyes. *Sternum* yellowish with narrow black margin, and sometimes two broader, rather indistinct darker longitudinal bands. *Abdomen* above dark yellowish-brown, variable in color; in two specimens marbled with yellow and brown on the anterior part of the dorsum, in the third with three pairs of black spots, in the fourth with a broad yellow median band on the anterior half narrowing suddenly just behind the middle and continuing to the spinnerets, while the posterior half of the dorsum has a few transverse yellow and brown lines; sides brownish or yellowish; venter yellowish, lighter than the sides, without distinct spots but with an indistinct dark mark behind the epigynum. *Epigynum* reddish-brown. *Chelicera* light reddish-brown. *Labium* and *maxillæ* yellowish-brown. *Legs* and *palpi* pale yellowish-brown.

Comparison.—See *P. nigromaculatus.*

29. **Pirata marxi** Stone. (Pl. XXX, fig. 47.)

Pirata marxi Stone, 1890.

(1 ♀, type, York county, Pa., Stone Coll.)

Eyes.—First row fully as broad as the second, its lateral eyes higher. Eyes of second row largest, about their diameter apart. Third row broadest, its eyes much nearer the second row than each other. Dorsal eye area less than one-sixth the length of the cephalothorax.

Form.—Superior spinnerets fully double the length of the inferior. Cephalothorax in front about one-half its greatest diameter, highest about the middle. Chelicera about 1½ times as long as the head is high in front. Sternum longer than broad. Legs rather stout.

Dimensions.—Length of cephalothorax, 3.4 mm.

Length of abdomen, 4.5 mm.

Length of first leg, 11.5 mm.

Length of second leg, 11 mm.

Length of fourth leg, 14 mm.

Color in Alcohol.—*Cephalothorax* clear reddish-brown, a yellowish submarginal band not extending to the head, a narrow buff median band from the middle eyes to the dorsal groove and on each side of the posterior half of it a yellowish area. *Sternum* light reddish-brown, with a darker brown margin from which pointed lines radiate centrad. *Abdomen* above with a yellowish band attenuating from in front to the spinnerets, its posterior half segmented by brownish transverse lines, in the anterior half of this band a narrower band ending in a point at its middle and darkest laterally; to each side of the median band a brownish band flecked anteriorly with small yellow spots, and containing in its posterior half a row of 4–5 larger yellowish spots. Sides yellowish, marbled and streaked with brown posteriorly. Venter yellow, just behind the epigynum two, posteriorly slightly converging, rows of four small brown spots, the length of each row not much more than the width of the epigynum. *Epigynum* reddish-brown, and the region in front of it is darker than the region behind it. *Spinnerets* yellowish-brown. *Chelicera* reddish-brown. *Maxillæ* brownish, the *labium* is the same color at the tip but blackish at the base. *Legs* reddish-brown, as are the *palpi*.

Comparisons.—This form comes nearest *Pirata piraticus* Clerck., the coloration and size of the two are quite similar (judging from Emerton's description), but the epigyna are different (compare Emerton's fig. 7*b*, Pl. XLVIII).

30. Pirata procursus n. sp. (Pl. XXX, fig. 48.)

(2 ♀♀, types, Stone Coll., Harvey's Lake, Luzerne county, Pa.)

Eyes.—First row about straight, nearly as long as the second. Eyes of the second about 1½ times their diameter apart. Third row widest, its eyes nearly as large as those of the second row, and considerably nearer the second row than each other. Dorsal eye area less than one-quarter the length of the cephalothorax.

Form.—Superior spinnerets about double the length of the inferior. Cephalothorax broad, in front about one-half its greatest diameter, highest at the posterior eyes, its posterior declivity gradual. Sides of head steep. Length of chelicera about 1¼ times the height of the head in front. Sternum a little longer than broad, its anterior margin slightly concave. Legs slender.

Dimensions.—Length of cephalothorax, 3.6 mm.

Length of abdomen, 4 mm.

Length of first leg, 11.2 mm.

Length of second leg, 10 mm.
Length of third leg, 11.2 mm.
Length of fourth leg, 16 mm.

Color in Alcohol.—*Cephalothorax* dark reddish-brown, eye region black with whitish hairs; an indistinctly banded, broad, lighter median band extends from the middle row of eyes backward to the end of the thorax, it is as broad anteriorly as the eye area, constricted in front of and again behind the median groove, and narrowed in its posterior portion; the forehead is lighter than this band; the extreme margin of the thorax is blackish. *Sternum* dark reddish-brown. *Abdomen* above rather indistinctly marked with blackish and dark buff, as follows: a narrow buff median band anteriorly, to each side of it a narrower buff band, all these on the posterior dorsum breaking into large, ill-defined buff spots that reach to the spinnerets; at each antero-lateral margin of the dorsum a black spot; sides brownish, streaked longitudinally with narrow buff lines; venter yellowish-brown and quite sharply delimited from the color of the sides, without distinct markings. *Epigynum* dark reddish-brown and yellow. *Spinnerets* yellowish, the superior ones darker. *Chelicera* clear reddish-brown, *labium* and *maxillæ* lighter. *Legs* reddish-brown, distinctly mottled and annulated with buff on all the joints. *Palpi* colored like the legs.

Comparisons.—This form is well marked by three peculiar features—the structure of the epigynum, the equality in length of the first and third legs (unique, to my knowledge, in this family), and in that the posterior eyes are almost as large as the middle ones. In the length of the legs it resembles a *Pardosa*, as also in the wide separation of the eyes of the second row. I have decided to class it as a *Pirata* on the ground of the great length of the superior spinnerets, of the rather close approximation of the second and third rows of eyes, and of the hairiness of the legs.

Genus **OCYALE** Sav. and Aud. (Pl. XXX, fig. 49.)

31. Ocyale undata (Hentz).

Micrommata undata Hentz, 1841.
? *Micrommata serrata* Hentz, 1841.
nec *Micrommata carolinensis* Hentz, 1841.
Ocyale undata Emerton, 1885.
Ocyale undata Hentz, Marx, 1889.
Ocyale undata (Hentz), Stone, 1890.
Ocyale undata Hentz, Banks, 1892.

(Numerous specimens, but no mature ♂♂, from Philadelphia and Chester county, Pa.)

Eyes.—First row broader than the second by more than the diameter of one of its eyes, lateral eyes larger and a little higher. Eyes of second row about their diameter apart. Third row broadest, its eyes a little larger than those of the second row, about their diameter behind that row, and placed on tubercles. Dorsal eye area about one-sixth the length of the cephalothorax.

Form.—Cephalothorax broad and flat, highest at the posterior eyes, in front more than one-half its greatest transverse diameter.

Length of chelicera about 1¾ times the height of the head in front. Sternum nearly as long as broad, nearly straight in front, pointed behind. Legs slender. Superior spinnerets twice the length of the inferior.

Dimensions, ♀.—Length of cephalothorax, 5.5 mm.

Length of abdomen, 8.5 mm.

Length of first leg, 24.5 mm.

Length of second leg, 24.5 mm.

Length of third leg, 20 mm.

Length of fourth leg, 24 mm.

Color in Life, ♀.—*Cephalothorax* above brownish-yellow, with a broad brown median stripe from the posterior eyes to the end of the thorax, an interrupted brown submarginal stripe on each side, extreme margin of head brown; all these brown areas are due to the absence of hairs upon them, the yellowish-brown to the presence of hairs which are longest on the sides of the head; posterior eyes on black tubercles. *Sternum* light yellowish-brown, margins a little darker. *Abdomen* above with a pale and indistinctly bounded reddish-brown stripe, which is nearly as broad as the dorsum, extends its entire length, and is scalloped along its posterior half; bounding each side of the anterior third of this stripe is a narrow yellow stripe, and on the posterior half of the dorsum on each side a row of five yellow spots (in a line with these yellow stripes), of which the most anterior are elongated and largest; in the median line of the anterior half of the broad reddish-brown dorsal stripe is a slightly darker brown stripe, also bordered anteriorly with narrow yellow lines, and with a row of five yellow spots behind each of these lines. The sides are indistinctly streaked with yellow and brown. The venter pale yellowish-brown, with a rather indistinct, broad, darker median stripe containing a narrower light one. *Spinnerets* brown. *Epigynum* black. *Lung books* yellow. *Chelicera* pale reddish-brown. *Maxillæ* and *labium* pale brown, the latter with darker base. *Legs* reddish-brown with buff hairs and black spines, but no distinct annulations. *Palpi* colored like the legs.

Comparisons.—Hentz's *Micrommata carolinensis* cannot be considered a synonym of *undata,* as Emerton and Marx have done, since Hentz placed *carolinensis* in the tribe of the *Biarcuatæ,* in which the " upper and lower rows of eyes [are] bent and opposed."

Genus **DOLOMEDES** Latr.

The following key will help to distinguish the species here described, but the structure of the copulatory organs is the only sure diagnostic character; there is one ♀ of what is probably *D. sexpunctatus* Hentz in the Stone collection, but I have not included it since it is not mature:

A.—Posterior portion of the abdomen with transverse yellow markings of the shape of a W, ... *urinator.*
B.—Posterior portion of the abdomen not so marked, . *idoneus.*

32. Dolomedes urinator Hentz. (Pl XXX, fig. 50.)

Dolomedes urinator Hentz, 1841.
? *Dolomedes tenebrosus* Hentz, Emerton, 1885.
Dolomedes urinator Hentz, Marx, 1889.
Dolomedes tenebrosus Hentz, Stone, 1890.
? *Dolomedes urinator* Hentz, Banks, 1892.

(♀♀, but no ♂♂, from Philadelphia, Chester county, Bucks county, Lancaster county, York Furnace, Pa.)

Eyes.—First row broader than the second by less than the diameter of one of its lateral eyes, lateral eyes slightly larger and higher. Eyes of the second row slightly more than their diameter apart. Third row broader than first, its eyes fully as large as the eyes of the second row.

Form.—Cephalothorax flat and broad, rounded, its greatest diameter equaling the length from the third eye row backward, in front more than one-half its greatest transverse diameter, highest behind the middle. Chelicera less than twice the height of the head in front. Legs slender. Sternum broader than long.

Dimensions.—Length of cephalothorax, 10.5 mm.

Length of abdomen, 14 mm.

Length of first leg, 42 mm.

Length of second leg, 43 mm.
Length of third leg, 40 mm.
Length of fourth leg, 43 mm.

Color in Alcohol.—*Cephalothorax* brown or deep reddish-brown, a pair of wedge-shaped black spots close together just in front of the median groove, a narrow pale median line between these which is sometimes continued forward as far as the plane of the posterior eyes, and generally backward around the median groove to the posterior end of the thorax; on each side a curved yellow line extends from the posterior eye backward to the wedge-shaped spot of the corresponding side, the space enclosed by these two lines being oval and widest behind and redder than the rest of the cephalothorax; the extreme margin of the thorax black, on each side a more or less distinct, broad, yellowish submarginal band, sometimes broken into large spots, and with yellow bands radiating from it to the median groove; a small black mark at the posterior margin of each posterior eye. *Sternum* yellowish or reddish-brown, with either a lighter median line or a triangular lighter area. *Abdomen* above deep brown, with yellowish and blackish markings as follows: A rather broad yellowish median stripe extending to about the middle, enlarged at its middle and forked at its posterior end, a pair of narrow and short lines of the same color connecting with it at an angle on each side, and all these edged laterally with black; on the posterior half of the dorsum transverse yellow markings, each edged anteriorly with black, of angular form and with the convexity directed forward, or more or less of the shape of a W; they are 4–6 in number and the more anterior ones are wider. In specimens from West Chester the whole dorsum is much darker, the yellow and black markings very obscure, while on the posterior half are 4–5 pairs of small white spots. Sides of the abdomen brownish. Venter with a yellowish or yellowish-brown mark extending in front from the lung slits, where it is as broad as these, backward to the spinnerets where it is much narrower, this light area banded on each side by a row of minute blackish dots, and sometimes containing narrow dark lines. *Epigynum* reddish-brown, the region in front of it yellowish. *Chelicera* dark reddish-brown, *maxillæ* and *labium* of the same color, but their distal ends yellow. *Legs* brownish below; above darker reddish-brown with buff markings on the femora and more obscure rings on the other joints, the distal ends of the tibiæ and tarsi black. *Palpi* annulated buff and reddish-brown.

Comparisons.—Of all the species of *Dolomedes* described by Hentz *D. urinator* is most similar to this one. It agrees with his fig. 3, Pl. XVI, in the eyes and the general coloration, but his description is very meagre. Whether the form described by Emerton is *tenebrosus* Hentz I cannot decide from his description, and Emerton's figure of the epigynum (9*c*, Pl. XLIX) shows differences from the species described by me.

33. Dolomedes idoneus n. sp. (Pl. XXX, fig. 51.)

(♀, type, West Chester, Pa., author's collection; another mature ♀ from Harvey's Lake, Luzerne county, Pa., Stone Coll.)

Eyes.—First row broader than the second by about half the diameter of one of its lateral eyes which are slightly higher and slightly smaller. Eyes of the second row not quite their diameter apart. Third row widest, its eyes about as large as those of the second row.

Form.—Cephalothorax much of the same form as in *urinator*. Chelicera massive, their length less than twice the height of the head in front. Legs stouter than in *urinator*. Sternum a little longer than broad.

Dimensions.—Length of cephalothorax, 10.2 mm.
Length of abdomen, 12.5 mm.
Length of first leg, 40 mm.
Length of second leg, 39.2 mm.
Length of third leg, 37 mm.
Length of fourth leg, 41 mm.

Color in Alcohol, type.—*Cephalothorax* reddish-brown, its markings very similar to those of *D. urinator*, but no black mark at the posterior eyes, and the wedge-shaped marks just in front of the dorsal groove very indistinct. *Sternum* yellowish with blackish margin. *Abdomen* above yellow and brownish-black, the yellow forming a median stripe on the anterior third of the dorsum ending posteriorly in a blunt point, a large spot on the middle, irregular arches on the sides of the dorsum, and a median row of indistinct spots on the posterior dorsum; sides dark-brownish, somewhat streaked with yellowish; venter behind the lung slits brown, lighter than the sides, with two parallel dark lines on each side of the mid-line. *Epigynum* black, except the large rounded part which is bright red. *Lung books* paler than the venter. *Chelicera* deep black, *labium* and *maxillæ* black basally but yellowish distally. *Legs* distinctly marked and annulated with deep reddish-brown and yellowish on all the joints except the metatarsi, which are blackish. The *palpi* are colored like the legs.

Comparisons.—This form differs markedly in the epigynum from the form here described as *urinator*, but is otherwise very similar.

I have been obliged to describe it as a new species, though the same form may have been previously described, for the following reasons: of the described American larger species of *Dolomedes*, those of Walckenaer and C. Koch are altogether insufficiently characterized. Of Hentz's species, *tenax* and *hastulatus* are excluded by the character of their eyes, and *sexpunctatus* by its smaller size and very different coloration, and *scriptus*, *albineus* and *lanceolatus* by their different coloration. There remains *D. tenebrosus*, Hentz's full description of which is as follows: "Livid brown; abdomen and cephalothorax varied with blackish angular markings; feet annulated with blackish; frequently measuring over four inches from the extremity of the first pair of legs to that of the fourth pair; male with legs 1, 2, 4, 3." This form may be identical with my *idoneus*, but Hentz's description characterizes no better than do any of Walckenaer's, and Hentz's figure of the eyes (fig. 12, Pl. XIX) does not agree with the eye arrangement in *idoneus*; and further, Hentz states that *tenebrosus* "does not seek the vicinity of water, near which it was never seen, but dwells generally in elevated dry places," while both specimens of *idoneus* were found near water. Hentz's description is not adequate in this genus where the structure of the copulatory organs is a necessary diagnostic, and it is best to regard *tenebrosus* as insufficiently characterized, to drop the name, and thus avoid future futile attempts to recognize it.

D. idoneus is readily distinguished in its epigynum from the form described by Emerton as "*D. tenebrosus* Hentz," yet Hentz's description applies equally well to Emerton's specimens as to those of *idoneus*.

Banks states of *D. scriptus* Hentz: "What has been taken as *D. tenebrosus* Hentz is this species. What I feel sure is *D. scriptus* H. has the epigynum as figured by Emerton for *D. tenebrosus* and very similar to that of *D. scapularis* as figured by Keyserling.

D. tenebrosus H. has a much broader epigynum and a broad septum, which does not, however, cover the cavity." I do not understand how we may feel confident of ever identifying *tenebrosus*, and Keyserling's figure of the epigynum of *scapularis* is quite different from mine of *idoneus*.

Family OXYOPIDÆ.

Characters of the Family.—The same characters as in the *Lycosidæ*, except that the eyes are arranged in three rows or four rows, 2. 2. 4., or 2. 2. 2. 2. The eyes of the first row are never largest.

Genus **OXYOPES** Latr.

34. Oxyopes salticus Hentz. (Pl. XXX, fig. 52.)

Oxyopes salticus Hentz, 1841.
Oxyopes gracilis Keyserling, 1876.
Oxyopes salticus Hentz, Marx, 1889.
Oxyopes astutus Hentz, Banks, 1891.

(2 mature ♀♀ from Philadelphia, Pa., author's collection.)

Eyes.—Eyes of the first row smallest, more than their diameter apart, much nearer the second row than to the edge of the forehead, removed less than their diameter from the second row. Eyes of second row largest, separated 1½ times their diameter. Third row broadest, its eyes separated by less than their diameter from the second row. Fourth row slightly broader than the second, its eyes about double their diameter apart. The eyes of the second, third and fourth rows on black tubercles.

Form.—Cephalothorax broad and short but high, highest at the middle, in front more than one-half its greatest transverse diameter. Length of the chelicera not quite the height of the head in front. Sternum longer than broad. Superior and inferior spinnerets of equal length. Legs slender with very long spines.

Dimensions.—Length of cephalothorax, 2.9 mm.

Length of abdomen, 3 mm.

Length of first leg, 10.4 mm.

Length of second leg, 9.5 mm.

Length of third leg, 9.7 mm.

Length of fourth leg, 9 mm.

Color in Alcohol.—*Cephalothorax* above light yellow, two blackish-brown stripes arise at the posterior eyes and pass caudad and unite at the very indistinct median groove, and a pair of similarly colored broader stripes arise at the third pair of eyes and, arching backward on the sides, unite dorsally behind the median groove; all these stripes composed of hairs which readily rub off, the thorax elsewhere being hairless; from each eye of the first row a narrow black stripe passes ventrad across the forehead and nearly to the end of the chelicera; there are two small black spots and, most dorsally, a short black stripe on each lateral margin of the head; the region between the second and third eye rows is blackish. *Sternum* yellow with blackish spots on the margins. *Abdomen* above with a broad lancet-shaped mark, margined (especially posteriorly) by black, ending pointed at the middle of the dorsum, this stripe is surrounded on each side by a narrower clear yellow band, these two yellow bands joining just behind the middle and continuing back to the spinnerets as a single median line, and this median yellow line is margined on each side by a blackish stripe; the remainder of the dorsum is yellow or yellowish-brown. Sides of the abdomen streaked with black lines which continue backward to the spinnerets, but do not extend anteriorly beyond the transverse plane of the epigynum. Venter pale yellow or orange, a longitudinal median black mark (with lighter centre) in one specimen, in the other a pair of short parallel longitudinal black stripes, in neither specimen do these black markings extend along the whole extent of the venter behind the epigynum. *Epigynum* nearly black. *Chelicera* and *maxillæ* pale yellow like the sternum, *labium* darker. *Legs* pale greenish-yellow with black spines, the ventral surface of femora I–III with a longitudinal black line. *Palpi* colored like the legs, but with no black stripe.

LITERATURE CITED.

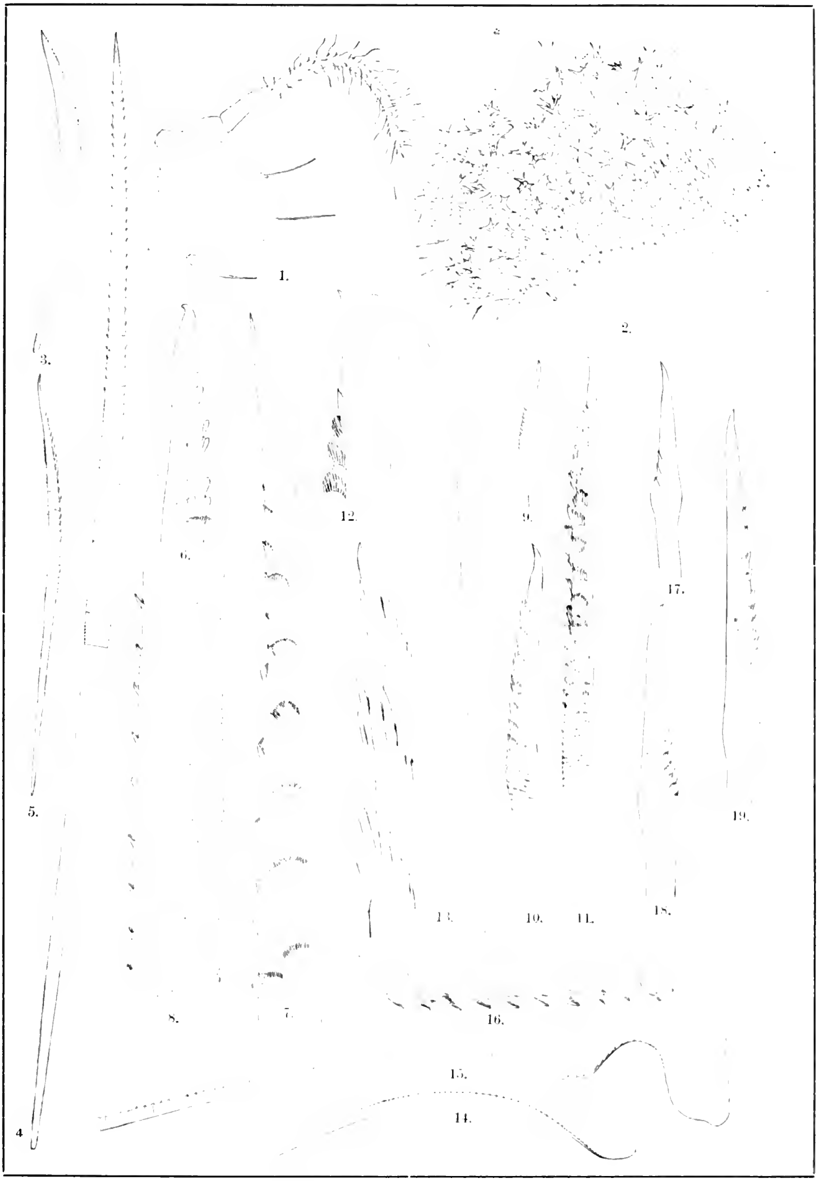
1891*a*. BANKS, N. Notes on some Spiders described by Hentz. *Entomolog. News.* Philadelphia, 2.
1891*b*. *Idem.* Synonymical Notes in Spiders. *Ibid.*
1892. *Idem.* The Spider Fauna of the Upper Cayuga Lake Basin. *Proc. Acad. Nat. Sci. Philadelphia.*
1846. BLACKWALL, J. Notice of Spiders captured by Professor Potter in Canada. *Ann. and Mag. Nat. Hist.* XVII.
1757. CLERCK, C. Svenska Spindlar. *Araneæ suecici.*
1885. EMERTON, J. H. New England Lycosidæ. *Trans. Con. Acad.* 8.
1895. *Idem.* Canadian Spiders. *Ibid*, 9.
1775. FABRICIUS, J. C. Systema entomologica, etc.
1831–1834. HAHN, C. W. Die Arachniden getreu nach der Natur abgebildet und beschrieben.
1899. HANCOCK, J. L. The Castle-building Spider (Lycosa Domifex). *Entomol. News.* Philadelphia, 10.
1841. HENTZ, N. M. Descriptions and Figures of the Araneides of the United States. *Boston Journ. Nat. Hist.* 4

1876. Keyserling, E. Ueber amerikanische Spinnenarten der Unterordnung Citigradæ. *Verh. zool.-bot. Ges. Wien.*
1836–1848. Koch, C. Die Arachniden.
1881. Marx. On some new tube-constructing Spiders. *Amer. Nat.*
1889. *Idem.* Catalogue of the described Araneæ of Temperate North America. *Proc. Nat. Mus. Washington.* 12.
1878. McCook H. C. *Trans. Amer. Ent. Soc.* VII.
1877. Scudder, S. H. The tube-constructing Ground Spider of Nantucket. *Psyche.* II.
1876. Simon, E. Les Arachnides de France, T. 3. Paris.
1890. Stone, W. Pennsylvania and New Jersey Spiders of the Family Lycosidæ. *Proc. Acad. Nat. Sci. Philadelphia.*
1875. Thorell, T. Notice on some Spiders from Labrador. *Proc. Boston Soc. Nat Hist.* 17.
1837. Walckenaer, M. le Baron. *Histoire naturelle des Inscctes, Aptères.* (Suites à Buffon.) Paris.

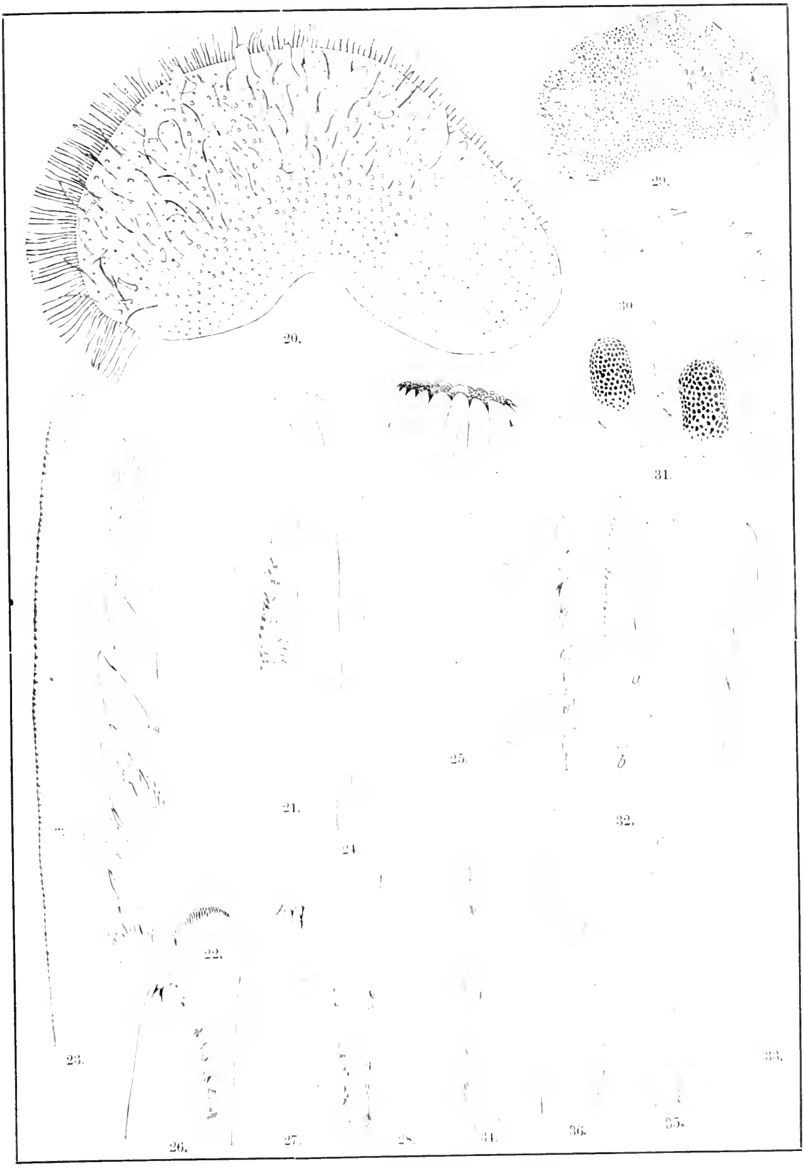
Explanation of Plates XXIX and XXX.

All the figures are drawn with the aid of the camera lucida and reduced one-half. All the figures of ♂ palpi exhibit the right palpi from the ventral surface, and in most of them the hairs have been omitted.

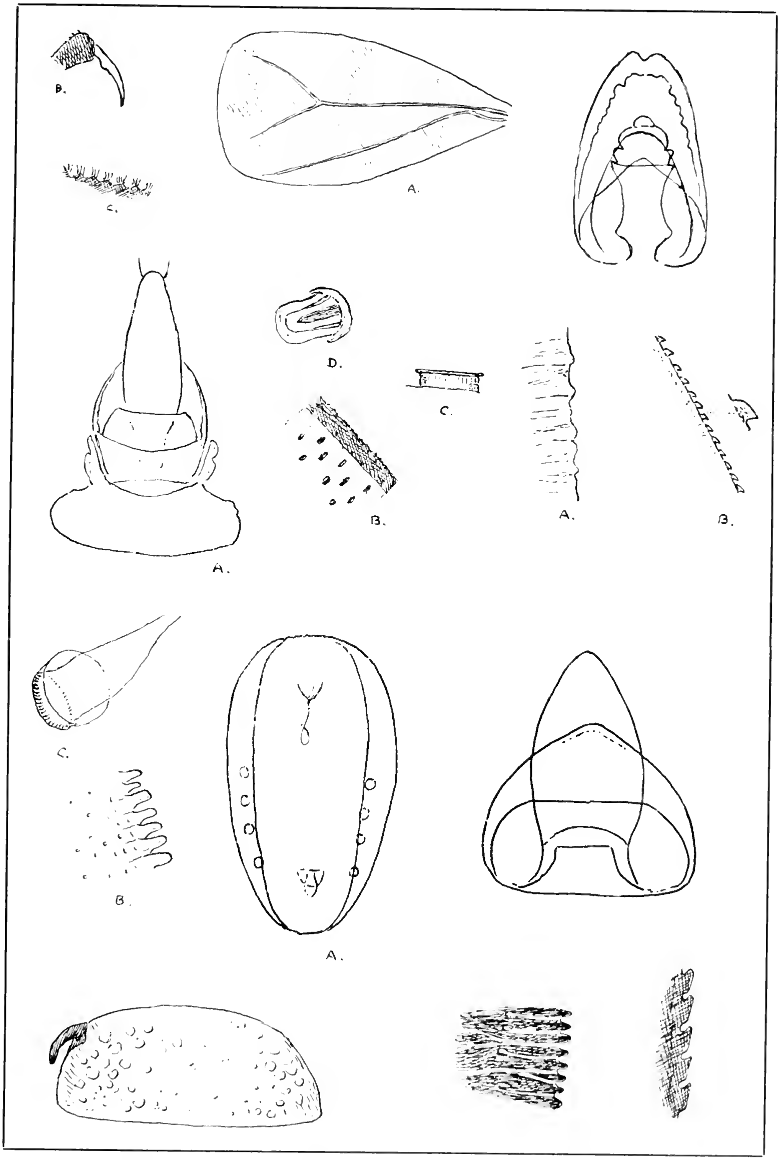
Plate XXIX, Fig, 1.—*Lycosa nigra* (Stone), type, epigynum.
Fig. 2.—*Lycosa sublata* n. sp., type, epigynum.
Figs. 3, 4.—*Lycosa ocreata pulchra* n. subsp., types, epigynum, ♂ palpus.
Figs. 5, 6.—*Lycosa relucens* n. sp., types, epigynum, ♂ palpus.
Fig. 7.—*Lycosa sepulchralis* n. sp., type, epigynum.
Fig. 8.—*Lycosa charonoides* n. sp., type, epigynum.
Figs. 9, 10.—*Lycosa stonei* n. sp., epigynum, ♂ palpus.
Figs. 11, 12.—*Lycosa verisimilis* n. sp., types, epigynum, ♂ palpus.
Fig. 13.—*Lycosa arenicola* Scud., epigynum.
Fig. 14.—*Lycosa punctulata* Hentz, epigynum.
Figs. 15, 16.— *Lycosa scutulata* Hentz, epigynum, ♂ palpus.
Figs. 17, 18.—*Lycosa cinerea* (Fabr.), epigynum, ♂ palpus.
Figs. 19, 20.—*Lycosa carolinensis* Walck., epigynum, ♂ palpus.
Figs. 21, 22.—*Lycosa inhonesta* (Keys.), epigynum, ♂ palpus.
Figs. 23, 24.—*Lycosa nidicola* Emerton, epigynum, ♂ palpus.
Fig. 25.—*Lycosa baltimoriana* (Keys.), ♂ palpus.
Figs. 26, 27.—*Lycosa lepida* (Keys.), epigynum, ♂ palpus.
Plate XXX, Figs. 28, 29.—*Lycosa frondicola* Emerton, epigynum, ♂ palpus.
Figs. 30, 31.—*Lycosa purcelli* n. sp., epigynum, ♂ palpus.
Figs. 32–34.—*Pardosa nigropalpis* Em., epigyna, ♂ palpus.
Figs. 35, 36.—*Pardosa minima* (Keys.), epigynum, ♂ palpus.
Figs. 37, 38.—*Pardosa scita* n. sp., types, epigynum, ♂ palpus.
Fig. 39.—*Pardosa solivaga* n. sp., type, epigynum.
Figs. 40, 41.—*Pirata humicolus* n. sp., types, epigynum, ♂ palpus.
Figs. 42, 43.—*Pirata liber* n. sp., types, epigynum, ♂ palpus.
Figs. 44, 45 —*Pirata nigromaculatus* n. sp., types, epig. ♂ palpus.
Fig. 46.—*Pirata elegans* Stone, type, epigynum.
Fig. 47.—*Pirata marxi* Stone, type, epigynum.
Fig. 48.—*Pirata procursus* n. sp., type, epigynum.
Fig. 49.—*Ocyale undata* (Hentz), epigynum.
Fig. 50.—*Dolomedes urinator* Hentz, epigynum.
Fig. 51.—*Dolomedes idoneus* n. sp., epigynum.
Fig. 52.—*Oxyopes salticus* Hentz, epigynum.
Fig. 53.—*Lycosa nigraurata* n. sp., ♂ palpus.



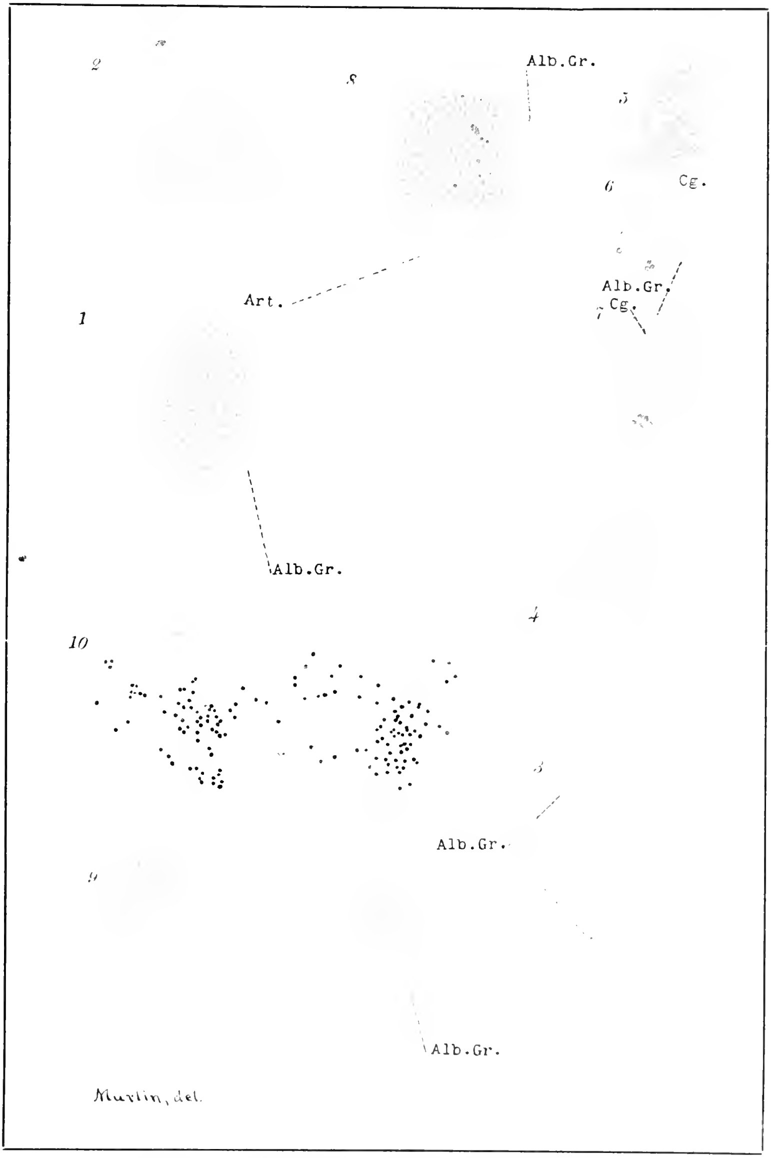
MOORE. NEW POLYNOIDÆ.



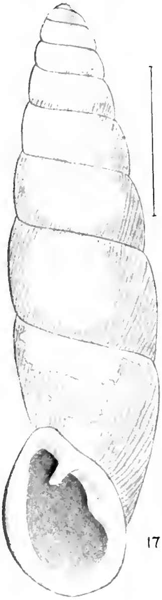
MOORE. NEW POLYNOIDÆ.



COCKERELL. CLASSIFICATION OF ALEYRODIDÆ.

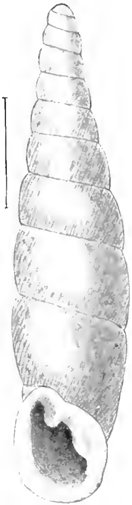


MURLIN. DIGESTIVE SYSTEM OF ISOPODS.


17


18


19


24


23

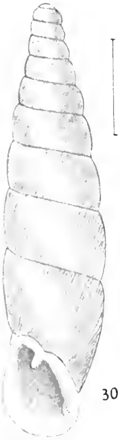

20


28


25

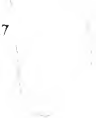

21


22


30


31

26


27


29

32

PILSBRY. JAPANESE LAND SNAILS.


33


34


37


38


35


36


39


40


43


44

45

46


41

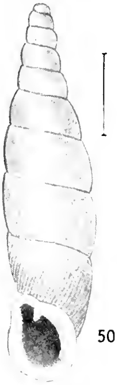

42

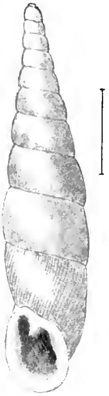

47


48

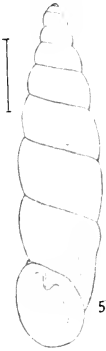

49

PILSBRY. JAPANESE LAND SNAILS.


50


51


52


53

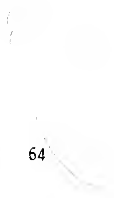

61


55


56


57


54


64

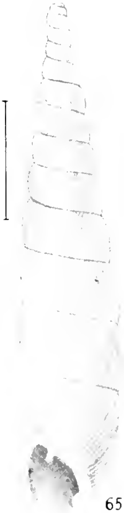

58


59

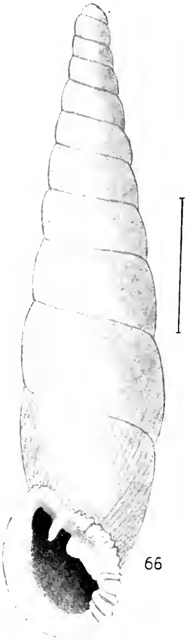

60


62

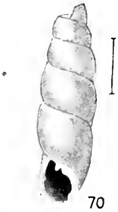

63


65

PILSBRY. JAPANESE LAND SNAILS.


66


67

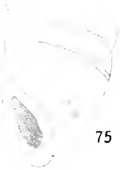

70


72


71


68


69


75


77

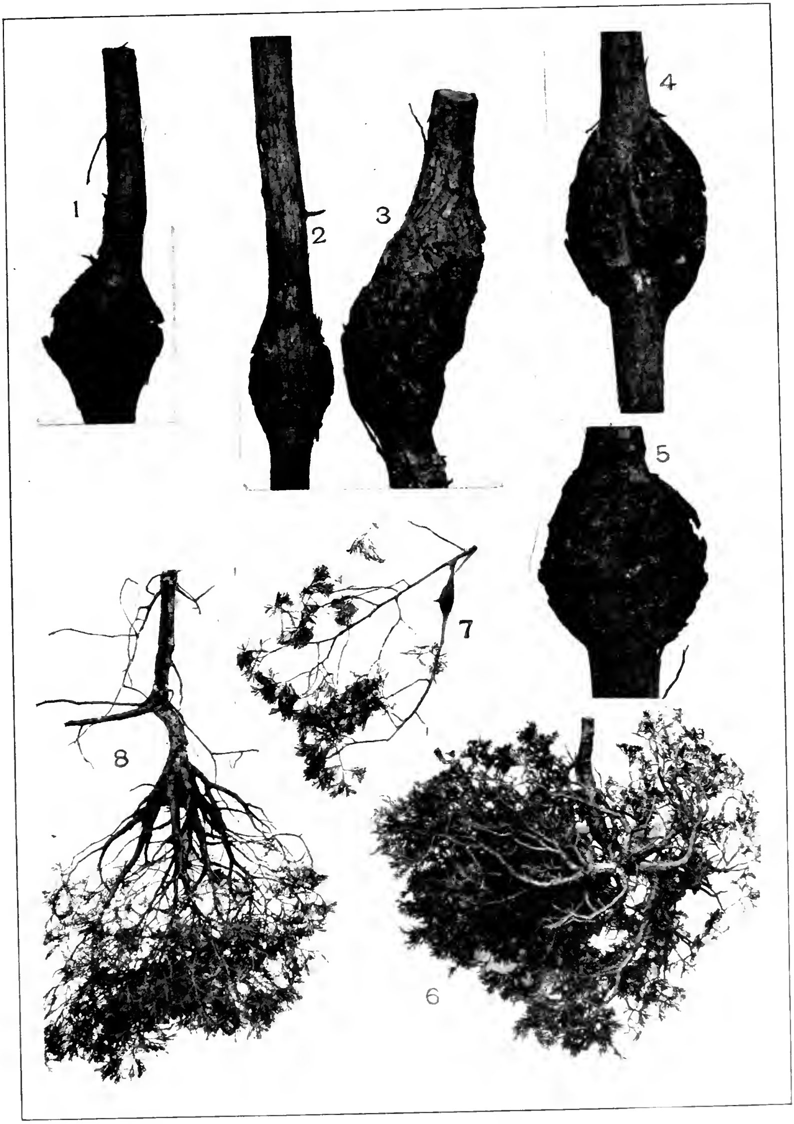

73


74

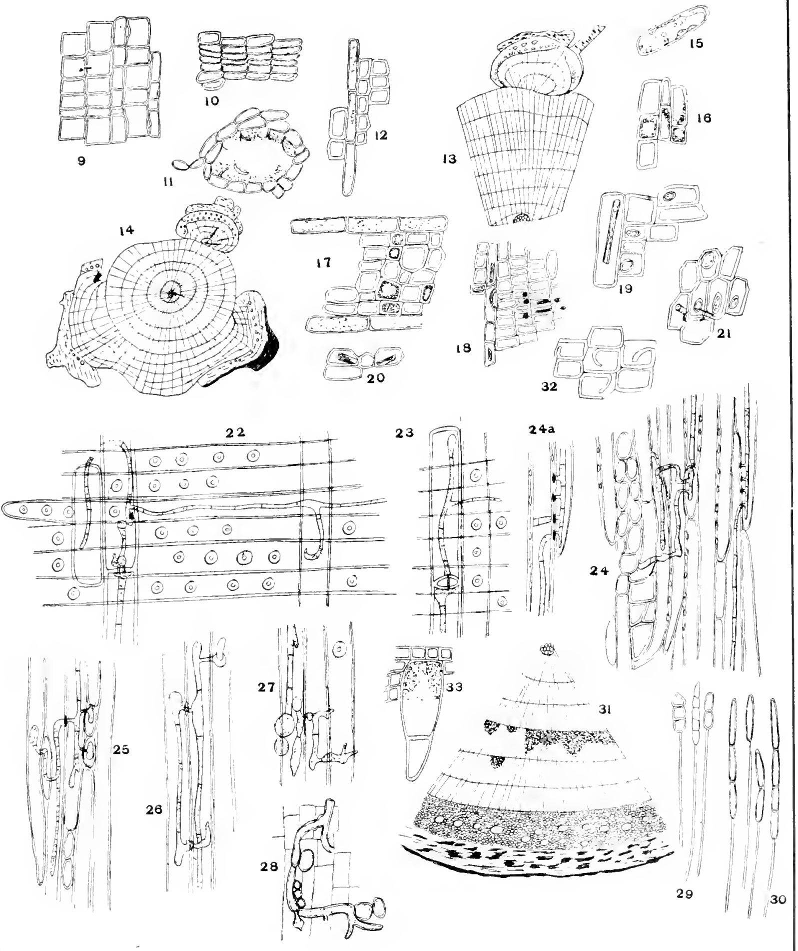

76

PILSBRY. JAPANESE LAND SNAILS.

PLATE XXII.

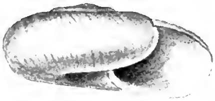


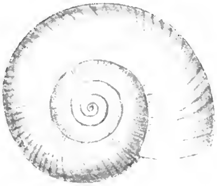
HARSHBERGER. DISEASES OF WHITE CEDAR.

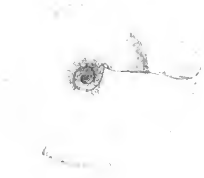


HARSHBERGER. DISEASES OF WHITE CEDAR.

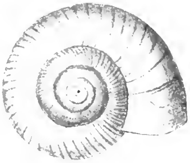

1

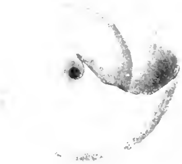

2

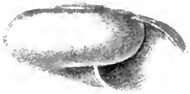

3

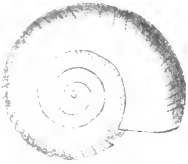

4

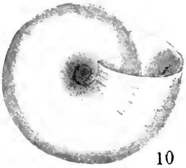

5


6

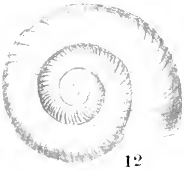

7


8


9

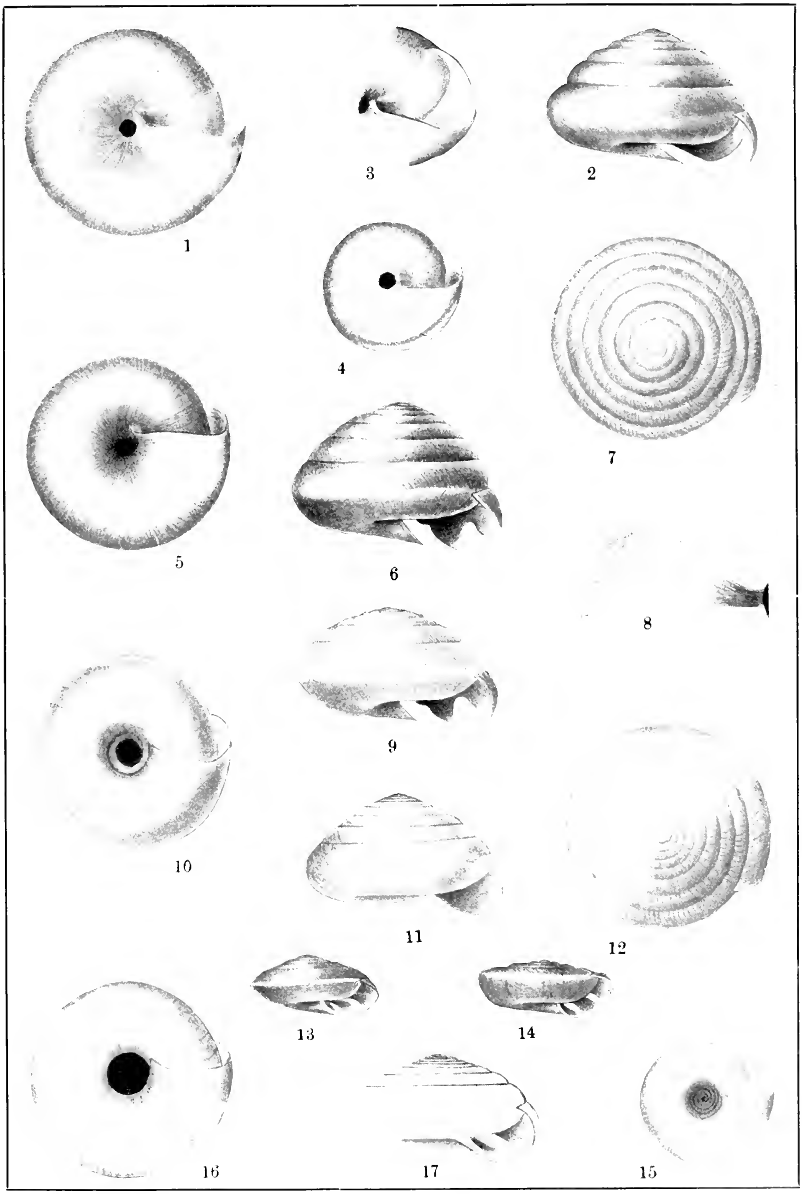

10


11


12

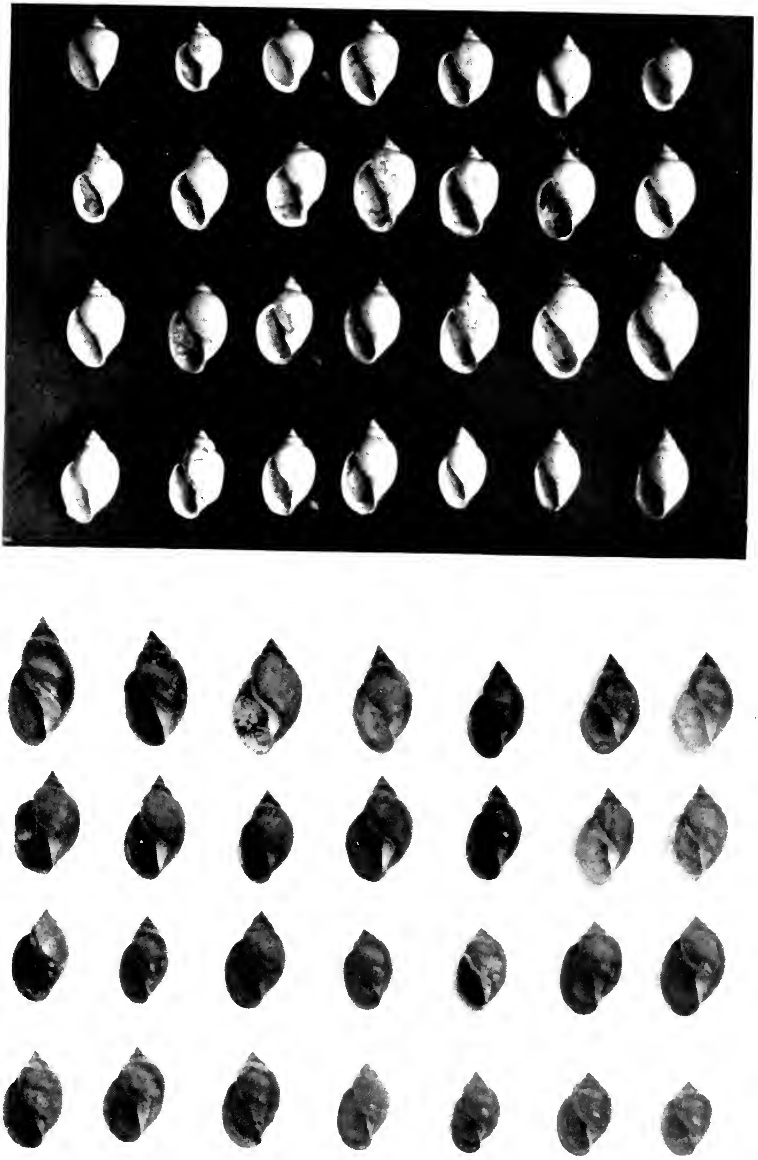
E. G. Vanatta, del.

WALKER AND PILSBRY. MT. MITCHELL MOLLUSCA.

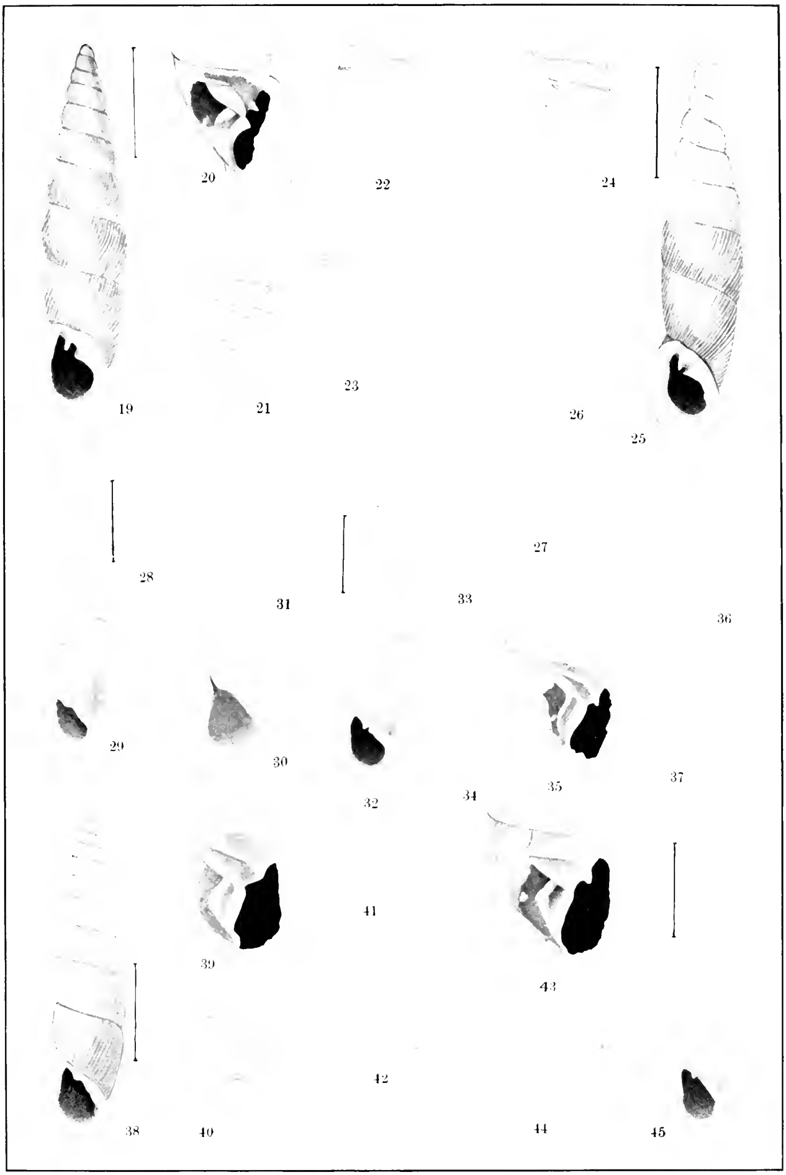


E. G. Vanatta, del.

WALKER AND PILSBRY. MT. MITCHELL MOLLUSCA.

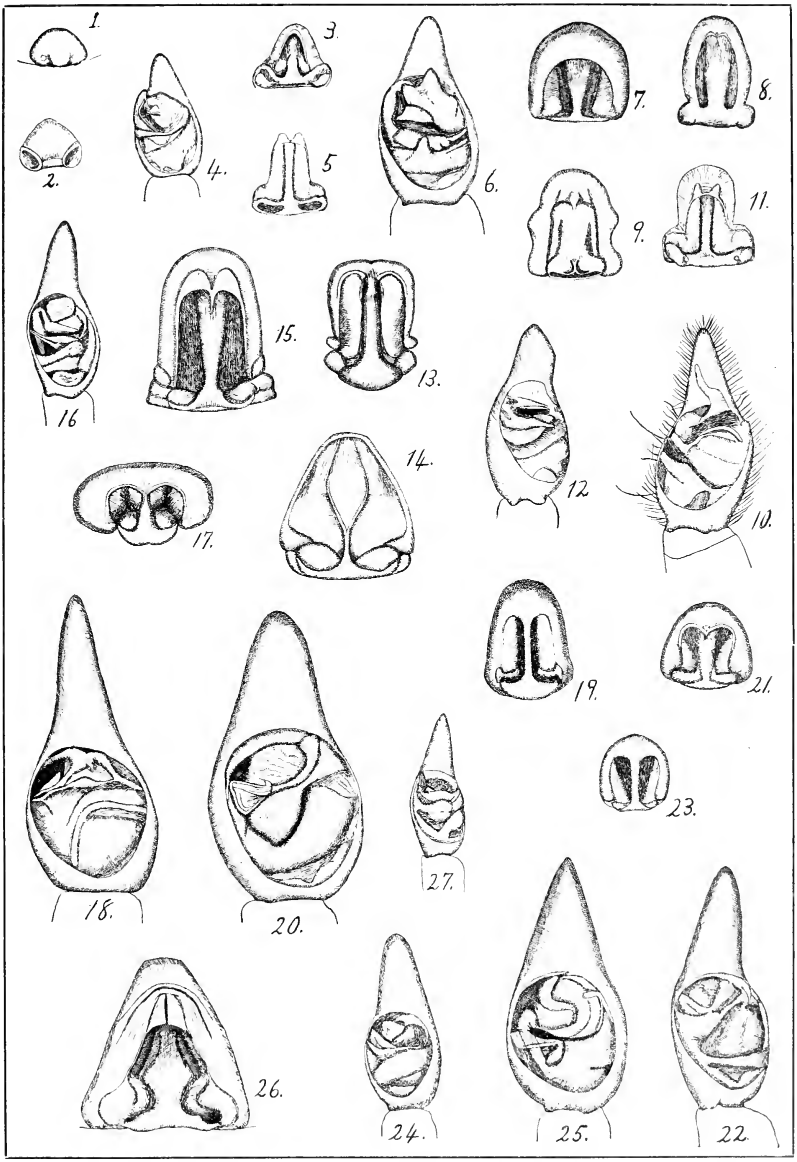


SPRINGER. LIVING AND FOSSIL PHYSÆ

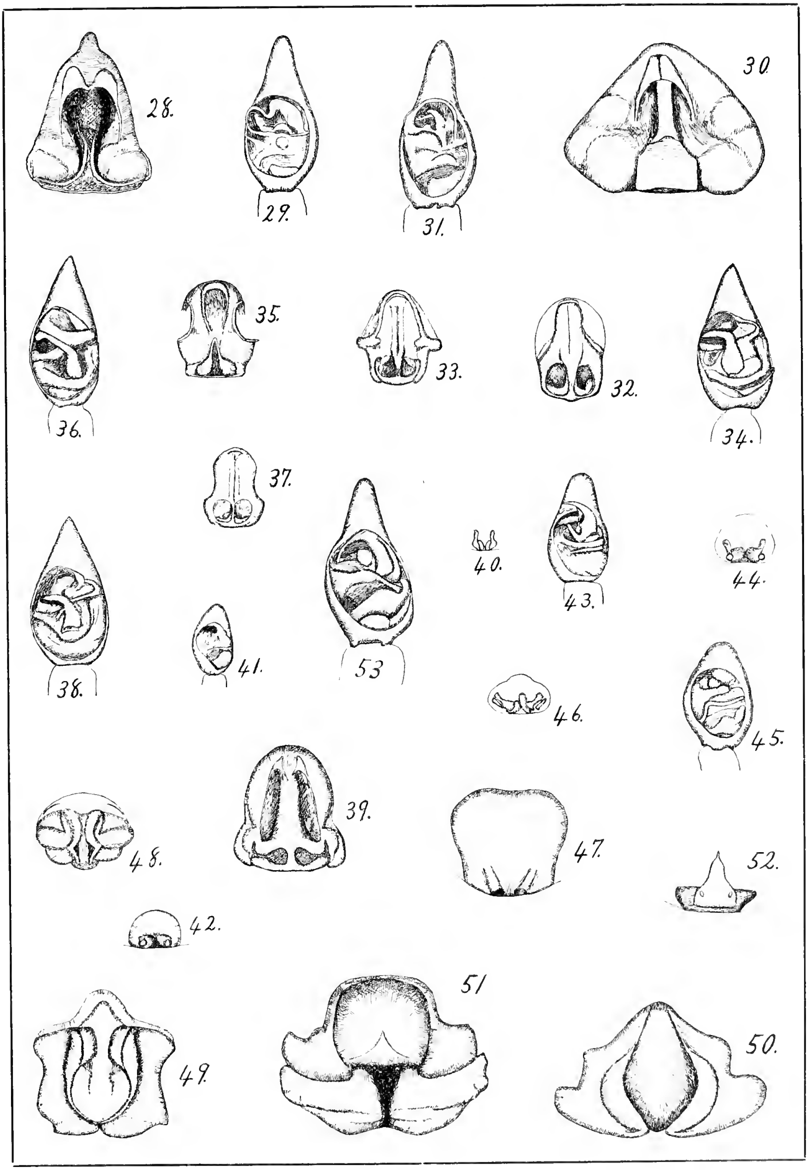


Pilsbry del.

PILSBRY. NEW JAPANESE MOLLUSCA.



MONTGOMERY. LYCOSIDÆ AND OXYOPIDÆ.



MONTGOMERY. LYCOSIDÆ AND OXYOPIDÆ.

SEPTEMBER 16.

Mr. ARTHUR ERWIN BROWN, Vice-President, in the Chair.

Ten persons present.

Papers under the following titles were presented for publication:

"On the Genus Phrynotettix Glover (Haldemanella Auct.)," by James A. G. Rehn.

"Notes on an Ant," by Adele M. Fielde.

New Land Mollusca from Idaho.—DR. PILSBRY spoke of land mollusks collected in Idaho by the Rev. E. H. Ashmun, whose work in former years has added so largely to our faunistic knowledge of Arizona and New Mexico. Among other new and interesting finds, a new species of the Zonitid genus *Pristiloma* was found, the easternmost of its kind. The following description was offered:

PRISTILOMA IDAHOENSE n. sp.

Shell imperforate, depressed, the spire low conoid, yellowish corneous, glossy, smooth except for faint growth-lines, stronger near the suture. Whorls 6, very narrow and slowly increasing, the last very obtusely angular at the periphery, very convex beneath, only slightly impressed at the axis. Aperture very narrowly lunate, the peristome simple and thin, the columellar margin thickened within, suddenly but minutely dilated at the axial insertion. Alt. 2.1, diam. 3.4 mm.

Steven's Ranch, Weiser Cañon, Washington Co., Idaho, types No. 82,353 Coll. A. N. S. Phila.; also Price Valley, Weiser Cañon, in the same county, and Big Payette Lake, Boise Co., Idaho; collected by Rev. E. H. Ashmun, 1901.

In the key to species of *Pristiloma* published by the speaker in 1899 (*Proc. A. N. S. Phila.*, p. 187), this species would group with *P. lansingi* and *P. arctica*. It differs from the latter in having more and narrower whorls, a higher periphery, and a narrower mouth. It differs from *lansingi* in the larger size, absence of any lip-rib (in over 100 specimens examined), the less rounded periphery, and the greater number of whorls.

The death of William N. Lockington, a member, was announced.

SEPTEMBER 23.

Mr. ARTHUR ERWIN BROWN, Vice-President, in the Chair.

Ten persons present.

The death of Rudolf Virchow, a correspondent, was announced.

SEPTEMBER 30.

Mr. ARTHUR ERWIN BROWN, Vice-President, in the Chair.

Seven persons present.

A paper entitled "Contributions toward a knowledge of the Orthoptera of Japan, I—Acrididæ," by James A. G. Rehn, was presented for publication.

The following were ordered to be printed:

ON THE GENUS PHRYNOTETTIX Glover (HALDEMANELLA Auct.)

BY JAMES A. G. REHN.

The genus *Phrynotettix* was erected in 1872, on the figure of a specimen from the Pecos river, Texas, in Glover's *Illustrations of North American Entomology, Orthoptera* (Pl. VI, fig. 25), and has been entirely disregarded since, nearly all authors giving preference to Saussure's later name *Haldmanella.* The original figure of *Phrynotettix* is clearly recognizable, and the absence of a description should not militate against the adoption of it under such conditions. Four nominal species have been described, but a study of the descriptions proves that all are synonymous, while one quite distinct form from northern New Mexico appears to be undescribed.

PHRYNOTETTIX Glover.

Ephippigera Haldeman (not *Ephippiger* Latreille = *Ephippigera* Burmeister), Stansbury's Exped. to the Great Salt Lake, p. 371, 1852.

Phrynotettix Glover, Illustr. N. Amer. Entom., Orth., Pl. VI, fig. 25, 1872.

Eremobia Thomas (not of Serville), Rept. U. S. Geogr. Surv. West 100th Merid., V, p. 886, 1875.

Haldmanella Saussure, Addit. Prodr. Œdipodiorum, p. 153, 1888.

Haldemanella Bruner, Proc. U. S. Nat. Mus., XII, p. 81, 1890.

Haldemannia Townsend, Insect Life, VI, p. 31, 1893.

Type.—*Phrynotettix verruculatus* Glover = *Ephippigera tshivavensis* Haldeman.

Key to Species (*based on females*).

a.—Pronotum of female elongate-ovate, frontal costa not markedly constricted dorsad and not separated from fastigium by a definite transverse carina, *tshivavensis* (Haldeman).

aa.—Pronotum of female cordiform, frontal costa considerably constricted dorsad and separated from fastigium by a single low callous carina, ... *taosonus* n. sp.

Phrynotettix tshivavensis (Haldeman).

Ephippigera tshivavensis[1] Haldeman, Stansbury's Exped. to the Great Salt Lake, p. 371, Pl. X, fig. 3, 1852. (Chihuahua.)
Ephippigera tschivavensis Walker, Cat. Derm. Salt. Brit. Mus., III, p. 545, 1870. (Utah.)
Phrynotettix verruculata Glover. Illust. N. Amer. Entom., Orth., Pl. VI, fig. 25, 1872. (Pecos River, Texas.)
Eremobia magna Thomas, Rept. U. S. Geogr. Surv. West 100th Merid., V. p. 886, Pl. XLIII, fig. 5, 1875. (Lower Arizona.)
H[aldmanella] Tschivavensis Saussure, Addit. Prodr. Œdipodiorum, p. 153, 1888.
Haldemanella robusta Bruner, Proc. U. S. Nat. Mus., XII, p. 81, 1890. (Southern Arizona.)
Haldemannia tschivavensis Townsend, Insect Life, VI, p. 31, 1893. (Las Cruces, New Mexico.)
[*Haldemanella*] *tschivavensis* Scudder, Catal. Descr. Orthopt. U. S. and Can., p. 44, 1900.
Haldemanella verruculata Scudder and Cockerell, Proc. Davenport Acad. Sci., IX, p. 39, 1902. (Organ Mountains, New Mexico.)

Distribution. — Previously recorded from Chihuahua, Pecos river, Tex.; lower and southern Arizona, La Cueva, Organ mountains, and Las Cruces in New Mexico, besides a record published by Riley of one immature specimen from the Argus mountains, Inyo county, Cal., the latter specimen being now before me. The record from Utah, given by Walker and generally followed, is no doubt erroneous. Walker had no material himself, and the original specimen described by Haldeman came from Chihuahua. The locality Utah was probably assumed from the title of the work in which Haldeman published.

The series examined includes the following localities: El Paso, Tex., March 31, 1902, and Alamogordo, Otero county, N. M., May 13, 1902 (Viereck and Rehn); Lake Valley, Sierra county, N. M. (Cope); Shovel Mount, Burnet county, Tex., July 31, 1901 (F. G. Schaupp).

Synonymy.—An examination of the published figures and descriptions of the forms which I have included under this species will show that they are identical, the slight differences which are apparent being mainly in the figures, and can be accounted for by the fact that several of them lack a considerable portion of the detail of the insect. The original figure by Haldeman is very good, in fact the best published, and Bruner's types of *robusta*

---

[1] In the original form of the species Haldeman introduced in the first syllable the Hebrew letter *resh*, to give the proper sound to the Latinized name. Walker translated it *sch*, but *sh* is sufficient.

(two of which I have examined) exactly fit it except for one trifling character, which the series examined shows to be a very variable one, namely, the obtuse-angulate or rotundate character of the caudal angle of the lateral lobes of the pronotum. Coloration appears to bear absolutely no weight as a diagnostic character, and is only of interest in that the males are deeper and more richly colored than the females.

Some measurements of the pronotum, in comparison with that of the new species, may be of interest:

Females.	Length.	Greatest Width.
P. tshivavensis:		
Chihuahua (from Haldeman), ...	14 mm.	9 mm.
Lower Arizona (from Thomas), . .	18.7 "	12.5 "
Southern Arizona (from Bruner), . .	22 "	15 "
Lake Valley, N. M., ...	20.5 "	13 "
Alamogordo, N. M., ...	23 "	15 "
P. taosanus:		
Taos Valley, N. M. (type), . . .	17 "	12.5 "

Phrynotettix taosanus n. sp.

Type.—♀; Taos Valley, Taos county, N. M., June, 1883. Collection of the U. S. National Museum.

The most important differential characters are given in the key of the species. The median carina of the metazona is also very apparent, while in *tshivavensis* it is obsolete;[2] the transverse sulci are also more arcuate in *taosana*, and the central portion of the caudal region of the prozona more tuberculate.

Body short and broad. Head with the vertex about equally long as broad (decidedly broader than long in females of *tshivavensis*), median carina distinct and extending to the tip of the fastigium; frontal costa compressed above and separated from the fastigium by a distinct rugose carina, below the ocellus strongly compressed and obsolete, sulcate throughout; eyes rather small, very much shorter than the infraocular genæ. Pronotum rather short, broad and cordiform in outline, the surface heavily rugose as characteristic of the genus, cephalic border subarcuate, the lateral carina strongly constricted cephalad, the caudal margins straight; median carina distinct but most developed on the meta-

---

[2] In immature specimens this carina is very distinct, but the type of *taosana* is a fully adult female, and the presence of a distinct median carina cannot be laid to immaturity.

zona, the central region of the prozona heavily tuberculate, the posterior portion strongly developed; transverse sulci arcuate, particularly the second and third; lateral lobes with the ventro-caudal angle obtuse-angulate, the central portion of the lobe bearing a considerable depression which extends caudad and dorsad from the ventro-cephalic angle. Tegmina not exceeding the tip of the pronotum in length, the reticulations very close (in *tshivavensis* these are much coarser and the principal veins are more apparent). Abdomen not exceeding the hind femora in length, the dorsal aspect keeled.

General color reddish-brown, the exernal faces of the femora marked with ochraceous.

Measurements.

Total length, ...	34.5 mm.
Length of pronotum, ...	17 "
Greatest width of pronotum, ...	12.5 "
Visible length of tegmina, ...	7.5 "
Length of hind femora, ...	13 "

Specimens Examined.—One, the type.

NOTES ON AN ANT.

BY ADELE M. FIELDE.

There is no regeneration of the antennæ.—A queen of *Stenamma fulvum piceum*[1] deprived of her antennæ in July, 1901, lived in one of my artificial nests with workers and other queens until January 5, 1902, and gave no indication of regenerating the lost organs. Of the many ants whose antennæ were wholly or partially excised by me in 1901, in the experiments made upon the ants' sense of smell,[2] some lived several months, but none ever showed sign of regenerating any excised part.

Ability to live in isolation.—On the 27th of August, 1900, I took three workers from an apple-core lying by the roadside and segregated them in a Petri cell, from which they were never removed. One died February 23, 1902; one died March 1, 1902, and one is still living, September, 1902, the survivor having lived alone more than six months. She busies herself with the inert young that I lend to her and reclaim before they hatch, and she appears to be healthy and happy. She is wholly tame, and evinces no desire to leave her cell when I take off its cover; but she seems to enjoy disporting herself upon my hand, or upon the hand of another person, where she will voluntarily stay for long periods. She appears to have, concerning human hands, unexplained preferences which do not depend on acquaintance, temperature or race.

Familiarity with the nest-aura does not reconcile aliens.—Two of my small nests,[3] one containing ants of the C colony, the other containing ants of the G colony, have stood in juxtaposition one year, and have been cleaned weekly with the same appliances, but

---

[1] The writer is in her third year of study of this ant. It is the species under consideration in this paper in every case, unless another species is named.

[2] "Further Study of an Ant," *Proceedings of the Academy of Sciences of Philadelphia*, October, 1901.

[3] "Portable Ant Nests," *Biological Bulletin*, Vol. 2, No. 2, 1900.

the inmates of the two nests continue to fight each other on meeting, as they did when first taken from their natural nests.

Kings.—The kings have the distinctive odor of their blood relations.—July, 1902, I isolated, each in a Petri cell, eight deälated queens, more than one year old, and representing two communities. Into each of the cells I introduced, one at a time, several kings, but a few days or few weeks old, and with no previous association with any of these queens. In every case the queen was at once friendly, and continued for many days to be friendly, with all kings of her own colony, but was so hostile to kings of any alien colony that she avoided or killed every alien king introduced. She must have recognized colony odor in these kings. The kings appear to be deficient in the sense of smell. They at times, especially in the light, and on warm days, become wildly amorous upon contact of the head with a queen, a worker or another king, regardless of the lineage of either. The kings are not clever, never follow a trail, never take part in the care of the young, and are at all times dependent. They can lap food for themselves; but I have seen so many as three kings feeding at the same time from the mouth of one worker, while other kings stood around as if waiting their turn to be fed.

Queens.—It may be said of the queens that while virgin they manifest marked preference or dislike toward certain kings. Having once mated they afterward permit no close approach of an alien king. They condone the stupidity of kings of their own lineage, and tolerate from them attentions to which no response is conceded.

It has been affirmed that workers remove the wings from fertilized queens. That a queen may drop her wings without assistance was shown by two living in my nests. Both were hatched on August 5, 1902, from pupæ taken by me from the natural nest on August 3, and they both mated in captivity on August 22, when seventeen days old, with kings a few days old, and of their own colony. As soon as they had mated I again isolated each, and each dropped her wings within a few days upon the floor of her solitary cell.

A queen may defer mating for a year at least, and then mate with a king a year younger than herself, and may, later on, begin the laying of eggs. Light and warmth appear to be required for stimulation of the king and queen to mating, and it may be that queens hatched late in summer do not mate until the next succeeding summer. A winged queen taken by me from the natural nest of the C colony, August 22, 1901, had no opportunity to mate until September 24, when I put into the artificial nest where she lived several kings of the H colony, just taken from the ground. These kings all died within a few days, and the queen probably did not mate during 1901, as she retained her wings and laid no eggs throughout the winter of 1901–1902. She had no association with any king between September, 1901, and July 6, 1902, when I put into the Petri cell where she was then isolated a king of her own colony, five days old. She at once seized him gently by a wing, and presently licked him from end to end. She could not have mated earlier than July 6, and may not have mated until August, when I put other kings and also workers, all of her own colony, into her cell. On August 20, 1902, she lost her wings, having worn them a year or more. She laid her first egg on August 24, four days after losing her wings.

Another winged queen, also taken from the natural nest of the C colony on August 22, 1901, had no opportunity to mate until September 21, when I put into her habitation two kings of her own colony. She probably did not mate with either of them, for she retained her wings and laid no eggs throughout the winter of 1901–1902. There were no males in the nest where she lived from September, 1901, to July 13, 1902. On the latter date, after she had been isolated one month, I put into the Petri cell where she then lived a king of her own colony, and several workers. The king was but four days old, but may have mated immediately with the still winged queen. She lost her wings on the 10th of August, having worn them nearly a year since her capture. On the 14th of August she laid her first egg, and on the 20th she had eight eggs.

Memory.—Have the ants an intellectual memory ?

Experiment a.—In one of my artificial nests were four deälated queens of the C colony, taken by me from their natural nest near Wood's Hole, Mass., September 7, 1900, with workers. On the 23d of September, 1901, I put into this nest some pupæ of *Formica fusca subsericea,* and five days later one of these pupæ hatched, and was permitted to live with the resident Stenammas. The

Formica was somewhat larger than either of the Stenamma queens, and was very active. She remained in association, at times, with these queens until November 28, a period of two months, and was then finally removed from their nest. Five and a half months later, May 11, 1902, I put the four queens into a clean Petri cell, and introduced to their cell a *Formica fusca subsericea* from Central Park, New York City. The introduced Formica exhibited great fear in the presence of the Stenamma queens, and made energetic efforts to escape from the cell; but the queens showed neither fear nor dislike of the Formica, and never opened their mandibles when I forced the Formica to touch them. The fears of the Formica gradually subsided, and after two weeks' residence she would touch antennæ with the queens in most friendly fashion. The Formica was thereafter often huddled with the queens, and she lived with them until May 31, 1902, when the four queens were killed by an accident. The Formica survived and I put her into a similar cell with C colony queens that had never fostered a Formica. These queens separately and together attacked the Formica and killed her after two days' persecution. It is possible that the odor of the Formica remained in the nest inhabited by the four Stenamma queens, and that they had not to exercise memory in the case. But the odor of the Wood's Hole Formica and that of the Central Park Formica was not identical, for I put *Formica fusca subsericea* of these two places together and found that they fought each other to the death.

Experiment b.—On the 22d of August, 1901, I sequestered pupæ and larvæ from the natural nest of the C colony, and then segregated ants hatched therefrom between September 4 and September 10. These segregated ants had no association with any other ant. On the 26th of September a large *Formica fusca subsericea* hatched out from a pupa that I had put into their cell three days earlier, and it was kindly cared for by the little Stenammas, although it was four or five times their size. On the 6th of October, the Stenammas being about one month old and the Formica ten days old, I separated them, putting the Stenammas into one clean Petri cell and the Formica into another. The inhabited cells were respectively cleaned once a week,[4] and were cleaned seven

---

[4] The cells were cleaned, after temporarily removing the ants to another clean cell, by washing the cell and its enclosed sponge with

times. On the 24th of November, after fifty days of separation, I put the Stenammas, now only two in number, into a clean cell, and introduced the Formica. The Formica was in as complete a panic as could have been one of its kind that had never seen a Stenamma. She ran from the Stenammas, snapped at them when forced into proximity, and gave starts of terror when coming inadvertently into touch with them. The Stenammas, on the contrary, showed neither fear nor dislike of the big foster-child that had been returned to them. The fear manifested by the Formica gradually diminished, and after about two weeks together the Formica would voluntarily approach and touch antennæ with the Stenammas.

I then took two Stenammas of the same size and lineage as these fostering ants, placed them in conditions in all respects similar, and introduced this same Formica to their cell. The Stenammas at once attacked the Formica, and would have slain her had I not intervened. I then returned her to the fostering ants, and left her with them one week longer.

I then repeated the separation of the two Stenammas and the Formica, again keeping them apart fifty days, and likewise cleaning the two cells once a week. On February 5, 1902, I again reunited the three ants, and this time found that the memory of each species for the other appeared to be perfect. There was no manifestation of fear nor repulsion on either side. Perhaps the increased age of the Formica, or her longer residence with the Stenammas previous to the second test enabled her to better remember them. She died a natural death the 10th of February.

In order to ascertain the existence of fighting qualities in these two Stenammas, I put into their cell aliens of their own species and found that they retained the habitual aversion of their kind toward strangers.

On the 11th of June, 1902, the same two Stenammas, then much engrossed in the care of pupæ, fiercely attacked Wood's Hole *Formica fusca subsericea* that I introduced into their cell. This Formica was not of the same colony as the one that they had fostered.

These two Stenammas seem to have remembered for fifty days

---

soap in hot water, soaking in boiling water, and rinsing in running water. A full description of the cells used in these experiments may be found in "A Study of an Ant," *Proceedings of the Academy of Natural Sciences of Philadelphia*, July, 1901.

an ant of a different subfamily from themselves. They had never met any other ant of that subfamily.

Experiment c.—On the 23d of September, 1901, I put into an artificial nest containing queens and workers of the C colony some pupæ of *Formica fusca subsericea,* and on the 29th of September one of these pupæ hatched, and continued to reside with the Stenammas. On the 20th of October I removed the Formica to a Petri cell, which was cleaned weekly, and I kept her there until November 24, thirty-five days, when I introduced to her cell two queens and four major workers from the nest in which she had been hatched. The Formica exhibited great fear, as these ants usually do when brought into the presence of Stenammas; but the Stenammas appeared to be wholly friendly to the Formica. It is possible that the Stenammas have a better memory than have the Formicas, or it may be that her odor had continued to be manifest in the nest of the Stenammas, modifying their action in regard to their former associate.

These Stenammas are very discriminating concerning the odor of all ants introduced into their habitation, whether it be of their own or other maternal lineage.—An example of the persistent aversion of these ants toward the odor of an alien community was given by the residents in two of my artificial nests. In nest M, ants of the C colony, captured September 7, 1900, had reared during the summer of 1901 pupæ introduced from the E colony, and had also reared from the pupa-stage two *Formica fusca subsericea.* The fostered workers of the E colony remained in the nest; the two Formicas were removed December 1, 1901. On the 6th of June, 1902, I took all the ants, including queens and workers, in this nest and put them into a similar artificial nest inhabited by queens and workers of the C colony that had had no association with other ants since their capture from the natural nest, August 22, 1901. There was instant battle between the residents and the introduced ants, and the fighting continued during the three following weeks, until all the ants reared from the E colony pupæ had been exterminated.

In other nests, where no ants of alien lineage had been reared, ants of the C colony immediately affilated after two years of separation. That the colony odor and not personal acquaintance determines this affiliation may be illustrated by a single example.

On August 14, 1902, I had an artificial nest where were many queens and workers with inert young, all taken from the natural nest of the C colony, and established in my nest on the 7th of the preceding June. Into this nest I then introduced a young worker, the offspring of a C colony queen and an E colony king, whose whole existence had been passed in an artificial nest that had been established by me August 22, 1901. The inmates of this nest had never since its establishment associated with outside ants, nor entertained alien offspring. The young ant was amicably received in the nest into which she was introduced, and was not once nabbed during the succeeding half-hour, while she moved about fearlessly among the hundreds of residents. Her having had an alien father did not make her less acceptable to her mother's blood-relations.

The male parent does not influence the odor of the progeny.—Ants reared from pupæ segregated before hatching, never having associated in any wise with other ants, and having their own odor as their sole criterion, manifestly find that criterion duplicated in the odor of ants of about their own age, when these ants are of the same lineage as themselves on the maternal side, regardless of their paternity. The hereditary odor descends through the mother, and is unaffected by the father, whether he be of the same lineage as the mother or of an alien colony. The mother alone determines the intrinsic odor of her progeny.

In August, 1901, I arranged eight new artificial nests, for the rearing of ants having a recorded parentage. Into four of these nests I put virgin queens of the C colony with kings of the C colony; and into four of the nests I put virgin queens of the C colony and kings of either the E or the H colony. About fifty workers of the C colony were put into each nest to act as nurses to the expected young. During the ensuing year young was produced in all of these nests, and with these young ants I made experiments, as recorded below, during the year 1902. The ants used in the experiments were, unless otherwise indicated, hatched from pupæ that had been removed from the nest several days before hatching, isolated or segregated in a clean Petri cell, and never brought into association with any other ant previous to the time of use in the experiment. Such ants had, then, no criterion of correct odor, other than that of their own bodies.

Experiment a.—May 5. Into a clean Petri cell I put a worker twenty-five days old, the offspring of a C colony queen and an E colony king. With this worker I put another, fifteen days old, whose parents were both of the C colony. The two affiliated at once.

Experiment b.—May 10. Into a Petri cell occupied by three workers, from seven to twelve days old, the progeny of a C colony queen and an H colony king, I introduced one by one three workers, from two to twelve days old, the progeny of a C colony queen and a C colony king. The affiliation was in each case immediate. They behaved toward each other as if they had always been associated. I then put the six young ants into an artificial nest inhabited by queens and workers of the C colony, and they were adopted without examination.

Experiment d.—June 11. Into a Petri cell occupied by five workers, from two to five weeks old, the progeny of a C colony queen and a C colony king, and engaged in the care of introduced larvæ, I put a worker a few days old, the offspring of a C colony queen and an E colony king. The callow was adopted into the group without objection of any sort.

Experiment e.—June 11. Into a Petri cell occupied by six workers, between one and three months old, the progeny of a C colony queen and a C colony king, and engrossed in the care of introduced larvæ, I put a callow a few days old, the offspring of a C colony queen and an H colony king. The callow was immediately accepted by the residents.

Experiment f.—August 5. Into a Petri cell I put a callow two days old, the offspring of C colony parents, and hatched in one of my artificial nests that had been established just one year. With this callow I put one of about the same age hatched in the ancestral wild nest of the same colony. The two callows instantly affiliated, though they must have had different fathers.

The following experiments show not only that the mother alone determines the intrinsic odor of her offspring, but that the hereditary odor is modified by the age of the ant. As in the foregoing experiments, the workers first placed in the Petri cells are those sequestered while in the pupa stage, having no acquaintance with any ant other than those of their own segregated group of workers.

Experiment g.—February 23. Into a Petri cell occupied by two workers about one month old, the progeny of a C colony queen and a C colony king, I put two large and dark-colored workers taken from the ancestral nest in the preceding August. Each of the two residents instantly attacked an introduced adult, and used their stings with such violence that I removed the adults through fear of endangering the lives of the junior ants. I then introduced two other workers, also of the C colony, but less deeply colored than those I had removed. The two parties avoided each other, always associating by twos during several hours; but within a day they were huddled in one group. Three days later I put the four into a C colony nest, and they were all amicably received there. There was difference of odor, perceived at the first meeting, although all the ants were of the same colony.

Experiment h.—May 9. Into a clean Petri cell I put five workers, from twelve to fourteen days old, the progeny of a C colony queen and an E colony king. With them I put five workers, four of them from twelve to twenty-five days old, one of them sixty-five days old, the progeny of a C colony queen and a C colony king. The two groups had each been segregated from the pupa stage of existence. All the nine ants that were less than twenty-six days old affiliated quickly. The oldest ant was repeatedly attacked by the ants that had not previously been associated with her, and was dragged unresisting from the group and cast down on the opposite side of the cell. After being thus ostracized for about three days she was received into full fellowship. As this ant had the same parentage and had spent all her life in segregation with the four younger ants that were at once accepted into full fellowship, her age appears to be the sole cause of her having been differently treated, and indicates a different odor due solely thereto.

Experiment i.—June 14. Into a Petri cell occupied by three workers, ten days old, the progeny of a C colony queen and an E colony king, and engaged in the care of introduced larvæ, I put a worker, also ten days old, the offspring of a C colony queen and a C colony king. There was instant affiliation. I then introduced one by one ants of about the same age, but of diverse paternity, the mothers all being of the C colony, and all were amicably received, and were permitted to at once join in the care of the larvæ. When the group numbered ten, I added from a nest of the C colony a queen and an adult worker. Both were at once attacked and dragged away to the side of the cell opposite the larvæ. The queen was soonest tolerated, and within a day or two was permitted to join the group; but the adult worker was ostracized for eight or nine days.

Experiment j.—June 16. Into a Petri cell occupied by two minims ten days old, the progeny of a C colony queen and a C colony king, and engaged in the care of inert young, I put two major workers from an artificial nest of the C colony. The majors were much older and stronger than the two resident ants, but they submitted to being repeatedly dragged by the minims away from the nursery, and they were not allowed to join in the care of the young until after many days, one being ostracized until June 30, the other until July 4.

Experiment k.— July 27. Into a Petri cell containing four workers, each twenty-three days old, the progeny of a C colony queen and a C colony king, and engaged in the care of introduced pupæ, I put, one by one, five young ants, just taken from the natural nest of the C colony. Every one of these introduced ants was dragged to the side of the cell opposite the nursery, and were there cast down. If I lifted the cover of the cell they were dragged outside it.

I then chose callows from the natural nest, and likewise introduced them one by one into this cell. All were received without sign of dislike. In a few hours or days all the ants were grouped together about the pupæ.

Experiment l.—On the 22d of August, 1901, I segregated pupæ that hatched between August 27 and September 1, and I segregated the callows as soon as hatched, so that they never associated with other ants. On the 25th of the following December, the ants being then four months old and fully colored, I put into their Petri cell a queen of their colony taken while still winged, and at the time when these ants were taken as pupæ from the ancestral nest. This queen had since been kept in an artificial nest, with no other inmates than queens and workers of her own colony. The sequestered ants at once attacked and dragged the queen, but did not maim nor kill her. They continued to drag her away from the inert young and to ostracize her for about ten days, and then they gradually accepted her company. This indicates that no vast amount of time, perhaps not more than some forty or fifty days, are required for modification of the odor of the individual ant.

Other experiments invariably brought similar result. Whenever ants are hatched from sequestered pupæ, and reared without association with older ants, they always drag old ants of their own lineage away from the inert young, and sometimes refuse for many days to tolerate them near the nursery. The workers, on the other hand, never drag younger ants of their own maternal lineage away from the nursery, nor do they retaliate when the callows attack them. I have seen a very small pale callow tyrannize over a large deeply-colored adult for consecutive weeks.

A cause for the hostility of one colony to another of the same species and variety is a difference of odor, coincident with difference of age in the individuals composing the colony.

A queen, after mating, may settle in new ground, deposit her eggs, rear from them her progeny, and herself determine the inherent hereditary odor of the colony, which will be the same for all ants of that queen's lineage hatched at about the same time. Such progeny may be separated and kept segregated in sections for long periods, and the individuals of any section will at once affiliate with those of any other section on reunion. The pupæ may be segregated, and the subsequent affiliation of the ants produced therefrom will be equally complete, whether a queen be included in each division or not. The progeny of sister queens of the same age will instantly affiliate with each other or with the aunt-queen, provided that the segregation of each division has been perfectly maintained, and that there is little difference in the age of the ants.

Attacks made upon ants of the same lineage, when such are introduced into a segregated group, are more or less violent in proportion to difference of age between the residents and the introduced members.

A group may rear successive broods, in successive seasons, from the eggs of the same queen, and these broods will from their earliest days to their latest recognize the odor of all the kindred with which they were associated during the first few days of active existence. Their standard of compatibility is then formed, and they will defend nest and young against the approach of all ants whose odor disagrees with that standard. It follows that ants in a nest containing queens and workers many years old would have a different standard from that of any more lately established nest, even though all were of the same lineage. This explains the fact that colonies apparently alike, and with nest-exits but a few feet apart, sometimes show bitterest hostility to one another. It also explains the fact that ants taken from the extremes of an ant-domain fifty yards in diameter, and kept apart for two years, amicably reunite, provided that no young has hatched in either segregated group. It furnishes also explanation of the highly variable behavior of the ants of the same lineage toward one another when brought together after segregation; and it enables one knowing the exact conditions to accurately prophesy what a given ant will do on meeting another given ant of her own lineage.

In the following experiments, which are but a few examples from among many made by me in the summer of 1902 for the purpose of ascertaining the cause of hostility between colonies of the same species, all the ants were of the C colony, much used by me because of easy access to its populous natural nest.

For the ants a year or more old, I used queens and workers of this colony that were captured by me on August 22, 1901, and that have since been kept by me in small artificial nests, where no pupa has been allowed to hatch, and to which no ant has ever been introduced from outside.

When the ants did not differ in size or color sufficiently for me to thereby distinguish them, I marked those that I desired to observe.[5]

The ants depended upon to show the feeling of their kind toward such as were introduced, were all engaged in the care of inert young in Petri cells, where they had been for some days or weeks established as a family group. When I was about to use any such cell in experiment, I sometimes introduced an ant of an alien colony in order to ascertain the presence of fighters among the residents of the cell. Such aliens were always removed before the experiment.

The ants could not carry intruders outside the cell, unless I lifted its cover. I therefore considered, in these experiments, the seizing and dragging of any ant away from the larvæ pile and across the

---

[5] I mark the ants upon the top of the abdomen using dried varnish, into which water-color paint has been rubbed before drying. The varnish is softened for immediate use by a drop of chloroform. The ant is gently held by the head until the chloroform has evaporated from the dab upon her abdomen. This mark often remains upon an ant several weeks, and does not appear to influence her action nor that of her associates in the experiment.

cell as equivalent to the casting out of that ant from the nest. I sometimes lifted the cover and allowed the resident ant to carry an intruder outside it. The Petri cells permitted more close and constant observation of the ants concerned than would have been possible in any other residence.

Experiment m.—On August 25, into a cell containing forty workers, hatched between July 4 and July 16 from pupæ previously segregated, I put one by one three workers, each twenty days old, also hatched from sequestered pupæ, and also segregated to the time of the experiment. The introduced ants were all accepted without examination or attention.

I then put in a queen, captured June 7, and since deälated. She undertook at once to sort the resident workers, and to carry some of them out of the cell. She was attacked by a resident and I removed her.

I then put in an ant over one year old. She was seized and dragged across the cell, and this was repeated three times on her approach to the young, after which I removed her.

I then put in another ant over a year old. Five residents attacked her at once and so violently that I rescued and removed her.

I then put in a queen one year old. She was seized and dragged across the cell and I removed her.

I then put in another queen of the same age and she was treated likewise.

Experiment n.—On August 25, into a cell containing fourteen workers, all hatched on August 5 from segregated pupæ, I put a marked ant less than thirty days older than the residents. She was accepted without examination. I then put in a queen hatched on the same day as were these residents, and since mated and deälated. She was instantly accepted into the ant-group.

I removed her, and put in a queen one year old. She was three times dragged by two residents away from the young and across the cell, and I took her out. This queen had mated with a king of an alien colony, and had since reared progeny.

I then put in another queen, a year old, who had mated with a king of her own colony, and had since reared progeny. She was likewise attacked and dragged.

I put in adults of various ages, all more than a month older than these ants, and all were attacked. In these attacks on older outsiders the marked ant was active. She had never before met old ants.

Experiment o.—On August 25, into a cell where there was a queen who was hatched on August 5 among segregated pupæ, and who was isolated soon after hatching, I put seven workers all under three days old. The eight ants at once snuggled together.

Experiment p.—On August 26, into a cell containing fifteen workers, all hatched from segregated pupæ on August 5, I put a deälated queen, also hatched on August 5. The workers at once accepted the queen. As these ants had never before seen a queen, they must have been guided in their acceptance of her by smell rather than by feeling. Feeling would have surely revealed a difference between the conformation of the newcomer and that of their habitual associates.

After half an hour I removed this young queen, and put in a queen one year old. She was instantly seized and dragged across the cell.

I took her out and put in a worker more than one year old. She was violently attacked and I removed her.

I then put in an ant only a few days older than the residents. She was at once allowed to join in the care of the larvæ.

I then put in another deälated queen, also hatched on August 5, but since associated with older ants. She was nabbed and pulled, but was afterward licked, and in fifteen minutes was snuggled.

I took her out and put in another queen one year old. She was attacked and dragged across the cell three times before I took her out.

I then put in a worker about forty days older than the residents, but who had always been segregated with ants of her own age. She was attacked and dragged.

Experiment q.—On August 26, into cell A, containing many workers that had hatched August 7 from pupæ segregated August 3, and that had never since August 3 been protected from daylight, I put several workers that were also hatched on August 7 from pupæ segregated August 3 in cell B, and that had always been kept in darkness. They affiliated instantly, and without mutual attention. I likewise put into cell B several workers from cell A, with the same result.

At a later date, ants that had passed their whole pupa-stage in the light affiliated with those of the same age that had passed their whole pupa-stage in darkness, and *vice versa.*

Experiment r.—On August 27 I put into a clean cell three queens, one captured, deälated, September 7, 1900; one captured winged, August 22, 1901, and one captured, winged, June 7, 1902. All were deälated at date. These queens had all at some time associated with queens older and younger than themselves, and they at once associated amicably with each other.

I then removed from the cell the youngest of the three queens, and introduced one of exactly the same age as was she, but who had, during her twenty-two days of life, had no association with any ant older than herself. This young deälated queen constantly fled from the two older queens, and refused during two days to be driven or cajoled into touch with them. Meantime they snuggled each other voluntarily, though they had never before met.

Experiment s.—On August 28, into a cell containing a score of workers, hatched August 5 from pupæ sequestered August 3, I put, one by one, three workers of the same size and color as these resident ants, but twenty-one months older, having been hatched between the 13th and the 21st of November, 1900. Each of the visitors was seized and dragged.

I took them out, and put into the cell, one by one, three workers, thirty-seven days old, and of the same size and color as the resident ants. Each of these visitors was received without seizure or nabbing.

I then took them out and put in a queen hatched August 5. She was at once accepted. I removed her and put in a deälated queen hatched in June. This queen was nabbed, but she immediately set herself to the regulation of her new family, and she successively picked up and carried across the cell seven young ants. As fast as she brought the ants from the ant-group at the larvæ-pile I removed them from the cell, and in half an hour she had settled in the midst of a serene family, where she appeared to be wholly acceptable.

I then took her out, and without returning the rejected workers, I put in a queen a year old. This queen was attacked with great violence by several residents together, and I removed her from the cell.

I then put in a queen that had lived in one of my artificial nests since September 7, 1900. She was likewise violently attacked, and I removed her.

Large and small workers, a year or more old, also met with hostile treatment.

The results from these and all other experiments recently made by me coincide with my observations during three years' study of this species, and confirm my view that the cause of that diversity of odor which characterizes diverse communities lies in the difference in the relative ages of the communities. The queen transmits her individual odor to her progeny, and it is probable, though not proven, that in successive seasons the odor of the progeny varies with the age of the producing queen, the odor being a product of metabolism.

Effects of light and color upon the ant.—The haste with which the wild ants catch up their inert young and scurry into darkness whenever their nests are uncovered indicates great sensitivity to light. In the summers of 1901 and 1902 I reared ants from the larvæ, letting them pass the whole pupa-stage in full daylight, both with and without ant-nurses, and I found that the ants thus reared had the same color and the same activities as had their congeners simultaneously reared in darkness.

Sir John Lubbock[6] has shown that the rays from which his ants withdrew were the ultra-violet, and Forel[7] has proven that his ants perceived these rays through the eyes. Accepting the results attained by these eminent myrmecologists, I undertook to give my ants opportunity for healthful living and for their ordinary domestic occupations in my glass nests, and at the same time to impel them to deliberate choice among the seven primary colors or some combination of these colors. I therefore established newly captured queens, workers and inert young in three sorts of dwellings, where my earlier experiments had shown that they could live comfortably for long periods. I used the maze which is minutely described in my paper, "Further Study of an Ant," and which is here represented in the drawing marked M; a portable four-roomed nest, made for these experiments, and represented in the drawing

---

[6] *Ants, Bees and Wasps*, pp. 211 to 217, Appleton & Co., New York, 1902.

[7] *Experiences et remarques critiques sur les sensations des Insectes.* Deuxième partie, pp. 10–24. Como, 1900.

marked N, and a score or two of Petri cells about ten centimeters broad and one centimeter deep. All these habitations contained flakes of sponge saturated with clean water, and were suitably supplied with morsels of food for the ants. In none of their residences did I ever disturb the ants oftener than twice in a single day by any alteration of their environment.

I put papers of vivid colors under the transparent glass floors of these habitations, offering always a choice between colors. In the maze four colors were presented; in the nest, three; in the Petri cells, two. During two months of experimentation in this line the ants never moved their young, nor themselves congregated upon one color in preference to another, nor did they in consequence of a change in the color of their floor, or of an interchange between black and white, ever remove from any spot upon which they had congregated. They gave no sign of regarding any quality in their floor other than its opacity, and the most vivid reds, greens and blues displayed there in full daylight failed either to entice or to agitate them.

Their behavior was very different when colored glass was used for transmitting the light that entered their abodes. In all cases diffused, not direct, sunlight was used in these experiments. The walls as well as the roof of the dwelling were transparent, and the superimposed colored panes extended two inches beyond the walls, so that the chosen light entered from every quarter except through the floor, which was always opaque white. This made the conditions nearly equal throughout the abode. The dwellings were placed upon a large table where the summer temperature was the same on all sides, and the diffused light from a large north window gave fairly equal illumination over the whole.[8]

The ants were not affected by the intensity of the illumination from rays of longer wave-length than violet.—I repeatedly interchanged the panes over a Petri cell, one-half of which was covered by a pane that shut out all rays except a few red ones, and the other half by a pane transmitting much red light. During a residence of several weeks in this cell the ants showed no preference for the less intense light.

I also covered one-half of a cell with a colorless pane, and the

---

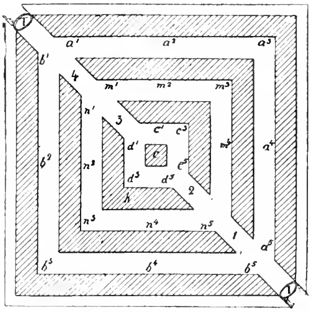
[8] These experiments were made at the Marine Biological Laboratory at Wood's Hole, Mass., in June, July, August and September, 1902.

other half of the cell with a dark-violet pane transmitting, as shown by the spectroscope, all the colors of the spectrum. I could scarcely discern the ants through the violet pane. But during a residence of several weeks in this cell the ants, after two removals from the colorless to the violet side, remained for many consecutive days under the transparent glass, and I repeatedly interchanged the two panes without causing the ants to remove from under the one or the other.

The same indifference to the intensity of illumination was shown by ants placed in cells covered one-half with a double layer, the other half with a single layer of green glass; one-half with a double layer, the other half with a single layer of yellow glass; or one-half with a double layer, the other half with a single layer of blue glass. The relative proportions of the primary colors, from red to indigo, transmitted by the various colored panes varied greatly, as the spectroscope showed. But the ants apparently disregarded these proportions, and were hasty or deliberate in their action in direct ratio to the number of rays from the violet end of the spectrum.

It is probable that ultra-violet rays were transmitted with the violet ones in all of my experiments.

It must be constantly borne in mind that the ants are instinctively photophob. They always take shelter under an opaque covering when a choice is offered between darkness and any rays of light, even pure red.



M.

Experiment 1.—June 8. I put into the maze four queens, fifty adult workers and a half-teaspoonful of larvæ, and covered the maze with colored panes, each covering one-quarter of the maze, from side to centre. Under the spectroscope the panes showed the light transmitted to be as follows:

The red pane transmitted only red rays.

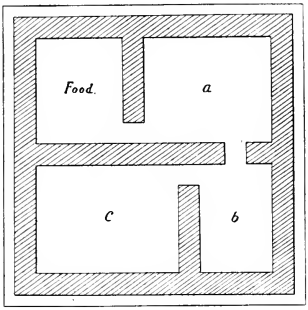
The orange pane transmitted red, orange, yellow, green, blue.

The green pane transmitted orange, yellow, green, blue, indigo.

The indigo pane transmitted yellow, green, blue, indigo, violet.

The ants spent thirty-eight days in the maze, and during that time made fifty settlements therein. Their first settlement, made by gathering the scattered larvæ and forming a single group including all the queens and workers, was under the red pane. I then placed the indigo pane over the group, interchanging it with the red, and the ants at once removed from under the indigo pane, and again grouped themselves under the red. Whenever I put the indigo pane over them they sooner or later removed from its light and settled under another pane, the total result being that they settled twenty-nine times under the red pane, ten times under the orange pane and eleven times under the green pane. Not once did they move from under the red, orange or green pane to the indigo. In removing, they as often settled on the side opposite as upon a side adjoining their last place of sojourn. All other conditions remained unchanged, making it certain that their removal was due solely to the interchange of the panes.

Their earliest removals from under the indigo pane were made in manifest haste, and were all made within a few minutes after I had interchanged the panes. But their haste gradually diminished, and on July 2, after the thirty-sixth removal, they remained several hours under the indigo pane before removing to orange. I changed the panes again at 6 o'clock P.M., putting them under indigo, and they passed the whole of July 3 under that pane, before removing to red on July 4. Their aversion to the violet rays, the only rays transmitted by the indigo pane that were not also transmitted by another pane, appeared to have then subsided, for they spent six whole days, from July 11 to July 16, inclusive, under the indigo pane. They appeared to have learned that it furnished a safe shelter for them.



N.

Experiment 2.—Using the artificial nest represented in the drawing, N, I put in, on June 9, five queens, thirty workers, and a teaspoonful of larvæ, all taken from a wild nest on the preceding day. The food-room was roofed with colorless glass, was used by the ants solely as a feeding place, and does not otherwise enter into the experiment. Over each of the three other rooms I placed a pane of colored glass—

Red, transmitting red rays only.

Yellow, transmitting red, orange, yellow, green, blue, indigo.

Blue, transmitting orange, yellow, green, blue, indigo, violet.

In 14 trials, occupying 14 days, the ants always removed from under the blue pane, whenever it was placed over them, and took shelter in another room. They removed 8 times to red, and 6 times to yellow.

In this experiment they always departed from the room to which violet rays were admitted, and settled in one of the two other rooms.

In order to secure an expression from the ants concerning particular colors I used Petri cells, offering a choice between only two panes. I made each test with newly captured ants, including one or more queens, ten or more workers, and some inert young.

Experiment 3.—Time, 40 days.

Red pane, transmitting red rays only.

Treble orange pane, transmitting red, green.

The ants showed no preference for either side of the cell. The panes were many times interchanged, but the interchange never caused their removal to the other side of the cell. The red and green rays were evidently as acceptable to them as were the red rays alone.

Experiment 4.—Time, 53 days.

Yellow pane, transmitting red, orange, yellow, green, blue, indigo.

Green pane, transmitting orange, yellow, green, blue, indigo.

The ants stayed indifferently through consecutive days under either pane, never removing from one side of the cell to the other on account of an interchange of the panes. They have therefore no preference for the red rays transmitted by the yellow pane.

Experiment 5.—Time, 50 days.

Red pane, transmitting red only.

Yellow pane, transmitting red, orange, yellow, green, blue, indigo.

The ants removed five times from under the yellow pane to the red; but were dilatory in their removals. They once waited three days, once four days, and once seven days, before removing.

Experiment 6.—Time, 20 days.

Yellow pane, transmitting red, orange, yellow, green, blue, indigo.

Blue pane, transmitting orange, yellow, green, blue, indigo, violet.

The ants always removed from under the blue pane within a few minutes after it was put over them. I interchanged the panes once or twice a day. In the first ten days they removed 20 times to the yellow side. The cause of the movement must have been either preference for the red or avoidance of the violet, and that the latter was the cause is indicated by Experiment 4.

Experiment 7.—Time, 21 days.

Indigo pane, transmitting yellow, green, blue, indigo, violet.

Violet pane, transmitting red, orange, yellow, green, blue, indigo, violet.

The ants removed five times from under the violet pane to the indigo side of the cell, but their movements were dilatory, and they stayed, toward the end of their sojourn, six consecutive days under the indigo pane, and then six consecutive days under the violet pane. This indicates lack of preference for the red and orange rays transmitted by the violet pane. The violet pane transmitted more of the violet rays than did the indigo pane.

Experiment 8.—Time, 21 days.

Blue pane, transmitting orange, yellow, green, blue, indigo, violet.

Colorless pane, transmitting red, orange, yellow, green, blue, indigo, violet.

The ants showed indifference concerning the two sides of the cell. They at first remained four days under the colorless pane, and when I then interchanged the panes, they remained ten consecutive days under the blue. I then reversed the panes again, and they remained under the colorless pane to the end of the test, seven days.

This indicates that the red rays transmitted by the colorless pane presented no definite attraction to them.

Experiment 9.—Time, 31 days.

Yellow pane doubled, transmitting red, orange, yellow, green, blue, indigo.

Green pane doubled, transmitting yellow, green, blue, indigo.

A daily interchange of the panes caused no removal of the ants. The red and orange transmitted on the yellow side did not attract them.

Experiment 10.—Time, 50 days.

Blue pane, transmitting orange, yellow, green, blue, indigo, violet.

Double indigo pane, transmitting yellow, green, blue, indigo, violet.

The ants stayed consecutive days on each side, and never removed on account of an interchange of the panes. They have not, therefore, a preference for the orange rays transmitted by the blue pane.

Experiment 11.—Time, 20 days.

Treble orange, transmitting red and green.

Double green, transmitting yellow, green, blue, indigo.

After three dilatory removals to the orange side, the ants became indifferent to their location in the cell.

Experiment 12.—Time, 30 days.

Treble orange, transmitting red, green.

Single orange, transmitting red, orange, yellow, green, blue.

The ants stayed indifferently under either pane, and never moved on account of interchanges of the panes. This indicates no preference for orange, yellow and blue rays.

Experiment 13.—Time, 45 days.

Double orange, transmitting red, orange, yellow, green.

Double green, transmitting yellow, green, blue, indigo.

The ants moved once to orange on account of interchange in the panes. The green side presented so little of blue and indigo under the spectroscope as to make the presence of those rays doubtful. The ants did not seek the red rays.

Experiment 14.--Time, 43 days.

Double orange, transmitting red, orange, yellow, green.

Single green, transmitting orange, yellow, green, blue, indigo.

The ants removed twice from green to double orange. This may indicate preference for red, or avoidance of the blue and indigo. The removals were dilatory, and the ants quickly became indifferent to the rays.

Experiment 15.—Time, 35 days.

Double orange, transmitting red, orange, yellow, green.

Yellow pane, transmitting red, orange, yellow, green, blue, indigo.

The action of the ants was the same as in the last experiment, and showed that the cause of the removals was not a preference for red, but an avoidance of the blue and indigo.

Experiment 16.—Time, 50 days.

Single orange, transmitting red, orange, yellow, green, blue.

Double green, transmitting yellow, green, blue, indigo.

The ants remained for consecutive days under each pane, and never removed on account of interchange of the panes. They have not, then, a preference for the red and orange transmitted by the orange pane.

Experiment 18. —Time, 43 days.

Single orange pane, transmitting red, orange, yellow, green, blue.

Single green pane, transmitting orange, yellow, green, blue, indigo.

The ants stayed consecutive days under each pane. I sometimes interchanged the panes twice a day, but such interchange never caused a change of location of the ant-group. The ants have not, then, a preference for red or for indigo.

Experiment 19.—Time, 22 days.

Single orange pane, transmitting red, orange, yellow, green, blue.

Single yellow pane, transmitting red, orange, yellow, green, blue, indigo.

The ants moved once to the orange side, and afterward stayed consecutive days under each pane. Interchanges of the panes never caused a removal of the ant-group. The ants have, then, but slight dislike for the indigo rays, the only rays in which the sides of the cell differed.

Experiment 20.—Time, 65 days.

Orange pane, transmitting red, orange, yellow, green, blue.

Violet pane, transmitting red, orange, yellow, green, blue, indigo, violet.

The ants removed hastily from under the violet as often as interchange of the panes was made, one or twice a day, for about twenty days. Thereafter they became indifferent to the violet rays. Their action indicates instinctive fear of the short wave-length rays, a fear that subsides with experience.

Experiment 21.—Time, 50 days.

Green pane, transmitting orange, yellow, green, blue, indigo.

Blue pane, transmitting orange, yellow, green, blue, indigo, violet.

The ants withdrew in haste from under the blue pane. I interchanged the glasses once or twice a day, and their removal from under the blue pane was speedily made, until about twenty days had elapsed, when they became dilatory in their removals and remained sometimes several days under the blue pane.

Experiment 22.—Time, 40 days.

Green pane, transmitting orange, yellow, green, blue, indigo.

Violet pane, transmitting red, orange, yellow, green, blue, indigo, violet.

The ants removed from under the violet pane and settled under the green pane as often as I interchanged the panes, once or twice a day, up to the twenty-fifth day, when they became dilatory and manifested increasing indifference to their roofing. The red rays did not neutralize the effect of the violet ones.

An analysis of the results of these experiments shows that the ants manifested no liking for any of the rays of light. If obliged to stay in light rays of some sort, the rays of longer wave-length are preferred to those of shorter wave-length. Dividing the spectrum, as we know it, into red, green and violet, we might say that to the ants' eyes red and green are most like the darkness that they prefer, and that violet is to them most luminous; or that the red and green are less visible to them than is the violet. In this regard the eyes of the ant appear to be the reverse of our own.

Our eyes perceive in the spectrum three fundamental colors—red, green and violet. The eyes of the ant may perceive there only two fundamental colors—one made up of the red and green rays, the other of the violet and ultra-violet rays.

After the experiments above recorded were completed, I put five queens and about three hundred workers, from a colony freshly brought from its natural nest, into each of five similar artificial nests, having opaque floors and walls and colorless glass roofs. The first nest I covered with cardboard, making its interior dark. The second I covered with panes transmitting only red and green rays, and in this the ants disposed themselves through the compartments in about the same way as did those in the first, the dark, nest. Over the third I put panes transmitting yellow, green, blue and indigo rays, and in this the ants disposed themselves with considerable regard to the shade afforded by the sides and partitions of the nest. Over the fourth I put panes transmitting only the rays at the violet end of the spectrum, and in this nest the ants disposed themselves with the same manifest effort to avoid the light as they did in the fifth nest, which was covered with colorless glass. Interchanging the panes caused the ants to rearrange themselves in accordance with the above scheme of relationship to the light.

Bearing in mind the fact that the ants showed no preference for red alone over the red and green (Experiment 3), it appears that the eye of the ant is not well adapted to the reception of light-rays whose wave-length is longer than in the violet rays; that it receives blue and indigo more perfectly than red, orange, yellow and green; and that there is a sudden increase of luminosity in the light-rays at that point in the spectrum where violet begins for our eyes.

The ants may discern colors, and yet have no preferences among the colors discerned. Color is determined by the wave-length in the light-ray, and since the ants discriminate between rays of different wave-lengths, they probably perceive color in the rays.

Sensitivity to the length of the wave indicates perception of color. They certainly discern white. Last year, when some of my Stenammas were intent upon the carrying of white pupæ through the maze into their nest, I dropped among the pupæ a few bits of white cord, cut to the size of the pupæ, and several ants picked up and carried bits of the cord a part of the way to the nest. They must have been deceived by the color, and must have lifted the bits of cord without smelling them, and on account of their color alone.

All my experiments emphasized the fact that the ants gradually lost their fear of the light, or of any modifications of it to which they were long exposed.

Ants hatched in the light, or hatched under violet or blue glass, and ants hatched in darkness and but a day or two old, all behaved under the colored panes exactly as did adult ants taken from the natural nests, showing that the withdrawal from light is instinctive, and that the instinct manifests itself from the beginning of the active life of the ant. I sequestered pupæ, and then segregated the ants hatched therefrom, and found that these ants, that had never associated with any other ants than those who had, like themselves, always lived in a Petri cell, behaved the same in regard to light-rays as did ants from the wild nests. The ant behavior in regard to light-rays is not the result of instruction from nor imitation of experienced elders.

I also repeated many of the experiments with ants five, ten and twenty days old, as well as with ants a few months old, reared in artificial nests, and found that this instinct prevailed at all ages, and over any sort of rearing. There was, however, a difference in the times within which ants of different ages become accustomed to the light-rays. The younger the ants the more quickly they ceased to move to the opposite side of the cell when I interchanged the panes.

The action of the ants when without inert young was essentially the same as when they had the care of eggs, larvæ and pupæ. The advantage gained in the experiments by the presence of the young was that the ants then reacted more speedily and definitely to the light-rays. The ants always grouped themselves upon or near the young, and there was so little of straggling that it seemed useless to count the few stragglers when reckoning results. The behavior of the ants toward the light-rays was the same whether queens were or were not present.

The withdrawal of the ants from the violet rays may have psychological relation to rain, or to some form of water. Four times when I put ants into cells of which one-half was covered with blue glass, the ants caught up their inert young and piled it all on top of the food enclosed in the cell, as if to raise the young out of the wet. This action on their part was so extraordinary as to cause me to make record of it. The ants living in my other Petri cells during the past two years have always assembled the young on the side of the cell opposite the food, and have in no case laid live larvæ or pupæ on the food-pile.

The plasticity of the ants is remarkably shown in their gradually learning to stay where they were never disturbed by me, under rays from which their instincts at first withdrew them.

OCTOBER 7.

Mr. ARTHUR ERWIN BROWN, Vice-President, in the Chair.

Eight persons present.

A paper entitled "Three New American Bats," by James A. G. Rehn, was presented for publication.

The deaths of Major J. W. Powell, a correspondent, and of Charles H. Hutchinson, a member, were announced.

OCTOBER 14.

The President, SAMUEL G. DIXON, M.D., in the Chair.

Twelve persons present.

A paper entitled "Additional Observations on the Strand Flora of New Jersey," by John W. Harshberger, Ph.D., was presented for publication.

OCTOBER 21.

Mr. CHARLES MORRIS in the Chair.

Eleven persons present.

A paper entitled "A Collection of Birds from Sumatra, obtained by Alfred C. Harrison, Jr., and Dr. H. M. Hiller," by Witmer Stone, was presented for publication.

OCTOBER 28.

MR. ARTHUR ERWIN BROWN, Vice-President, in the Chair.

Twenty-three persons present.

Papers under the following titles were presented for publication:

"A List of the Reptiles and Batrachians in the Harrison-Hiller Collection from Sumatra," by Arthur Erwin Brown.

"Studies on the Habits of Spiders, particularly those of the Mating Period," by Thomas H. Montgomery, Ph.D.

"Birds of the Seskiyou Mountains, California: A Problem in Distribution," by Malcolm P. Anderson and Joseph Grinnell.

In compliance with the recommendation of the Committee on the Hayden Memorial Geological Award, the medal was conferred on SIR ARCHIBALD GEIKIE, D.Sc., LL.D., late Director-General of the Geological Survey of Great Britain and Ireland.

ARCHIBALD GEIKIE was born in Edinburgh, the 28th of December, 1835, the youngest son of James Stuart Geikie. He was educated in the schools of his native city and, after graduation from the University of Edinburgh, he entered the Geological Survey of Scotland at the age of twenty years. Three years later, in 1858, he published his first book, entitled *The Story of a Boulder; or Gleanings from the Note-Book of a Field Geologist.* The work of the Geological Survey was largely confined to mapping, the first general geological map of Scotland being published in 1862.

While this map was issued under the direction of Sir Roderick I. Murchison, a large part of the work was contributed by Geikie. In 1867, at the age of thirty-two, Geikie was appointed Director of the Geological Survey of Scotland. All succeeding maps of the survey of Scotland were issued under his supervision, many of them being prepared by himself. Somewhat before this period he had begun to publish papers on physiographic geology, his work on *The Scenery of Scotland, Viewed in Connection with Its Physical Geology,* appearing in 1865. Subsequent papers deal with the effects of glaciation, modern denudation and other physiographic processes. In 1871 he was elected Murchison Professor of Geology and Mineralogy in the University of Edinburgh. The methods of geological surveying were carefully cultivated by Geikie, the results of his experience being given to the world in his *Outlines of Field Geology* (1876), which has gone through five editions, the last appearing in 1900.

In the year 1882, after serving on the Geological Survey of

Scotland for twenty-seven years, during fifteen of which he was Director, he was appointed Director-General of the Geological Survey of Great Britain and Ireland and Director of the Museum of Practical Geology, Jermyn street, London, which positions he held until his resignation from the Survey in 1901. He was knighted in 1891.

In 1879 he was selected to write the article on Geology for the *Encyclopædia Britannica*, 9th ed. His *Text-Book of Geology*, generally recognized to be the best presentation of the subject in any language, was issued in 1882, the second edition in 1885 and a third edition in 1893. His most important piece of research work, *The Ancient Volcanoes of Great Britain*, was published in 1897.

The following were ordered to be printed:

CONTRIBUTIONS TOWARD A KNOWLEDGE OF THE ORTHOPTERA OF JAPAN AND KOREA, I.—ACRIDIDÆ.

BY JAMES A. G. REHN.

The specimens which form the basis of this contribution are contained in the collection of the Academy, and are principally from three sources:

1. A series presented by Dr. H. C. Wood, simply labeled Japan, but in all probability from Yeso, as all the forms show Siberian affinities.
2. An excellent series from Kioto, purchased by the Academy from Mr. Y. Hirase.
3. A small series from Yokohama, contained in the Rehn Collection.

Family ACRIDIDÆ.

Subfamily **Acrydiinæ** (*Tettiginæ* Auct.)

Acrydium japonicum (Bolivar).

1889. *T*[*ettix*] *japonicus* Bolivar, Ann. Soc. Ent. de Belgique, XXXI, p. 263.

Four specimens, 3 males, 1 nymph.

Japan. Dr. H. C. Wood.

Subfamily **Acridinæ** (*Truxalinæ* Auct.).

Acrida nasuta (Linnæus).

1758. [*Gryllus*] (*Acrida*) *nasutus* Linnæus, Syst. Nat., X ed., p. 427.

Fifty-six specimens, 25 males, 28 females, 3 nymphs.

Chemulpo, Korea. Dr. W. H. Jones (7).

Japan. Dr. H. C. Wood (7).

Yokohama, Japan. Rev. H. Loomis (7). Rehn Collection.

Kioto, Japan. Y. Hirase (35), Nos. 14 and 15.

Both extreme color phases of this species are represented in the series, with many intermediates exhibiting a complete transition from the uniform green to the ochraceous and umber form.

Parapleurus fastigiatus n. sp.

Types, ♂ and ♀, Japan. Dr. H. C. Wood.

Allied to *P. alliaceus* (Germar), but differing in the greater extension of the preocular portion of the head (thus producing an extended frontal costa and triangularly acuminate fastigium), and in the lesser development of the mediastine and scapular area of the tegmina. No relationship exists with *P. fasciatus* Brunner,[1] which approaches *Duronia* in possessing partial lateral carinæ.

♂.—Head with the vertex tumid, a slight longitudinal sulcus being present; fastigium considerably produced, excavated, apex narrowly truncate, the lateral carinæ well marked, only a trace being visible of the median carina; frontal costa constricted below the ocellus, strongly expanded ventrad, sulcate throughout the entire length, punctate in the dorsal portion; eyes rather prominent, ovate; antennæ slightly depressed, twice as long as the head and pronotum. Pronotum subcylindrical, cephalic border subtruncate, caudal rotundate, median carina distinct, cut about the middle by the transverse sulcus; lateral lobes equally long as broad, the ventral margin deeply sinuate cephalad. Tegmina rather elongate, extending a considerable distance beyond both the abdominal apex and the hind femora; mediastine and scapular areas elongate, not dilated. Mesosternal lobes separated by an interspace much longer than broad; metasternal lobes almost confluent. Subgenital plate acuminate, possessing a distinct keel on the dorsal surface. Posterior femora slender, genicular lobes rotund-angulate; tibiæ not equaling the femora, bearing twelve spines on the external margin, ten to eleven spines on the internal margins.

♀.—Head with the fastigium rather broad, obtuse-angulate, the apex narrowly truncate, excavated but with no trace of a median carina; frontal costa constricted below the ocellus, moderately expanded ventrad, shallowly sulcate throughout the entire length, punctate dorsad; eyes of medium size, ovate; antennæ slightly longer than head and pronotum. Tegmina slightly exceeding the apex of the abdomen. Mesosternal lobes separated by an interspace subquadrate in outline; metasternal lobes considerably separated by a rectangular interspace. Posterior tibiæ with ten to eleven spines on the external and eleven spines on the internal margins.

General color (specimens taken from spirits and dried) dull yellowish-brown; postocular streak blackish, this streak extending

---

[1] *Rev. Syst. Orthopt.*, p. 127.

to the middle of the tegmina, in scapular area of the latter whitish; genicular arches and the tips of the spines on the posterior femora black.

Measurements.

	♂	♀
Length of head and body,	20 mm.	29 mm.
Length of pronotum,	4 "	5 "
Length of tegmina,	18 "	22 "
Length of hind femora,	13.5 "	16 "

Total number of specimens examined 4, 2 males and 2 females.

Chrysochraon japonicus Bolivar.

1898. *Chrysochraon japonicus* Bolivar, Ann. Mus. Civ. Stor. Nat. Genova, XXXIX, p. 82.

Two specimens, ♂ and ♀.

Japan. Dr. H. C. Wood.

Chorthippus[2] **latipennis** (Bolivar).

1898. *Stenobothrus latipennis* Bolivar, Ann. Mus. Civ. Stor. Nat. Genova, XXXIX, p. 83.

Eighteen specimens, 4 males, 13 females, 1 nymph.

Kioto, Japan. Y. Hirase (9), No. 17.

Japan. Dr. H. C. Wood (9).

This species was described from Korea and Yamada, Hondo, the latter locality being on the east coast not very far from Kioto.

Aiolopus[3] **tamulus** (Fabricius).

1798. [*Gryllus*] *Tamulus* Fabricius, Entom. Syst., Suppl., p. 195.

One female.

Kioto, Japan. Y. Hirase.

As already pointed out by Brunner,[4] this name far antedates *tricoloripes* Burmeister.

Mecostethus magister n. sp.

Type, ♂.

Japan. Dr. H. C. Wood.

This species appears to be closely related to the North American *M. lineatus* (Scudder), but differs in the greater size, the more sharply defined and constricted frontal costa, the comparatively

---

[2] This name, used by Fieber (*Lotos*, III, p. 100, May, 1853), should replace *Stenobothrus* Fischer on the grounds of priority.

[3] As in the case of *Chorthippus*, this name has priority over *Epacromia* Fischer.

[4] *Révision du Syst. Orthopt.*, p. 128.

shorter wings, and in the carination of the ventral surface of the subgenital plate. No relationship appears to exist with the European *Mecostethus grossus* (Linn.).

Head moderately prominent, the frontal costa forming a very marked angle at the junction with the fastigium; fastigium produced, the median and lateral carinæ well marked, and all terminating at the narrowly truncate apex; frontal costa slightly expanding ventrad, sulcate throughout, the margins slightly constricted at the ocellus; eyes large, ovoid, moderately prominent; antennæ depressed, very much longer than head and pronotum. Pronotum rugulose; cephalic margin truncate, caudal margin obtuse-angulate, lateral carinæ apparent only on the cephalic margin of the prozona, median carina well developed, uniform, severed by the transverse sulcus which crosses slightly caudal to the middle; lateral lobes with the ventro-cephalic angle rounded, tegmina exceeding the caudal femora. Mesosternal lobes separated by a space subquadrate in outline; metasternal lobes very narrowly separated caudad. Subgenital plate strongly produced, the caudal portion subhastate in outline, bearing a marked longitudinally disposed carina on the ventral surface. Caudal femora slender, genicular lobes rounded; tibiæ almost equaling the femora in length, bearing 12–13 spines on the margins.

Color (specimen from spirits).—General tint dull grayish-brown, eyes, postocular streak and lateral lobes of the pronotum reddish-brown. Ulnar area and extremity of the tegmina blackish, this color also suffusing the genicular region of the caudal femora and tibiæ as well as the distal extremities of the latter. Scapular area of the tegmina whitish.

Measurements.

Length of head and body,	28.5 mm.
Length of pronotum,	6.5 “
Length of tegmina	27 “
Length of hind femora,	19 “

Subfamily Œdipodinæ.

Œdaleus nigrofasciatus (DeGeer).

1773. *Acrydium nigrofasciatum* DeGeer, Mém. Ins., III, p. 493, Pl. 41, fig. 5.

A series of 90 specimens of this very variable species. The following localities and sources were represented in the series:

Japan. Dr. H. C. Wood (4).

Yokohama, Japan. Rev. H. Loomis (30), Rehn Collection.

Kioto, Japan. Y. Hirase (54), Nos. 10 and 23.

Chemulpo, Korea. Dr. W. H. Jones (2).

With the extensive series examined ample opportunity was presented for studying the range of variation exhibited by this species. Several of the types would be regarded as distinct, if it were not that the extremes and intermediates occurred in the same locality. The variations have been studied under two heads—structure and coloration.

Structure.

The most peculiar and the most unusual structural form of this species is that in which the cephalic portion of the dorsal aspect of the pronotum is strongly inflated or bullate. Four specimens in the series illustrate this singular phase, between which and the normal condition no intermediates were examined. Kioto and Yokohama were the localities represented in the four specimens.

The other great structural difference is in the median carina of the pronotum. In the majority of cases it is straight or very slightly arcuate, with a slight incision at the transverse sulcus; in some cases it is much more arcuate on the prozona than in the metazona; in a few (7) it is highly arched, not notched by the transverse sulcus. The specimens belonging in the latter category are all from Yokohama.

Examples of this species are found both subbrachypterous and macropterous.

Coloration.

The two general types of coloration, the brown and green, as pointed out by Saussure, are present in the series, many representatives of each, and a great number of intermediates showing what a wide range this broadly diffused species has in the color scheme.

The extreme green phase has the base color of the head, pronotum and dorsal aspects of the closed tegmina and caudal femora, as well as portions of the pleuræ rich grass green, the lateral portions of the tegmina basally of a chocolate tint marbled with cream, the overlying tint being grouped into transverse bars anteriorly.

The extreme brown phase is of a general dull umber tint, the maculations of the tegmina and posterior femora (these parts being uniform in the green phase) being brownish-black.

Between these two extremes are found many intermediates representing almost imperceptible gradations. Many individuals show variations which are individual or restricted to a comparatively few examples. The most important of these appear to be worthy of note.

The presence of four converging light lines on the pronotum somewhat in the form of a cross These lines are present only in the brown phase, or closely related intermediates, and in some specimens are strongly marked, but as a rule are but faintly so. In DeGeer's original figure of this species (Pl. XLI, fig. 5) this pattern of coloration is represented, though in rather a crude manner. The blending of the chocolate marbling on the lateral portions of the tegmina to form transverse bars is also a noticeable character. This latter phase is mainly found in the green type.

Œdaleus infernalis Saussure.

1884. *Œ*[*daleus*] *infernalis* Saussure, Prodromus Œdipodiorum, p. 116.

Three specimens, 1 ♂ (?), 2 females.

Japan. No further data.

Kioto, Japan. Y. Hirase.

One specimen is apparently a male, but the tip of the abdomen is missing.

Pachytylus migratorius (Linnæus).

1758. [*Gryllus*] (*Locusta*) *migratorius* Linnæus, Syst. Nat., X ed., p. 432.

One female.

Chemulpo, Korea. Dr. W. H. Jones.

Pachytylus cinerascens (Fabricius).

1793. [*Gryllus*] *cinerascens* Fabricius, Ent. Syst., II, p. 59.

Three specimens, 1 male, 2 females

Chemulpo, Korea. Dr. W. H. Jones (2).

Chefoo, China. Dr. W. H. Jones (1).

Trilophidia annulata japonica Saussure.

1888. *Tr*[*ilophidia annulata*] var. *japonica* Saussure, Addit. Prodr. Œdipodiorum, p. 54.

Four specimens, 2 males, 2 females.

Kioto, Japan. Y. Hirase, No. 28.

Subfamily **Pyrgomorphinæ.**

Atractomorpha bedeli Bolivar.

1884. *Atractomorpha Bedeli* Bolivar, Monografia de los Pirgomorfinos, p. 69.

Thirty-two specimens, 9 males, 20 females, 3 nymphs.

Japan. Dr. H. C. Wood (3).

Yokohama, Japan. Rev. H. Loomis (2). Rehn Collection.

Kioto, Japan. Y. Hirase (27), Nos. 20 and 21.

One specimen from Kioto differs from the usual form in having the whole superior aspect of the insect speckled with blackish-brown instead of being uniform greenish. In the males the superior surface of the abdomen is bright carmine.

Subfamily **Locustinæ** (*Acridiinæ* Auct.).

Oxya velox (Fabricius).

1793. [*Gryllus*] *velox* Fabricius, Entom. Syst., II, p. 60.

Nineteen specimens, 10 males, 9 females.

Kioto, Japan. Y. Hirase. Nos. 18 and 19 (part).

As noticed by Brunner,[5] this species, which usually passes as *hyla* Serville, should bear the name given above.

Oxya vicina Brunner.

1893. *O[xya] vicina* Brunner, Rév. du Syst. des Orthoptères, p. 152.

Thirty-one specimens, 16 males, 15 females.

Yokohama, Japan. Rev. H. Loomis (4), Rehn Collection.

Kioto, Japan. Y. Hirase (27), Nos. 18 and 19 (part).

This species is very closely allied to *O. velox*, but differs in several characters which, while not striking, are sufficient to differentiate it with little trouble.

As Brunner has simply given a key and a brief description of this species, the notes made after a comparative examination with specimens of *O. velox* may be of interest.

The ventral surface of the last segment of the abdomen in the female of *vicina* is longitudinally bicarinate for the greater part of its length; in *velox* this is smooth. The basal portion of the mediastine area of the tegmina in the female of *vicina* is moderately expanded, the margin gently rounded; in *velox* this section is but slightly more developed, but the greatest depth is caudal and not median, while the margin is abruptly excavated posteriorly, quite different from the gentle curve of *vicina*.

---

[5] *Révision du Syst. des Orthoptères*, p. 152.

The tegmina in *velox* always exceeds the caudal femora in length, while in *vicina* they do not equal it. This is apparently the only method of distinguishing the males of the two species.

Another rather interesting character noticed is that in *velox* the dorsal aspect of the pronotum is uniform wood-brown, while in *vicina* it is greenish in all the specimens examined but one. Fabricius with little doubt had *velox* as restricted by Brunner, as his description particularly mentions the brown surface of the pronotum.

Locusta[6] japonica (Bolivar).

1899. *Acridium Japonicum* Bolivar, Ann. Mus. Civ. Stor. Nat. Genova, XXXIX, p. 98.

Twenty-four specimens, 15 males, 9 females.

Japan. Dr. H. C. Wood (1).

Yokohama, Japan. Rev. H. Loomis (23), Rehn Collection.

This species possesses a dull, uniformly colored phase of which three representatives are in the series examined.

Burr[7] erroneously credits this species to Burmeister, probably through a slip of the pen.

Coptacra fœdata (Serville)?

1839. *Acridium fœdatum* Serville, Orthoptères, p. 662.

Six specimens, 1 male, 5 females.

Japan. Dr. H. C. Wood.

As these specimens have been immersed for a considerable time in spirits, little can be determined on comparison with Serville's description. It is mainly by the elimination of *C. præmorsa* Stal, of which *cyanoptera* Stal and *annulipes* Bolivar appear to be synonyms,[8] and which possesses a non-sulcate frontal costa, that we arrive at some idea of the relationship of the specimens. Serville's species has been recorded from Java, Burma and Cambodia.

Podisma dairisama Scudder?

1897. *Podisma dairisama* Scudder, Proc. U. S. Nat. Mus., XX, p. 114.

Three males.

Japan. Dr. H. C. Wood.

These specimens, while apparently referable to this species, differ

---

[6] For the use of *Locusta* in this connection see Rehn, *Ent. News*, XIII, p. 102.

[7] *Ent Month. Magaz.*, XXXIV, p. 29.

[8] *Vide* Brunner, *Révision du Syst. des Orthopt.*, pp. 159-160.

in the very short tegmina, which are in no case half as long as the tegmina, and in the quadrate interspace between the mesosternal lobes and excavated blunt tips to the cerci. Regarding the latter Scudder says (*antea*, p. 115) "blunt-tipped," but the figure (Pl. VIII, fig. 7) gives no idea of the character of the apex as found in the specimens here examined.

Podisma mikado (Bolivar).

1891. *Pezotettix Mikado* Bolivar, Anales Soc. Españ. Hist. Nat., XIX, cuad. 3, p. 323.

Eight specimens, 1 male, 4 females, 3 nymphs.

Japan. Dr. H. C. Wood.

This species was originally described from the female alone, and on comparing the description with my specimens it seems that they are identical. In the general form of the subgenital plate the male agrees with *Podisma* as restricted by Scudder,[9] but in the caudal extension of the pronotum it agrees with *Eupodisma* Scudder,[10] which has for its type *Podisma primnoa* Fischer de Waldheim, from Transbaicalia and the Amur region of eastern Siberia.

As the male has never been described, a few notes on the abdominal appendages may be of interest.

Supra-anal plate obtuse-angulate at the apex, with a median shallow sulcus which is centrally constricted. Cerci tapering in the basal two-thirds, but apically expanded and excavated, the terminal portion slightly depressed. Furcula rounded, scarcely perceptible lobes. Subgenital plate very broad basally, with an acuminate subapical process; margin circular, entire.

Eyprepocnemis plorans (Charpentier).

1825. *Gryllus plorans* Charpentier, Horæ Entomologicæ, p. 134.

Five females.

Yokohama, Japan. Rev. H. Loomis. Rehn Collection.

---

[9] *Proc. U. S. Nat. Mus.*, XX, pp. 12 and 111.

[10] *Ibid.*, pp. 12, 112 and 117.

THREE NEW AMERICAN BATS

BY JAMES A. G. REHN.

Artibeus hercules n. sp.

Type.—No. 5,785, Collection of the Academy of Natural Sciences of Philadelphia.

Eastern Peru. Collected by John Hauxwell. Presented by E. D. Cope.

General Characters.—Allied to *A. planirostris* (Spix), but differing in the larger size, the much larger foot and in numerous dental characters.

Size.—This form is much larger than *A. planirostris*, its only ally. The foot averages at least two and a half millimeters longer, the forearm exhibits over five millimeters difference, and the tibia and metacarpus of the third finger are also more extensive, the former averaging three millimeters and the latter over six millimeters difference.

Foot.—The foot is very slender, in fact no wider than in *A. planirostris*, though averaging over two millimeters longer. The foot of *planirostris* is heavy and broad, the basal portion being the same length as in *hercules*, the difference in the latter being wholly in the length of the toes.

Color.—These specimens have been in alcohol for a number of years, and as a result the exact color of the membranes and fur cannot be ascertained. They appear much darker than in *planirostris*, but this is in all probability due to the preserving fluid.

Skull.—The single skull of *A. hercules* examined is that of a paratype and lacks the cranial portion. The anterior section of the skull is, as in accordance with the general characters, much larger and heavier, the palate being comparatively wider. The mandible has the coronoid process with a forward trend, which is not noticed in *A. planirostris*.

Teeth.—Second upper premolar subquadrate in basal outline, quite different from the subpyriform tooth of *A. planirostris*, the internal node well developed and forming a conspicuous cusp.

First upper molar broad, deep, the anterior inner angle more developed than in *A. planirostris*, which species has this portion rounded. Second lower premolar very heavy and broad, the posterior internal border with the dentate ridge low. First lower molar subquadrate in outline.

Remarks.—This species is quite distinct from *A. planirostris* (Spix), the only species to which it is at all closely related. The large size and rather peculiar dentition will immediately distinguish it.

Comparative measurements.

	A. hercules.		*A. planirostris.* Chapada, Brazil.
	No. 5,785, Eastern Peru.	Average of two specimens.	Average of two specimens
Length of forearm, . . .	65.2 mm.	65.1 mm.	60 mm.
Length of tibia, ...	24 "	24.5 "	21.5 "
Length of foot, ...	18 "	18.5 "	16 "
Length of metacarp. (3d finger)	61.5 "	61.2 "	55 "
Length of ear, ...	20 "	20.5 "	20 "

Skull.

	A. hercules, No. 5,786.	*A. planirostris* No. 4,877.
Length of upper tooth row, ...	12 mm.	10.5 mm.
Width across first molar, ...	14.5 "	13 "
Length of lower tooth row, ...	12.5 "	11 "

Artibeus parvipes n. sp.

Type.—No. 5,494, Collection of the Academy of Natural Sciences of Philadelphia.

Santiago de Cuba, Cuba, March 15, 1892. Male. Collected and presented by Dr. Benjamin Sharp.

General Characters.—Allied to the Jamaican *A. jamaicensis* Leach, but differing in the smaller forearm and tibia, and the narrower and lighter built foot.

Distribution.—Specimens from Santiago province, Cuba, are all that have been examined.

Size.—General size apparently the same as *jamaicensis*, but the forearm and tibia are constantly smaller. The forearms of six specimens average 53.7 mm., against 58.3 mm. in six specimens of *jamaicensis*. The tibiæ average 20.8 against 21.9 mm. in the same series.

Foot.—The foot is narrower and lightly built throughout, while in *jamaicensis* the foot is heavier and each toe is individually broader.

Color.—Apparently the same as *jamaicensis*, but no skins have been examined.

Skull.—Identical with *A. jamaicensis*, but very slightly smaller.

Teeth.—The second upper premolar is broader and with a heavier internal shoulder, the teeth being actually broader than *jamaicensis*, though the latter possesses a slightly larger skull.

Remarks.—This form is easily separated from the Jamaican animal by the lighter, slenderer foot and the shorter forearm.

Specimens Examined.—Seven alcoholic specimens.

Santiago de Cuba. One (type). The Academy of Natural Sciences of Philadelphia.

Mt. Magota, Santiago Prov., Cuba. Six. The Academy of Natural Sciences of Philadelphia.

Comparative measurements.

	jamaicensis. No. 5,705, A. N. S. Phila. Port Antonio, Jamaica.	*parvipes.* Type No. 5,494, A. N. S. Phila. Santiago de Cuba.
Length of forearm, ...	58 mm.	52.5 mm.
Length of tibia, ...	23.5 "	21.5 "
Length of foot, ...	15 "	14 "
Length of ear, ...	18.5 "	16.5 "

A short time ago Dr. J. Percy Moore, of the University of Pennsylvania, submitted to me an alcoholic specimen of a species of *Nyctinomus* from the Bahamas. A hasty examination and comparison with available material revealed the fact that it represented a distinct form. Later, after speaking to Mr. G. S. Miller, Jr., of the U. S. National Museum, regarding the animal, he kindly turned over to me a series of skins of this species from Little Abaco, which had been submitted to him by the British Museum. A series of Cuban specimens were also forwarded which greatly facilitated comparison.

Nyctinomus bahamensis n. sp.

Type.—Collection of the School of Biology, University of Pennsylvania. Governor's Harbor, Eleuthera, Bahamas, November 18, 1890. Male. Collected by Dr. J. Percy Moore.

General Characters.—Closely allied to the Cuban form of the *brasiliensis* group, but differing in the larger size, in the shallower central emargination of the nose-pad, and the more grayish general coloration.

Distribution.—Specimens have been examined from Eleuthera and Little Abaco, Bahamas.

Size.—Apparently intermediate between *cynocephalus* from the mainland and the Cuban form of the *brasiliensis* group. The forearm is constantly longer than that of the Cuban form, which discrepancy also applies to the tail.

Head.—The nose-pad of *bahamensis* has the upper line almost straight, the central emargination being very shallow; in the Cuban form the emargination is much deeper and more rotundate.

Color.—Upper parts broccoli-brown, drab-gray below. The Cuban form is Prout's brown above, below drab.

Skull.—Exactly as in the Cuban form.

Remarks.—This form may be readily differentiated from the Cuban form by the length of the forearm, while the coloration on actual comparison is fairly distinctive.

Specimens Examined —One alcoholic specimen and six skins.
Eleuthera. One alc (type). University of Pennsylvania.
Little Abaco. Six skins. British Museum.

Comparative measurements.

	El Guamo, Cuba. ♂ No. 103,776, U. S. N. M.	Little Abaco, Bahamas. ♂ No. 21, Coll. J. L. Bonhote.
Total length, . . .	85 mm.	91 mm.
Length of forearm, .	36 "	42 "
Length of tail, . .	29 "	36 "

ADDITIONAL OBSERVATIONS ON THE STRAND FLORA OF NEW JERSEY.

BY JOHN W. HARSHBERGER, PH.D.

The writer presented at some length in the *Proceedings* for 1900 (pp. 623-671) an "Ecological Study of the New Jersey Strand Flora" The supplementary study which is given here represents the material collected in a field study since the publication of the aforementioned brochure. The notes are arranged under several subheads, but, when taken together, they throw additional light upon a region of ecologic interest.

The Strand at Holly Beach.

Holly Beach, situated one mile beyond Wildwood, was visited a second time in August, 1901, for a more extended survey. The beach along the sea front is flat, as at Wildwood, without a sea-dune. The driftwood area in 1901 was very extensive. The tree formation, which is dense at Wildwood, gradually decreases in extent until it disappears at the edge of an extensive salt meadow. Along the edge of the grass-covered meadows, the grass of which was being cut for hay, were found an abundance of the rose mallow, *Hibiscus moscheutos* L., *Kosteletzkya virginica* Gray, *Cassia chamæcrista* L. and *Asclepias incarnata* L. *Cephalanthus occidentalis* L. was noticed in the thicket growth. The meadow was sufficiently high in many places to enable the farmer to cultivate Indian corn, which grew normally in such unusual surroundings.

Forest at Wildwood.

The trees of this forest seem to have reached maturity and are on the decline. This is without doubt due to the removal of the undergrowth from about the trunks of the dominant trees. The soil dries out more quickly under such altered conditions, the wind has better chance to reach the trees and to circulate about them, producing an increased transpiration which proves deadly to the maturer arborescent species that had established a balance between the absorption of water by the roots and the transpiration of water from the leaves. As an indication of this, the tops of many of the trees have died. "Before Columbus," a cedar mentioned in the first paper, has been injured by the disturbance of this nice balance. "Elliptical" is dead. "United We Stand" is a fanciful name given to two united holly trees. "The Union" is a growth where a cedar and a holly tree have been joined by an ancient natural approach grafting.

The Strand at Sea Side Park.

Observation at this place on the New Jersey shore was conducted in 1901, from August 24 to September 2. *Kosteletzkya virginica* A. Gray was abundant in the converted salt meadow. It opens its flowers for insect pollination early in the morning before 9 o'clock, and closes them about 1 o'clock; for by 2 o'clock the flowers are closed tightly. *Hibiscus moscheutos* L. opens its flowers just after sunrise, and the flowers remain open until about sundown, when the petals begin to roll together. As will be shown in a subsequent paper, this plant shows mutation, and in many respects corroborates the statements of DeVries on the origin of species by mutation.[1] The changes produced in the flora by the grading operations on the upper end of the strand are most marked. *Echinochloa crus-galli* (L.) Beauv. (*Panicum crus-galli* L. var. *hispidum*)[2] was abundant, and associated with this grass in the graded areas of sand *Spartina polystachya* (Michx.) L., *Spartina patens* (Ait.) Muhl.; while as a newly introduced weed, *Linaria linaria* (L.) Karst. (*Linaria vulgaris* Mill.) grew in association with one of the sand grasses, *Sieglingia purpurea* (Walt.) Kuntze (*Tricuspis purpurea* A. Gray). *Mollugo verticillata* L. was found along the railroad in abundance in 1901 and in the dune complex in 1902. Wherever the areas burned over annually were left undisturbed in 1901, there *Rhus copallina* L. grew with the utmost vigor, and this was accentuated in 1902 upon a return to the beach after an absence of a twelvemonth.

The Hibiscus society mentioned in the previous report of the strand at Sea Side Park was found in 1901 to be encroached upon by *Rhus copallina* L. and *Scirpus debilis* L., so that an admixture of these plants took the place of the pure growth of the rose mallow.

---

[1] DeVries, *Die Mutationstheorie.*

[2] Names after Britton, *Manual of the Flora of the U. S. and Canada.*

The following plants were noted upon the beach along Barnegat Bay, near the Island Beach Life Saving Station, in 1901, viz., *Mollugo verticillata* L., *Echinochloa crus-galli* (L.) Beauv. (*Panicum crus-galli* var. *hispidum*), *Cyperus strigosus* L. and *Erechtites hieracifolia* (L.) Raf. Wherever the wind acts with its full transporting power in the dune complex, the dunes of which are held in place by *Myrica cerifera* L., *Ammophila arenaria* (L.) Link, *Hudsonia tomentosa* Nutt., *Prunus maritima* Wang and *Rhus radicans* L., there the sand is scooped out and carried away with the formation of a dune hollow, into the bottom of which the ground water rises by seepage. The steps in this process can be followed at South Sea Side Park. A dune valley, which has not been brought down to the level of the ground water, may consist of pure sand bottom and sides without vegetation, or if plants be present, they are confined to the area of drifted sand and not to the area that is wind-swept. In such a hollow, the drifted sand

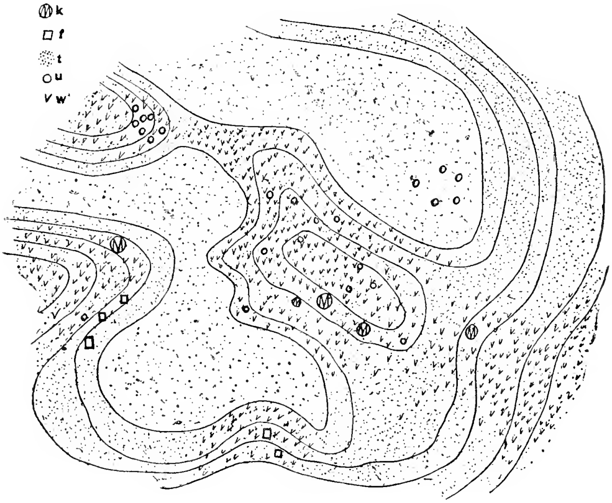


Fig. 1.

k. *Myrica cerifera* L.; f. *Hudsonia tomentosa* Nutt.; t. Pure sand.; u. *Solidago sempervirens* L.; w. *Ammophila arenaria* (L.) Link.

supports, as shown in fig. 1, three character plants, viz., *Myrica cerifera* L., *Solidago sempervirens* L. and *Hudsonia tomentosa* Nutt. The sides of the irregular basin not wind-swept support the marram grass, *Ammophila arenaria* (L.) Link, *Solidago sempervirens* L., *Hudsonia tomentosa* Nutt., and an occasional clump of wax-berry, *Myrica cerifera* L. If the sand is still farther transported by the wind, there remain hillocks of dry sand in the center of a level damp stretch on the level of the ground water. Sometimes the bottom of the hollow forms a level trough of wet sand, surrounded by sun-dried sand on all sides. Such a hollow, illustrated in the accompanying figure (fig. 2), is tenanted by three character plants. The wet sand supports a continuous growth of *Scirpus debilis* L.; the side of the dune trough, *Panicum virgatum* L., a grass which may be called a tussock grass, because it does not form a continuous turf, but grows in clumps more or less isolated from each other. In the higher drier sand of the depression, before the slopes of the dunes of the dune complex are reached, there grows a character plant, *Solidago sempervirens* L. We have, therefore, a replacement of the original dune occupants,

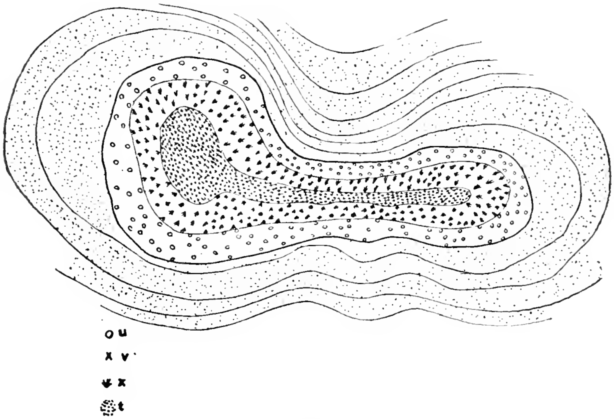


Fig. 2.

u. *Solidago sempervirens* L.; v. *Scirpus debilis* Pursh; x. *Panicum virgatum* L.; t. Pure sand.

viz., *Ammophila arenaria* (L.) Link, *Hudsonia tomentosa* Nutt., *Myrica cerifera* L. etc., by three plants, *Scirpus debilis* L., *Panicum virgatum* L. and *Solidago sempervirens* L. If this process is carried still farther, then we have a large number of marsh-loving species appearing in the wet sand of the basin-shaped or elongated depression. The following figure (fig. 3) shows such a dune valley, the bottom of which is wet by the seepage of the ground water through the sand. The lower damp, marshy places are covered with a growth of *Scirpus debilis* L., from which arises *Typha latifolia* L. and a tall sedge, *Scirpus sylvaticus* L. The higher still damp areas support *Cyperus nuttallii* Eddy and *Juncus* sp., although these two plants are, as a rule, not found in association. The islands, or knolls of sand, which remain in the marshy area are held in situ by *Myrica cerifera* L., *Ammophila arenaria* (L.) Link and *Solidago sempervirens* L. These three plants grow together side by side. *Euthamia caroliniana* (L.) Greene (*Solidago tenuifolia* Pursh.) is found where the sand is damp. The sand marsh is

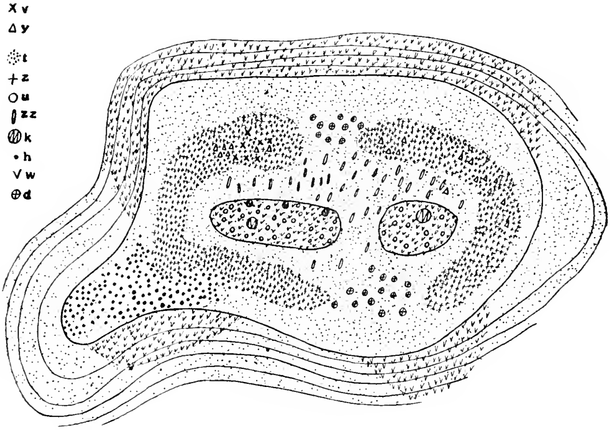


Fig. 3.

y. *Typha latifolia* L.; t. Pure sand; z. *Scirpus debilis* Pursh.; u. *Solidago sempervirens* L.; zz. *Euthamia caroliniana* (L.) Greene; k. *Myrica cerifera* L.; h. *Cyperus nuttallii* Eddy; w. *Ammophila arenaria* (L.) Link; d. *Juncus* sp.

fringed directly with *Ammophila arenaria* (L.) Link, *Solidago sempervirens* L. and an occasional *Myrica* berry, while outside of these the slopes of the dunes are wind-swept and destitute of vegetation. In the degradation of a dune and the formation of a wind-swept hollow, we have a succession of societies which are approaching the ultimate state, that of a mesophytic thicket. The transition, noticed in the dune complex at Sea Side Park, is from an intensely xerophytic association of species to marsh-dwelling xerophytes, and from these in turn to xerophytic shrubs and trees culminating in a mesophytic thicket filling the extent of the original dune valley.

The annexed figure (fig. 4) illustrates a xerophytic marsh associa-

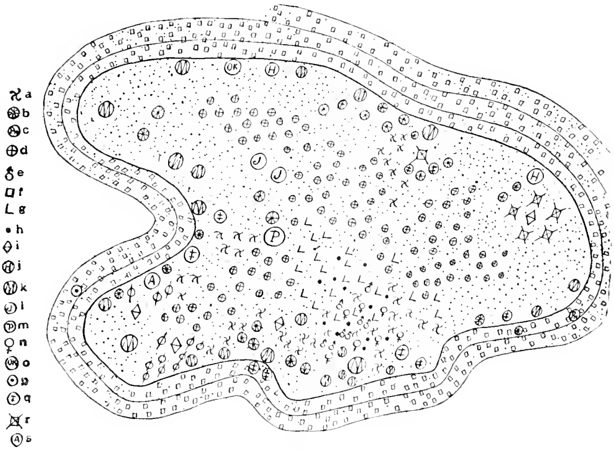


Fig. 4.

a. *Oxycoccus macrocarpus* (Ait.) Pers.; b. *Vaccinium corymbosum* L. and *Gaylussacia resinosa* (Ait.) T. & G.; c. *Panicum virgatum* L.; d. *Juncus* sp.; e. *Drosera rotundifolia* L.: f. *Hudsonia tomentosa* Nutt.; g. *Lycopodium carolinianum* L.; h. *Pogonia ophioglossoides* (L.) Ker.; i. *Ilex glabra* (L.) A. Gray; j. *Ilex opaca* Ait.; k. *Myrica cerifera* L.; l. *Juniperus virginiana* L.; m. *Pinus rigida* Mill.; n. *Drosera filiformis* Raf.; o. *Quercus minor* (Marsh) Sarg.; p. *Andropogon virginicus* L.; q. *Kalmia angustifolia* L.; r. *Chamaecyparis thyoides* (L.) B. S. P.; s. *Acer rubrum* L.

tion in the transverse dune complex at Sea Side Park, surrounded by the encroaching army of shrubs and trees of xerophytic habit in the stage before the culminating one, the mesophytic thicket. The mesophytic thicket at South Sea Side Park occupies from what has gone before the hollows, or rounded depressions in the dune complex, and in its simplest make-up consists of the two following associations of species: One thicket examined consists of *Pinus rigida* Mill., *Sassafras sassafras* (L.) Karst., *Vaccinium corymbosum* L., *Juniperus virginiana* L., *Chamæcyparis thyoides* (L.) B. S. P. and *Myrica cerifera* L.. Another hollow contains *Ilex opaca* Ait., *Juniperus virginiana* L., *Prunus maritima* Wang, while, as an undergrowth, associated together, are *Rhus radicans* L. and *Solidago sempervirens* L.

Either before the final condition is reached, or after such thickets have been formed, the original condition of the dune complex may be restored by the drifting in of the sand into the depression, resulting in a destruction of the long-established plant societies. Such vicissitudes in the life history of plant societies are not common, although examples are found occasionally on the New Jersey strand. As a rule, before the final culmination of dune hollow history is reached, the elevated sand hills surrounding it are captured by sand-binding plants, such as *Ammophila arenaria* (L.) Link, but especially *Hudsonia tomentosa* Nutt., which forms heaths about the depression, effectually preventing the transport of the sand and its deposition in the basin-shaped valleys adjoining. In case the sand is transported, it begins to fill up the dune valley through the action of the oceanic flotsam and jetsam. The accumulation of such material in the storm-washed waterways between the dunes has gone on for ages. Before the advent of civilized man, the material washed ashore consisted of the trunks and limbs of trees, seaweed, leaves and the floatable objects carried to sea by the rivers. Since the occupation of the shore by white men, the flotsam and jetsam consists of a remarkable collection of nondescript rubbish, such as ship timbers, chips of wood, broken boards, spars of boats, sides of rowboats, old cots, mattresses, bottles, and, in fact, anything and everything used by man that is floatable and can stand the action of salt water for months at a time.

The piling up of such rubbish in the dune complex acts as an effective means of binding the sand and preventing its drifting.

Soon about such objects the sand begins to form a dune, which grows larger and higher as the seasons pass until it is covered by the marram grass which binds it. A new washway may be made around this newly formed dune and the drift of previous years may be uncovered. The writer believes that if a trench were dug for a mile or two along the beach and paralleling the ocean, a distinct stratum of rubbish would be revealed, if the excavation was made deep enough to reach the level above the ground water.

The presence of so much wood undergoing decay accounts for the growth of the fungi found by the writer growing in the pure (?) sand of the dune complex. *Astræus stellatus* is common. *Thelephora terrestris* Fr. is found growing about the stems of *Hudsonia tomentosa* Nutt. The puffball, *Lycoperdon turneri* E. and E., was found associated with these, while *Clitocybe trullisata* Ellis, found with largely developed base and small pileus, indicates, according to Prof. Peck who identified it, something unusual in the conditions of growth. *Fuligo* (*Æthalium*) *septica* Gmel., a myxomycete, is found commonly attached to decaying driftwood.

Several new plants were found in 1902 growing in close contiguity with the objects drifted in through the oceanic spillways. *Artemisia stelleriana* Bess., reported previously from eastern Massachusetts and Sandy Hook, was found. *Rumex acetosella* L. and *Helianthus* sp. were also collected in such situations. Only one conclusion can be drawn from their presence, namely, that their seeds were washed ashore with the rubbish mentioned.

The thicket formation on the strand a mile below the Island Beach Life Saving Station perceptibly narrows its width. At the Island Beach Life Saving Station it forms a broad band of vegetation, but below this point it is nowhere over a hundred yards wide and is confined to the more sheltered bay side of Barnegat peninsula. Between the thicket formation and the narrow forest, the dune complex forms the dominant feature of the landscape, except where a slue or thoroughfare enters the beach from the bay side. At one place the strand is so narrow where this slue extends, that during heavy storms in winter the ocean and bay meet, cutting the strand into islands more or less separated from each other. *Scirpus lacustris* L is the character plant along the edge of this slue, and where the slue becomes a marsh this plant forms pure societies. Where the ground becomes firmer, social groups of

Hibiscus moscheutos L. hold sway, while on the higher ground along the borders *Baccharis halimifolia* L., *Rhus copallina* L. and *Myrica cerifera* L. occur.

The importance of these slues and the corresponding channels or spillways cut into the dune complex during the heavy storms of winter, when bay and ocean may be said to unite, is evident upon careful consideration. Barnegat Bay and many similar ones along the Jersey coast are practically free from aquatic vegetation, such as *Zostera marina* L., *Fucus vesiculosus* L., *Vallisneria spiralis* L., etc., which may contribute material to fill up the bay with vegetal detritus. The water in physical constitution oscillates between two extremes, salt and fresh. If the barrier between the sea and the lagoon is at times closed, so that the water in the bays becomes fresh, the result is that plants which are especially adapted to the production of salt marshes are killed by the fresh waters, while the occasional invasion of salt water during storms by way of the dune hollows and stronger tides through the inlets destroys the fresh-water plants, which might otherwise establish a swamp of their species. By these alternations some of the largest bays have been kept open, although in many places shallow in the extreme. *Ruppia maritima* L., as it grows in Barnegat Bay, seems to be the only species which has succeeded in adapting itself to such fluctuating conditions. It has been referred to as the character plant of the shallower waters of that bay, and with the consideration of the above facts its probable future rôle in preparing the way for other adaptive hydrophytes becomes evident.

Ludlam and Seven Mile Beaches.

Strictly speaking, a beach is that part of a shore between high and low water, but in New Jersey the term is applied to what are really sea islands. Ludlam Beach, on which Sea Isle City is located, extends from Corson's Inlet to Townsend's Inlet. Except at a point below Sea Isle City, the beach is almost on a level, and during a violent storm it is likely to be entirely submerged, especially at high tide. The dunes that exist below the town are much cut up. *Ammophila arenaria* (L.) Link dominates the foreground along the beach. The Myrica thicket exists on the dune complex associated with *Baccharis halimifolia* L. and *Rhus radicans* L. The highest dunes on Ludlam Beach, at Life Saving

Station No. 34, have a few cedars and stand some distance back from the ocean front, and this disposition of dunes is most marked at Townsend's Inlet, where they encroach on the extensive salt meadows.

Crossing Townsend's Inlet, Seven-Mile Beach is reached with the highest sea dunes on the whole New Jersey coast. This beach, settled upon in 1788,[3] was not investigated ecologically prior to the summer of 1901. A description of the flora was not incorporated, therefore, in my paper published in 1900. Passing Avalon, the highest dunes (forty-two feet) are found close to the sea front. The dunes are held in place by *Ammophila arenaria* (L.) Link, and where the dune has encroached on the forest an occasional dead tree may be seen sticking out from the dune surface. Beyond Piermont, the district of Seven-Mile Beach studied by the writer is reached. The dunes fronting the ocean half-way between Stone Harbor and Piermont are rounded knolls about six to ten feet high covered with marram grass, *Ammophila arenaria* (L.) Link. The beach at low tide is extremely flat, and by the appearance of the sand may be divided into three zonal areas: (1) The firm, hard beach covered at high tide with salt water; (2) a higher beach with dry, loose, drifted sand held in place by driftwood; (3) the wet beach filled at high tide by pools of water. The two latter areas comprise the middle beach of my previous paper. The upper beach is characterized by scattered patches of sea blite, *Cakile edentula* (Bigel.) Hook, and *Ammodenia peploides* (L.) Rupr, which forms rounded annual or temporary dunes. Here and there channels have been cut into the low dunes which are hardly worthy of the name, so that at high water the tide runs back to the meadows behind. Several of these cuts occur meeting marshy places behind, surrounded by dunes on the seaward side of the railroad. On the exposed sand of these depressions *Portulaca oleracea* L. grows, and on their edge creeps *Strophostyles helvola* (L.) Britton. Just before the channel joins the marshy areas a large amphitheatre of barren wet sand is found, fringed by *Scirpus lacustris* L, *Atriplex arenaria* Nott., *Salicornia herbacea* L., *Portulaca oleracea* L., outside of which character plants in concentric circles, *Strophostyles helvola* (L.) Britton,

---

[3] The house built then stood in Piermont, at Second avenue and Thirty-first street.

Pluchea camphorata (L.) D.C., *Cenchrus tribuloides* L., *Euphorbia polygonifolia* L., *Xanthium canadense* Mill. This society may be said to be dominated by *Strophostyles helvola* (L.) Britton. In the standing water grows in hammocky places *Spartina stricta* (Ait.) Roth. These hammocks catch the blowing sand and are destined to become dune islands. Such a dune island in the midst of a marsh was covered by *Spartina patens* (Ait.) Muhl., killed on one side by the sand blast.

Nearer Piermont, the physiography of the beach changes and the marked feature of this region is the height of the dunes and the absence of marshes and pools of water in the dune complex. The sea beach here is flat and about one hundred feet wide. The same zonal areas of lower and middle beach are present. The upper beach facing the dunes is flat and covered by *Salsola kali* L., *Cakile edentula* (Bigel) Hook and *Xanthium canadense* Mill. The frontal dune is ten feet high, sloping on the windward or land side. Upon it grow *Ammophila arenaria* (L) Link., *Cenchrus tribuloides* L., *Sieglingia purpurea* (Walt) Kuntze. The Myrica zone is absent in the hollows back of this dune. Its place is taken by the social groups of *Strophostyles helvola* (L.) Britton which forms dark-green mats. In the deeper hollows, *Gerardia maritima* Raf. and *Euphorbia polygonifolia* L may be called character plants. The dune complex is undulating with rising hills of sand, covered on the seaward side by *Strophostyles* and on the landward slope are *Solidago sempervirens* L. and occasional clumps of *Myrica cerifera* L., not dominant; *Œnothera humifusa* Nutt., *Baccharis halimifolia* L. and *Andropogon virginicus* L. Across the area controlled by these herbaceous plants, the barren wind-swept zone is reached upon which no vegetation grows except the marram grass, *Ammophila arenaria* (L.) Link, an occasional red cedar, and as rare plants, *Phytolaca decandra* L. and *Euphorbia polygonifolia* L. Dead trees stand up out of the sand over this zone, which is about six hundred feet wide. The high dunes (40–50 feet) are reached by gradual ascent after crossing the area devastated of its trees by the drifting in of the sand. These high dunes are abrupt on the landward side, where they encroach on the dense deciduous forest behind. This forest seems doomed to extinction, if the past history of these dunes is followed in the dead trees of the wind-swept area. Not many years ago this forest was some five hundred feet wider than at present, and by the relentless, unrestrained activity of the drifting sand it has been slowly, but surely, engulfed. It is a peculiar scene from the top of this dune: on the land side there is a dense mass of dark-green foliage, beyond which there is the broad expanse of green salt meadows with their bays and thoroughfares.[4] The sand which has formed these dunes comes fresh from the great ocean mill, ascends the surface of the dune and falls over its crest into the forest. When a stiff breeze is blowing it skims along like drifting snow, sufficiently strong to lacerate the skin, trimming the tops of the trees as flat as though shorn with shears The writer is of the opinion that the shapes of the trees along our coast is due more to the sand blast than to the direct action of the wind.

Gifford[5] describes the formation of these dunes: "If the forests are what cause the dunes, by preventing the west wind from blowing back the sand, how did the forests form? Single trees here and there, or groups of trees, which are clean underneath, so that the west wind sweeps through without serious interruption, do not cause the formation of dunes. In the course of time, however, a thicket forms under these trees. They become covered with grapevines, Virginia creepers and greenbriers. The birds and the wind scatter the seeds of many sorts of shrubs and bushes, such as *Prunus maritima*, sweet gale, *Baccharis halimifolia*, etc., until a dense forest is formed through which the west wind cannot penetrate, the consequence of which, in the course of time, is a dune, which in turn finally engulfs and kills the forest that had caused it." The forest which is being destroyed consists of the red cedar, *Juniperus virginiana* L., holly, *Ilex opaca* Ait., black gum, *Nyssa sylvatica* Marsh, wild cherry, *Prunus serotina* Ehrh., *Quercus lyrata* Walt., hackberry, *Celtis occidentalis* L., willow oak, *Quercus phellos* L., swamp maple, *Acer rubrum* L., persimmon, *Diospyros virginiana* L., pitch pine, *Pinus rigida* Mill., red mulberry, *Morus rubra* L., while as lianes may be mentioned *Parthenocissus* (*Ampelopsis*) *quinquefolia* (L.) Planch., *Vitis labrusca* L., *Vitis æstivalis* Michx., *Tecoma radicans* (L.) D.C., which reminds one of the dunes of the seashore of eastern Virginia, where the trumpet

---

[4] A thoroughfare is a waterway or channel from one bay to another along the New Jersey coast.

[5] GIFFORD, *Annual Rep. State Geologist of New Jersey*, 1899, "Report on Forests," p. 251.

creeper abounds and *Smilax rotundifolia* L. As the sand blows in about the trees, these lianes are covered up with the trees until the tops of the trees only are exposed. The lianes then take root and spread out in all directions circumferentially a distance of many feet from the tree which, now dead, formerly supported them. The lianes, therefore, began their life-history on the lower level ground and conclude their growth on the surface of the sand dune fifty feet above where they first took root—veritable vegetal Jacks-and-the-Bean Stalk. This curious biologic feature, never before mentioned, to the knowledge of the writer, in connection with the life-history of a sand dune, is exemplified on all of the higher sand hills at Piermont.

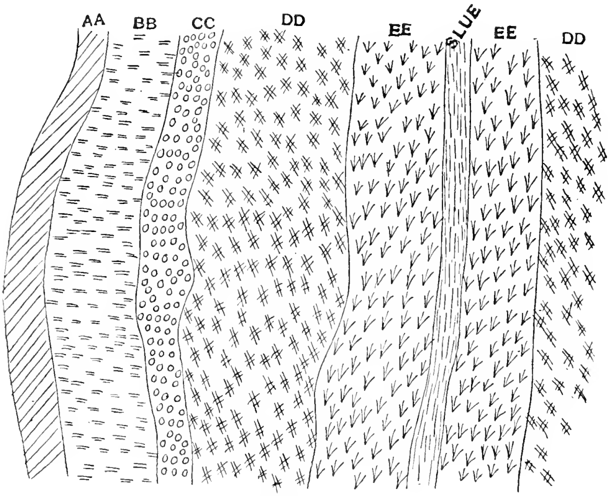


Fig. 5.

AA. Zone of *Hibiscus moscheutos* L., *Panicum virgatum* L.: BB. Zone of *Distichlis spicata* (L.) Greene, mature; CC. Zone of *Distichlis spicata* (L.) Greene, less mature; DD. Zone of *Salicornia herbacea* L., *Salicornia Bigelovii* Torr., *Spartina patens* (Ait.) Muhl., *Limonium carolinianum* (Walt.) Britton.; EE. Zone of *Spartina stricta* (Ait.) Roth.

On the ground in the forest the botanist finds *Mitchella repens* L., *Rhus radicans* L., etc. Crossing the railroad, which runs through the forest at this place, a strip of higher ground runs out some distance upon the meadow. The tension lines are well demarcated here. *Juniperus virginiana* L. is the only tree which borders directly the salt marsh. A rounded dune occurs on the edge of the marsh. From it a closer prospect of the salt marsh is to be had. *Juniperus virginiana* L., *Rhus glabra* L., *Myrica cerifera* L., *Sassafras sassafras* (L.) Karst., *Ilex opaca* Ait., *Rhus radicans* L., with the climbing *Willoughbæa scandens* (L.) Kuntze form the vegetal covering of this eminence. The outer zone of the salt marsh is characterized by the presence of *Hibiscus moscheutos* L. On the marsh proper occurs in several well-marked zones *Distichlis maritima* (L.) Greene in the more elevated portions, while *Salicornia herbacea* L., *S. bigelovii* Torr., *Spartina patens* (Ait.) Muhl., and *Limonium carolinianum* (Walt.) Britton grow in the wetter areas. Along the edge of the thoroughfare[6] through which the tidal water circulates is found a pure association of *Spartina stricta* (Ait.) Roth. The accompanying figure (fig. 5) shows the zonal distribution of the salt-marsh plants on Seven-Mile Beach. Near the outer edge of the marsh *Hydrocotyle umbellata* L. is found, while on exposed sand slopes *Opuntia opuntia* (L.) Coult. is at home with a rose and a willow forming nearby thickets.

COMPARISON OF THE DUNES AT PIERMONT AND AT SEA SIDE PARK.

The dune formation of the New Jersey coast, as previously mentioned, reaches its culmination at Piermont, where sand hills forty to fifty feet high are met with. The western slope of the dunes at Piermont are precipitous, while the eastern slope (a gradual incline) grades off into the lower dunes of the dune complex. The dunes at Sea Side Park range in elevation from ten to twenty feet, and the eastward or seaward slope is much the steepest. The causes which have brought about this difference are the following: The wave-made embankments on the sandy beaches differ in their form and in the conditions of their construction from those which are made up of pebbles.[7] The sand, owing to the fineness of its grains, is easily blown about by the wind. When the tide retires, a broad expanse of this material is left for some hours exposed to the sun. The surface dries, and the gales from

---

[6] Also spelled thorofare.

[7] Cf. Shaler, *Sea and Land*, pp. 49–51.

the sea sweep the particles up the slope until they arrive at the crest wall, where they are caught in the tangle of beach grasses and other plants, and are protected from the currents of air. When the movement of sand is most rapid, it may bury these plants out of sight, but most of them are tolerant of this covering of sand, and quickly grow upward and make a new entanglement for the moving sand. Such plants are *Ammophila arenaria* (L.) Link, *Prunus maritima* Wang. and others previously described. In this manner, the crest of the beach grows upward and the lee slope of the sand hill is always the steepest one. The dunes of the New Jersey coast are not so marked as some in other parts of the world (as, for example, at Eccles, in England, where one of these dunes in the last century invaded the village and buried the dwellings and the parish church so that even the top of the spire was hidden) for the reason that the prevailing winds of New Jersey are from the west; and the sand swept up from the sea-margin by the ocean storms and easterly breezes is, to a great extent, carried back by the off-shore winds. Even these dunes would have a precarious existence were it not for the fact that the vegetation, generally quite luxuriant, holds the sand in place. The prevalent west winds and the absence of protecting trees account for the character of the dunes at Sea Side Park, where the frontal dune slopes gradually up from the windward or landward side to the crest of the dune, the leeward or ocean side being quite steep and declivitous.

At Piermont, on the contrary, the western or windward slope of the dune is the steepest. Here a forest, formerly five hundred feet wider, is being engulfed by the drifting sand. The sand, carried by eddies of the prevailing western winds, but more especially by the winds of ocean storms, ascends the surface of the dune and falls over its crest into the forest. When a stiff breeze is blowing, the sand skims along like drifting snow sufficiently strong to decorticate trees. The forest, choked with undergrowth composed of climbing plants and shrubs, as previously mentioned, prevents the access of the western breezes that are prevalent and which are inimical to dune upbuilding, and the sand, therefore, moves relentlessly carried by the eastern winds that now and then blow upon the forest that engendered the dune. The presence of this forest, therefore, explains the peculiarities of the dune formation at Piermont, as contrasted with that at Sea Side Park.

THE ABSECON (ATLANTIC CITY) BEACH STRAND.

Dr. Thomas S. Githens has furnished me with the results of some observations upon the flora of Absecon Beach. The coast in the neighborhood of Atlantic City is occupied largely by human habitations, so that the flora has been modified except at several places about two to four miles south of Absecon Inlet. The geography of the island may be shown by the accompanying diagrams in fig. 6.

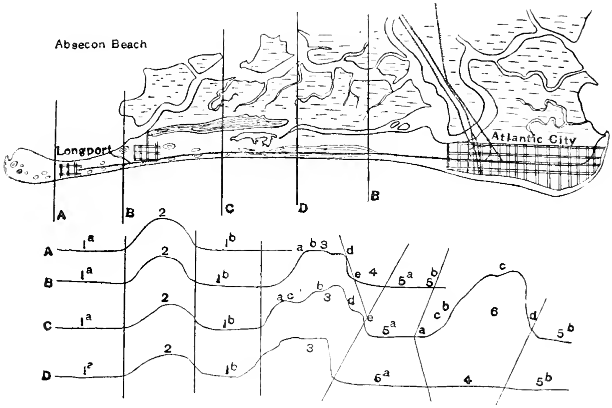


Fig. 6.

The upper figure is an outline map of Absecon Beach with the ecologic lines A, B, C, D drawn across it. The lower figure represents cross-sections of the beach along the lines A, B, C, D, and shows the relative elevations along each line. The letters and numerals designate different zonal areas, where the plants designated by similar numerals are referred to the several zones in the accompanying list, made by Dr. Thomas S. Githens.

The region, botanically considered, has been divided by Dr. Githens in his notes[8] as follows:

Area I.—Beach.

Zone (*a*)—Tide Beach.
Zone (*b*)—Second Beach.

---

[8] These notes confirm the observations of the writer, published in the *Proceedings of the Academy of Natural Sciences of Philadelphia* for 1900, but the terminology is somewhat different.

Area II.—Low Dunes.
Area III.—High Dunes.
    Zone (*a*)—Juniper Thickets.
    Zone (*b*)—Myrica Thickets.
    Zone (*c*)—Hudsonia Formation (bare places).
    Zone (*d*)—Ilex Thicket.
    Zone (*e*)—Border of Marsh.
Area IV.—Sand Flats (always damp).
Area V.—Marsh.
    Zone (*a*)—Drier Marsh.
    Zone (*b*)—Boggy Marsh.
    Zone (*c*)—Tidal Flats.
    Zone (*d*)—Lakes and Thoroughfares.
    Zone (*e*)—Thoroughfare Borders.
Area VI.—Island.
    Zone (*a*)—Marsh Border.
    Zone (*b*)—Treeless Space.
    Zone (*c*)—Wood.
    Zone (*d*)—Back Marsh Border.
Area VII.—Made Land.

It will be observed that the author of the notes confuses botanical and physiographic features. The classification should be either based on the floral make-up of the region, or be arranged according to its physiography. Thus, for example, this botanist has juniper thickets and dry marsh and boggy marsh zones. Barring these inadvertencies the classification of areas is a natural one. The first beach, according to Dr. Githens, supports no plants except occasionally *Cakile edentula* (Bigel.) Hook. The outer (Low Dune) is held in place by the character grass (*Ammophila arenaria* (L.) Link). The outer edge of the dune complex (Second Beach) is occupied by the Atlantic City and Longport Railroad, but in places *Cakile edentula* (Bigel.) Hook., *Ammophila arenaria* (L.) Link, *Cenchrus tribuloides* L., *Salsola kali* L. are found. The captured dunes (High Dunes of the classification) are covered with thickets of *Juniperus virginiana* L. and *Myrica cerifera* L., interspersed with bare spaces on which *Hudsonia tomentosa* Nutt., as a character plant, grows. *Prunus maritima* Wang. and *P. virginiana* L. grow in all the sheltered places. The landward slope is characterized by the presence of holly, *Ilex opaca* Ait., the height of the dune being determined by the height of the protecting trees, *i.e.*, twenty-five feet. The island is about two miles long, and is set in the middle of the marsh about half a mile inland from the high dunes. It is covered mainly by pine and oak trees which are quite large on its highest parts. Inside of this marsh island there is a comparatively dry marsh, in which all plants except grasses, rushes and sedges do better than in the larger marsh outside. At the ends of this island in the marsh, and on the landward side, are low-lying sandy plains, low enough to be saturated at high tide with salt water and which support a characteristic growth of *Buda* and similar succulent species. In the list, which is rather cumbersome, the numbers refer to the areas marked on the map represented in fig. 6, and the lower-case letters of the alphabet refer to the zones into which the several areas are divided. The plants, therefore, in the list occur in the areas and zones designated. A dagger (†) signifies that the plant is represented in the herbarium of Dr. Githens. The plants in the list are named according to the sixth edition of Gray's *Manual*, but for convenience of reference the writer, who has edited the notes of Dr. Githens, has added the names found in Britton's *Manual of the North United States and Canada*. The orders follow the sequence of Engler and Prantl's *Die Natürlichen Pflanzenfamilien*. The plants not given in the list published in "An Ecological Study of the New Jersey Strand Flora"[9] are designated by an asterisk.

The commingling of the plants of different zones may be represented as follows:

II to I*a* and I*b*.
III to II and I*b*.
V to IV.
III*e* to IV and V.
VI to V*e*.
VI*d* to V.

List of Species and Zones Occupied by Them.

VI*c*.	*Pinus rigida* Mill.
III*a*.	*Juniperus virginiana* L.

---

[9] *Proc. Acad. Nat. Sci. Phila.*, 1900, pp. 661-671.

V*a*.	*Typha latifolia* L.
V*a*.	*Typha angustifolia* L.
V*d*†.	*Ruppia maritima* L.
V*d*.	*Zostera marina* L.
II.	*Ammophila arundinacea* Hast. (*Ammophila arenaria* (L.) Link).
I, II, IV†.	*Cenchrus tribuloides* L.
V*a*†.	*Panicum crus-galli* L. (*Echinochloa crus galli* (L.) Beauv.).
V*a*†.	*Panicum proliferum* Lam.
*V*a*†.	*Panicum sanguinale* L. (*Syntherisma sanguinalis* (L.) Nash).
V*a*†.	*Panicum virgatum* L.
*V†.	*Setaria glauca* Beauv.
V.	*Spartina cynosuroides* [L.] Willd.
V†.	*Carex straminea* Willd.
V†.	*Cyperus nuttallii* Torr. [Eddy].
*V†.	*Cyperus ovularis* Torr. [(Michx.) Torr.].
*V†.	*Cyperus speciosus* Vahl.
V†.	*Fimbrystylis spadicea* Vahl.
V†.	*Scirpus maritimus* L.
V†.	*Scirpus pungens* Vahl. (*S. americanus* Pers.).
V.	*Juncus bufonius* L.
V†.	*Juncus canadensis* J. Gay.
V†.	*Juncus dichotomus* Ell.
V†.	*Juncus gerardi* Loisel.
V.	*Juncus scirpoides* Lam.
V†.	*Juncus tenuis* Willd.
III*a*.	*Commelyna* sp.
*VI*c*.	*Oakesia sessilifolia* Watson (*Uvularia sessilifolia* L.).
III*d*.	*Polygonatum giganteum* Dietr. (*P. commutatum* (R. and S.) Dietr.).
*III, VI†.	*Smilax glauca* Walt.
III, VI†.	*Smilax rotundifolia* L.
V*a*†.	*Iris versicolor* L.
V*a*†.	*Spiranthes cernua* Richard (*Gyrostachys cernua* (L.) Kuntze).
III*b*.	*Myrica cerifera* L.

VI_c_.	_Quercus alba_ L.
VI_c_.	_Quercus falcata_ Michx. (_Q. digitata_ (Marsh), Sudworth).
*VI_c_.	_Quercus tinctoria_ Gray (_Q. velutina_ Lam.).
VI_c_.	_Quercus ilicifolia_ Wang. (_Q. nana_ (Marsh) Sargent).
*VII.	_Polygonum acre_ H. B. K. (_P. punctatum_ Ell.).
VII.	_Polygonum incarnatum_ Watson [Ell.].
*VII.	_Polygonum persicaria_ L.
III_c_†.	_Polygonum ramosissimum_ Michx.
*III_e_, IV.	_Polygonella articulata_ Meisn. [L.].
*VII.	_Rumex acetosella_ L.
*VII.	_Rumex crispus_ L.
*V_e_†.	_Atriplex patulum_ L. var. _hastata_ Gray (_A. hastata_ L.).
VII.	_Chenopodium album_ L.
*VII†.	_Chenopodium ambrosioides_ L.
*VII†.	_Chenopodium anthelminthicum_ Gray.
V_b_†.	_Salicornia ambigua_ Michx.
V_b_†.	_Salicornia herbacea_ L.
V_b_†.	_Salicornia mucronata_ Bigel. (_S. Bigelovii_ Torr.).
II_a_ and _b_.	_Salsola kali_ L.
V_e_†.	_Suæda linearis_ Moq. (_Dondia americana_ (Pers.). Britton).
*VII.	_Amaranthus paniculatus_ L. (_A. hybridus paniculatus_ (L.) Uline and Gray).
VII.	_Amaranthus retroflexus_ L.
VII.	_Mollugo verticillata_ L.
III_a_†.	_Arenaria lateriflora_ L. (_Mœhringia lateriflora_ (L.) Fenzl.).
IV†.	_Arenaria peploides_ L. (_Ammodenia peploides_ (L.) Rupr.).
IV†.	_Buda marina_ Dumont (_Tissa marina_ (L.) Britton).
IV.	_Sagina decumbens_ Torr. and Gray.
*III_d_†.	_Silene stellata_ Ait.
VII.	_Portulaca oleracea_ L.
*VI_c_†.	_Aquilegia canadensis_ L.
V_a_†.	_Ranunculus cymbalaria_ Pursh. (_Oxygraphis cymbalaria_ (Pursh.) Prantl).

*III†.	*Sassafras officinalis* Nees (*S. sassafras* (L.) Karst).
I, II.	*Cakile americana* Nutt. (*C. edentula* (Bigel.) Hook.).
*VII†.	*Cardamine hirsuta* L.
III*a*, III*d*†.	*Geum album* Gmel. (*C. canadense* Jacq.).
*III*b*.	*Pyrus arbutifolia* L. f. (*Aronia arbutifolia* (L.) Ell.)
III.	*Prunus maritima* Wang.
*III.	*Prunus serotina* Ehrh.
*III.	*Prunus virginiana* L.
III*e*, VI*d*†.	*Rosa carolina* L.
VI*b*†.	*Rubus canadensis* L.
*VI*c*.	*Amphicarpæa monoica* Nutt. (*Falcata comosa* (L.) Kuntze).
VI*a*†.	*Cassia chamæcrista* L.
*VI*a*†.	*Cassia nictitans* L.
*VI*c*†.	*Desmodium canadense* D. C. (*Meibomia canescens* (L.) Kuntze).
VI*c*.	*Desmodium paniculatum* D. C. (*Meibomia paniculata* (L.) Kuntze).
III, VI†.	*Strophostyles angulosa* Ell. (*S. helvola* (L.) Britton).
*IV.	*Trifolium arvense* L.
*VII.	*Trifolium hybridum* L.
*VII.	*Geranium carolinianum* L.
III*d*†.	*Geranium robertianum* L.
*V*a*†.	*Linum virginianum* L.
*V*a*†.	*Polygala cruciata* L.
II, III*c*.	*Euphorbia polygonifolia* L.
III*e*†.	*Rhus copallina* L.
III*a*, VI.	*Rhus radicans* L.
III*d*.	*Ilex opaca* Ait.
*VI*d*.	*Celastrus scandens* L.
*VI*c*.	*Euonymus americanus* L.
III, VI†.	*Ampelopsis quinquefolia* Michx. (*Parthenocissus quinquefolia* (L.) Planch.).
III.	*Vitis æstivalis* Michx.
III.	*Vitis labrusca* L.
VI*d*†.	*Hibiscus moscheutos* L.
VI*d*†.	*Kosteletzkya virginica* [L.] Gray.

V*a*.	*Hypericum mutilum* L.
*III*c*†.	*Helianthemum canadense* [L.] Michx.
III*c*†.	*Hudsonia tomentosa* Nutt.
III*c*.	*Lechea minor* var. *maritima* Gray (*Lechea maritima* Leggett).
VI*b*.	*Opuntia vulgaris* Mill. (*Opuntia opuntia* (L.) Coult.).
*IV.	*Ludwigia palustris* Ell. (*Isnardia palustris* L.).
VII†.	*Œnothera biennis* L.
V*a*†.	*Œnothera pumila* L. (*Kneiffia pumila* (L.) Spach.).
V†.	*Discopleura capillacea* D. C. (*Ptilimnium capillaceum* (Michx.) Hollick).
III*d*.	*Osmorrhiza* sp.
VI*c*.	*Chimaphila maculata* [L.] Pursh.
*VI*e*.	*Gaultheria procumbens* L.
III†.	*Vaccinium corymbosum* L.
V*a*†.	*Statice limonium* L. (*Limonium carolinianum* (Walt.) Britton).
III*a*, III*b*.	*Trientalis americana* Pursh.
V*a*†.	*Samolus valerandi* L. (*S. floribundus* H. B. K.).
V*a*.	*Sabbatia stellaris* Pursh.
*VII.	*Apocynum cannabinum* L.
*VI*b*.	*Asclepias tuberosa* L.
III*e*†.	*Asclepias incarnata* L.
III*e*†.	*Calystegia sepium* L. (*Convolvulus sepium* L.).
III*e*†.	*Cuscuta gronovii* Willd.
*VII.	*Ipomœa purpurea* Lam. [(L.) Roth].
III*e*.	*Verbena hastata* L.
*III*e*†.	*Lycopus virginicus* L.
III*e*†.	*Monarda punctata* L.
III*e*.	*Teucrium canadense* L.
*VII.	*Trichostema dichotomus* L.
VII.	*Datura* sp.
*VII†.	*Solanum dulcamara* L.
VII†.	*Solanum nigrum* L.
V*a*†.	*Gerardia maritima* Rof.
V*a*†.	*Gerardia purpurea* L.
III*e*, V*a*†.	*Linaria canadensis* [L.] Dumont.

*VII.	*Plantago major* L.
II, III.	*Diodia virginiana* L.
*III*a*, III*b*†.	*Galium circæzans* Michx.
III*a*, III*b*†.	*Galium pilosum* Ait.
VI*c*, III*a*†.	*Mitchella repens* L.
*III*e*, VI*d*.	*Sambucus canadensis* L.
III†.	*Viburnum dentatum* L.
*VI*c*.	*Sicyos angulatus* L.
VII†.	*Achillea millefolium* L.
VII†.	*Ambrosia artemisiæfolia* L.
VII.	*Ambrosia trifida* L.
VII.	*Anthemis cotula* D. C.
*VI*c*†.	*Aster diffusus* Ait. (*A. lateriflorus* (L.) Britton).
V*a*†.	*Aster subulatus* Michx.
VI*a*.	*Aster tenuifolius* L.
V*e*.	*Baccharis halimifolia* L.
*III*e*†.	*Bidens bipinnata* L.
III*e*, VI*d*.	*Cnicus horridulus* Pursh. (*Carduus spinosissimus* Walt.).
*V*e*†.	*Eclipta alba* [L.] Hassk.
V*e*†.	*Erechtites hieracifolia* Rof.
*VII†.	*Erigeron canadense* L. (*Leptilon canadense* (L.) Britton).
*VI*b*†.	*Eupatorium teucrifolium* Willd. (*E. verbenæfolium* Michx.).
*II†.	*Gnaphalium polycephalum* Michx. (*G. obtusifolium* L.).
*VI*a*.	*Gnaphalium purpureum* L.
III*e*†.	*Helianthus giganteus* L.
*VI*c*†.	*Hieracium gronovii* L.
V*e*†.	*Iva frutescens* L.
*VI*a*†.	*Kuhnia eupatorioides* L.
*VI*b*, V*c*†.	*Liatris graminifolia* Willd. (*Lacinaria cylindracea* (Michx.) Kuntze).
V*a*, V*e*†.	*Pluchea camphorata* [L.] D. C.
*VI*c*†.	*Prenanthes alba* L. (*Nabalus albus* (L.) Hook.).
*VI†.	*Sericocarpus conyzoides* Nees. (*S. asteroides* (L.) B. S. P.).
VI*c*†.	*Solidago odora* Ait.

*VIc†.	*Solidago puberula* Nutt.
Va†.	*Solidago sempervirens* L.
Va†.	*Solidago tenuifolia* Pursh. (*Euthamia caroliniana* (L.) Greene).
*VII.	*Sonchus oleraceus* L.
VII†.	*Xanthium strumarium* L.

Additional List of New Jersey Strand Plants.

The data for the following list was obtained from two sources: (1) The collections made by the writer since 1900 on the New Jersey coast, and (2) the names on the sheets in the herbarium of the late J. Bernard Brinton, M.D., now at Biological Hall, University of Pennsylvania. Those collected by the writer are unmarked, while those plants collected by Dr. Brinton are marked by an asterisk. The orders are arranged according to the system of Engler and Prantl.

Fungi.

Fuligo (*Æthalium*) *septica* Gmel. Sea Side Park.
Gymnosporangium Ellisii Berk. (on white cedar). South Sea Side Park.
Thelephora terrestris Fr. Sea Side Park.
Clitocybe trullisata Ellis. Sea Side Park.
Polyporus versicolor Fr. South Sea Side Park.
Astræus stellatus. Sea Side Park.
Lycoperdon turneri E. and E. Sea Side Park.

Musci.

Polytrichum commune L. Island Beach Life Saving Station.

Ophioglossaceæ.

**Botrychium dissectum* Spreng. Ocean Beach.
**Botrychium obliquum* Muhl. (*B. lunarioides* var. *obliquum*). Ocean Beach, Cape May.

Lycopodiaceæ.

Lycopodium carolinianum L. Island Beach Life Saving Station.

CONIFERÆ.

Chamæcyparis thyoides (L.) B. S. P. (*C. sphæroidea* Spach.). Island Beach Life Saving Station.

TYPHACEÆ.

**Typha angustifolia* L. Cape May.

GRAMINEÆ.

**Andropogon furcatus* Muhl. Anglesea.
**Elymus canadensis* L. Anglesea.
**Panicum dichotomum* L. Ocean Beach.

CYPERACEÆ.

**Carex muhlenbergii* Schk. Anglesea.
**Carex festucacea* Willd. (*C. straminea* var. *brevior* Dewey). Avalon.
**Cyperus filiculmis* Vahl. Atlantic City.
**Cyperus cylindricus* (Ell.) Britton (*C. Torreyi* Britton). Anglesea.
**Eleocharis palustris glaucescens* (Willd.) A. Gray. Anglesea.
**Eleocharis rostellata* Torr. Cape May.
Scirpus sylvaticus L.
**Stenophyllus capillaris* (L.) Britton (*Fimbrystylis capillaris* A. Gray). Anglesea.

LEMNACEÆ.

Lemna minor L. Wildwood.

IRIDACEÆ.

Iris versicolor L. Sea Side Park.

ORCHIDACEÆ.

Pogonia ophioglossoides (L.) Ker. Sea Side Park.

FAGACEÆ.

Quercus alba L. Wildwood.

ULMACEÆ.

Celtis occidentalis L. Piermont.

MORACEÆ.

Morus rubra L. Piermont.
Broussonetia papyrifera (L.) Vent. Sea Side Park, Piermont.

POLYGONACEÆ.

**Rumex patientia* L. Avalon.
**Rumex verticillatus* L.

PHYTOLACCACEÆ.

Phytolacca decandra L. Piermont.

AIZOACEÆ.

Mollugo verticillata L. Sea Side Park, Piermont.

PORTULACACEÆ.

Portulaca oleracea L. Stone Harbor.

CRUCIFERÆ.

Lepidium virginicum L. Sea Side Park.

ROSACEÆ.

**Geum canadense* Jacq. (*G. album* Gmel.).
Pyrus malus L. Sea Side Park (planted).
**Rubus villosus* Ait. Anglesea.

LEGUMINOSÆ.

**Bradburya virginiana* (L.) Kuntze (*Centrosema virginianum* Benth.). Anglesea—the only station in New Jersey.
Gleditschia triacanthos L. Sea Side Park.
Strophostyles umbellata (Muhl.) Britton (*S. peduncularis* Ell.). Sea Side Park.

ILICACEÆ.

Ilex glabra (L.) A. Gray. Sea Side Park.

ACERACEÆ.

Acer saccharinum L. (*Acer dasycarpum* Ehrh.). Sea Side Park (planted).

Hypericaceæ.

Hypericum adpressum Bart. Cape May.

Cistaceæ.

**Lechea racemulosa* Michx. Barnegat.

Cactaceæ.

Opuntia vulgaris Mill. (*O. opuntia* (L.) Coult.). Sea Side Park, Piermont.

Onagraceæ.

Onagra biennis (L.) Scop. (*Œnothera biennis* L.). South Sea Side Park.

Ericaceæ.

Azalea viscosa L. South Sea Side Park.
**Chimaphila maculata* (L.) Pursh. Anglesea.
Clethra alnifolia L. South Sea Side Park.
Gaylussacia resinosa [(Ait.)] T. & G.

Cuscutaceæ.

Cuscuta Gronovii Willd. Sea Side Park.

Labiatæ.

**Koellia verticellata* (Michx.) Kuntze (*Pycnanthemum Torryei* Benth.). Ocean Beach.
Mentha spicata L. (*Mentha viridis* L.). South Sea Side Park.

Solanaceæ.

**Solanum nigrum* L. Atlantic City.

Scrophulariaceæ.

Gerardia tenuifolia Vahl. Cape Ann, Mass.
Linaria canadensis (L.) Dumont. Sea Side Park.

Bignoniaceæ.

Tecoma radicans (L.) D. C. Piermont.

RUBIACEÆ.

**Cephalanthus occidentalis* L. Anglesea.
**Galium pilosum* Ait. Anglesea.
**Galium trifidum* L. Cape May.
Mitchella repens L. Wildwood.

COMPOSITÆ.

**Aster multiflorus* Ait. Anglesea.
**Aster novæ belgii* L. var. *litoreus* A. Gray. Avalon.
**Aster patens* L. Ocean Beach.
**Aster surculosus* Michx. Ocean Beach.
**Doellingeria umbellata* (Mill.) Nees. (*Aster umbellatus* Mill.). Ocean Beach.
Eupatorium perfoliatum L. South Sea Side Park.
Euthamia caroliniana (L.) Greene (*Solidago tenuifolius* Pursh.). Sea Side Park.
Helenium autumnale L. Sea Side Park.
Helianthus sp. Sea Side Park.
**Hieracium scabrum* Michx. Anglesea.
Lactuca scariola L. South Sea Side Park.
**Rudbeckia hirta* L. Anglesea.
Solidago puberula Nutt. South Sea Side Park.

A COLLECTION OF BIRDS FROM SUMATRA, OBTAINED BY ALFRED C. HARRISON, JR., AND DR. H. M. HILLER.

BY WITMER STONE.

The present paper is based upon a collection of bird skins collected on the Island of Sumatra by Mr. Alfred C. Harrison, Jr., and Dr. H. M. Hiller, and presented by them to the Academy of Natural Sciences of Philadelphia. The collection, representing 138 species, is the most extensive ever brought to America from this island and adds materially to our knowledge of the distribution and relationship of a number of species.

Collecting was carried on at three different points: (1) At Batu Sangkar, Tanah Datar, in the highlands east of Padang, at from 1,500 to 3,000 feet elevation, during August and September, 1901; (2) at Goenong Soegi, in the Lampong district of southeastern Sumatra, at an elevation of less than 500 feet, during October and November, 1901, and (3) in the vicinity of Padang. No further data accompanies the specimens, but the collectors inform me that the apparent presence of a species exclusively at one locality, as shown by the specimens, does not necessarily indicate its absence from another, as species well represented in the Padang collection were in some instances passed by in Lampong. In consequence of this the fact that of 94 species obtained in Lampong and 59 in Padang, only 33 were secured in both places loses much of its significance. Moreover, upon comparing the published lists of Sumatra birds we find that the Marquis of Tweeddale's report, based upon a Lampong collection (*Ibis* 1877), contains 81 species not found in the present series, while our material includes 35 not mentioned by Tweeddale.

While information is still inadequate to form generalizations upon the details of the distribution of birds on the island, it would seem that the majority of the species range from the lower Malay peninsula throughout Sumatra and many into Java without material differentiation; and a comparison of the combined lists from Deli, in the northwestern extremity of the island, with those of

Lampong, in the southeastern corner, show that the majority of the species occur at both points. In fact, the high mountains of the south-central part of Sumatra seem to be the only region where a conspicuously different avifauna exists. The materials are, however, far too limited to warrant any positive statements on the matter.

In the following list the material in collection of the Academy has been used for comparison, and also several skins loaned by the U. S. National Museum, through Dr. C. W. Richmond, for which the author expresses his thanks. All references given below have been verified except a few which are marked with an asterisk.

Asarcornis scutulata (S. Müll.).

Anas scutulata S. Müller, Verh. Land en Volkenk., p. 159, 1839–44. Java.

Two specimens from Lampong have the head, rump and breast white, and white feathers in the wing. The breast has also a strong rusty suffusion and some black feathers scattered here and there.

Bubulcus coromandus (Bodd.).

Cancroma coromanda Boddaert, Tabl. Pl. Enl., p. 54, 1783.

Three specimens from the highlands of Padang.

Amaurornis phœnicura (Forster).

Rallus phœnicurus Forster, Zool. Ind., p. 19, Pl. IX, 1781. Ceylon.

One example from the Padang highlands.

Actitis hypoleuca (Linn.).

Tringa hypoleucos, Linnæus, Syst. Nat., X, p. 149, 1758.

Four specimens from Lampong.

Charadrius dominicus fulvus (Gm.).

Charadrius fulvus Gmelin, Syst. Nat., I, p. 687, 1788. Tahiti.

Four specimens from the highlands of Padang.

Caloperdix oculea sumatrana (Grant).

Caloperdix sumatrana Grant. Bull. Brit. Orn. Club, No. 11 (Nov. 1, 1892), Ibis, 1893, p. 118. Sumatra and Java.

Two adults and two downy young from the highlands of Padang.

Argusianus argus (Linn.).

Phasianus argus Linnæus, Syst. Nat. (XII), I, p. 272. 1766. Tartary.

One male from Lampong.

Gallus gallus (Linn).

Phasianus gallus Linnæus, Syst. Nat. (X), p. 158, 1758. India Orientale.

One from Lampong and another from the Padang highlands.

Carpophaga ænea (Linn.).

Columba ænea Linnæus, Syst. Nat. (XII), I, p. 283, 1766. Moluccas.

One specimen, Lampong.

Treron nipalensis (Hodgs.).

Toria Nipalensis Hodgson, Asiat. Res. XIX, p. 164, Pl. IX, 1836. Nepal.

Two examples from the Padang highlands.

Osmotreron vernans (Linn.).

Columba vernans Linnæus, Mantissa, p. 526, 1771. Philippines.

One from Padang and four from the highlands to the east.

Treron griseicapilla Schleg., *N. T. D.*, I, p. 70 (1863), from Sumatra, is separated mainly on account of the grayness of the head, but this seems to be a phase of plumage probably due to age.

Osmotreron olax (Temm.).

Columba olax Temminck, Pl. Col., 241, 1823. Sumatra.

Five specimens from Lampong.

Osmotreron fulvicollis (Wagl.).

Columba fulvicollis Wagler, Syst. Av. Columba, Species 8, 1827. Philippines.

One male from Lampong.

Turtur tigrinus (Temm.)

Columba tigrina Temminck and Knip Pigeons, I, Pl. 43, 1808–11. China and South Sea Islands.

Two specimens from Lampong and one from the Padang highlands.

Turtur turtur (Linn.).

Columba turtur Linnæus, Syst. Nat. (X), 165, 1758.

One specimen from Padang, very light in color; no doubt a domesticated bird.

Microhierax fringillarius (Drapiez).

——— Drapiez, Dict. Class. d'Hist. Nat., VI, p. 412, Pl. V, 1824*

Three specimens from Padang and two from the adjacent highlands.

Elanus hypoleucus Gould.

Elanus hypoleucus Gould, P. Z. S , 1859, p. 127. Celebes.

Two specimens from the highlands of Padang are probably referable to this species. The original description gives the under-wing coverts as pure white, but in these examples the ends of the longest of these feathers near the edge of the wing are clouded with slaty black. The wing measurements are:

Ketupa ketupa (Horsf.).

Strix ketupa Horsfield, Trans. Linn. Soc., XIII, p. 141, 1821. Java.

One example from Padang and two from Lampong.

Huhua orientalis sumatrana (Raffl.).

Strix sumatrana Raffles, Trans. Linn. Soc., XIII, p. 279, 1822. Sumatra.

Two specimens from the highlands of Padang.

Raffles described a young bird, but both Schlegel and Hartert consider the Sumatra form distinct from *H. orientalis* Horsf. of Java, and this name must therefore be adopted.

Psittinus incertus (Shaw).

Psittacus incertus Shaw, Nat. Misc., Pl. 769, 1790. Cage specimen, supposed to have come from India.

Four examples from Lampong.

Lorioulus galgulus (Linn.).

Psittacus galgulus Linnæus, Syst. Nat., I (XII ed.), p. 150, 1766. India.

Two from Padang and one each from the highlands and from Lampong.

Palæornis longicauda (Bodd.).

Psittacus longicaudus Boddaert, Tabl. Pl. Enl., p. 53, 1783. Malacca.

Four specimens from Lampong.

Eurystomus calonyx "Hodgs.," Sharpe.

Coracius calonyx "Hodgs.," Sharpe, P. Z. S., 1890, p. 551. Himalayan Terai.

Three specimens from Padang and one from Lampong district. These birds seem in some respects intermediate between the figures given on Pl. II, Vol. XVII of the *Catalogue of Birds*, representing *E. orientalis* and *E. calonyx*, but are closer to the latter. None of them have the terminal part of the tail plain black as shown in the figure of *orientalis*, but, on the contrary, the outer webs are strongly shaded with purplish-blue almost to their tips. At the base is an area of greenish-blue of greater or less extent, sometimes suffusing the inner web nearly to the tip, and in other examples almost entirely concealed at the extreme base of the feather. Compared with other material before me, these specimens agree well with one from Siam, but differ markedly from a Philippine specimen in the much smaller bill and in color pattern, the latter matching Sharpe's figure of *orientalis* exactly. Sharpe credits both forms to Borneo, *calonyx* being a winter visitor, and it is possible this is also the case in Sumatra.

Pelargopsis capensis (Linn.).

Alcedo capensis Linnæus, Syst. Nat. (XII), 1766, p. 180. "Cape of Good Hope" prob.=Java.

Four specimens from Lampong.

The unfortunate complication of names which exists in this group has given rise to a great diversity of treatment by different authors. The facts in case are briefly as follows: Linnæus (1758) gave the name *capensis* to a kingfisher described by Brisson from the Cape of Good Hope, but which we now know must have come from the Malay region.

Boddaert (1783) proposed the name *javana* for the bird figured by Daubenton (*Pl. Enl.*, 757) as from Java, but which we now know is the Bornean species.

Gmelin (1788) based a name *leucocephala* on the same plate.

Pearson (1841) described a species *gurial* from Bengal.

In the light of our present knowledge it is possible to fix the name *javana* upon the bird from Borneo (cf. Hartert, *Nov. Zool.*, IX, p. 202), and the other two names upon races of a closely allied group found from India to Java. The name *gurial* with a definite type locality is easily disposed of, which leaves *capensis* Linn. for one of the remaining races.

Sharpe (1870) was the first to designate these by name, proposing *floresiana* for the bird from Flores, *burmanica* for the Burmah form, and *malaccensis* for that of the Malay peninsula. At the same time he states that he considers Brisson's description, upon which Linnæus' name *capensis* was mainly based, to apply to the Javan bird, but that Daubenton's plate, also quoted by Linnæus, represents his *floresiana*. Subsequently (*Cat. Bds. Brit. Mus.*, XVII, p. 106) he considers Daubenton's plate to have been based upon Brisson, which seems to fix *capensis* more firmly than ever upon the Javan bird. Sharpe did not adopt the name *capensis* solely because of the incongruity, and so proposed the name *fraseri* for it (1870). The adoption of *capensis* is, I think, inevitable. Hartert (*Nov. Zool.*, IX, p. 202) claims that all the blue and green-backed species of *Pelargopsis* should be treated as subspecies of one widely spread group, which plan seems to simplify the matter materially, though the name *Pelargopsis capensis javana* for a Bornean bird will not meet with much favor from those who still believe in the propriety of ignoring names which are geographically misleading.

Alcedo meninting Horsf.

Alcedo meninting Horsfield, Trans. Linn. Soc., XIII, p. 172, 1821. Java.

Two males from Lampong and a female from the Padang highlands.

Alcedo euryzonia Temm.

Alcedo euryzonia Temminck, Planch. Col., text to livr. 86, 1830.

One male from Padang.

Ceyx rufidorsa Strickl.

Ceyx rufidorsa Strickland, P. Z. S., 1846, p. 99. Malacca.

One example from Lampong.

Sharpe renames this bird *euerythra* (*Cat. Birds*, XVII, p. 179) on the ground that Strickland's specimen is intermediate between this and *tridactyla*.

Carcineutes pulchellus (Horsf.).

Dacelo pulchella Horsfield, Trans. Linn. Soc., XIII, p. 175, 1821. Java.

Five males and three females, representing all the localities.

Halcyon concreta (Temm.).

Dacelo concreta Temminck, Pl. Col., IV, Pl. 346, 1825.

Male and female from the highlands of Padang.

Halcyon chloris (Bodd.).

Alcedo chloris Boddaert, Tabl. Pl. Enl., p. 49, 1783.

Five specimens from the Padang highlands. One of these (No. 38,928, Acad. Nat. Sci. Phila.) has the black on the ear coverts and collar replaced almost entirely by green, while the wings are brighter blue. This would seem to be the subspecies *armstrongi* Sharpe (*Cat. Birds Brit. Mus.*, XVII, p. 277), but it is unlikely that two forms would occur together unless one was a migrant, and it is possible that the peculiarities shown by this specimen may have something to do with season or age.

Buceros rhinoceros Linn.

Buceros rhinoceros Linnæus, Syst. Nat. (X), I, p. 104, 1758. India.

One male from the highlands of Padang.

Anthracoceros convexus (Temm.).

Buceros convexus Temminck, Pl. Col., Pl. 530, 1832.

Five specimens from Lampong and one from the Padang highlands.

One of the males has the casque laterally swollen anteriorly to a width of nearly two inches, so that it overhangs the bill on either side.

Anthracoceros malayanus (Raffl.).

Buceros malayanus Raffl., Trans. Linn. Soc., XIII, p. 292, 1822. Malacca.

One male from Lampong.

Rhytidoceros undulatus (Shaw).

Buceros undulatus Shaw, Gen. Zool., VIII, p. 26, 1811. Batavia.

One specimen from Lampong which has the base of the bill only slightly wrinkled, but with the black throat bar present; wing measures 19 inches.

Merops sumatranus Raffl.

Merops sumatranus Raffles, Trans. Linn. Soc., XIII, p. 294, 1821. Sumatra.

One young bird from Padang.

Merops philippinus Linn.

Merops philippinus Linnæus, Syst. Nat. (XIII ed.), I, p. 183, 1787. Philippines.

Three examples from Padang and one from Lampong.

There seems to be considerable variation in the amount of blue above, No. 38,852 being quite blue on the crown and with scattered blue feathers on the back.

Alcemerops amicta (Temm.).

Merops amicta Temminck, Pl. Col., IV., Pl. 310, 1824.

Four specimens from the Padang highlands and one from Lampong. No. 38,918 is molting, probably from the juvenal plumage, and shows the new bright-colored feathers coming in on the throat. The black bands on the end of the tail are not well defined and the belly is buff.

My friend, Dr. C. W. Richmond, has pointed out to me that the name *Nyctiornis* usually applied to this genus is antedated by *Nyctornis* Nitzsch (*Pterylographiæ Avium Halle,* 1833, p. 21 = *Nyctibius* Vieill.), consequently we must adopt Geoffroy's name as above.

Caprimulgus affinis Horsf.

Caprimulgus affinis Horsfield, Trans. Linn. Soc., XIII, p. 142, 1821. Java.

One specimen from Padang.

Macropteryx comata (Temm.).

Cypselus comatus Temminck, Pl. Col., Pl. 268, 1824. Sumatra.

Four specimens from Lampong.

Macropteryx longipennis (Rafin.).

Hirundo longipennis Rafinesque, Bull. Soc. Philom., III, p. 153, 1804.*

Three examples from Padang.

Pyrotrogon duvauceli (Temm.).

Trogon duvauceli Temminck, Pl. Col., 291, 1824.

Three specimens from Lampong.

Pyrotrogon diardi neglectus Forbes and Robinson.

Trogon diardii neglectus Forbes and Robinson, Bull. Liverpool Museum, II, p. 34 (1899).

One example from Lampong. Though I have been unable to consult the above reference I follow Hartert in adopting this name for the Sumatran bird.

Surniculus lugubris (Horsf.).

Cuculus lugubris Horsfield, Trans. Linn. Soc., XIII, p. 179, 1821. Java.

Two specimens from Lampong, which have the tail nearly square.

Hierococcyx fugax (Horsf.).

Cuculus fugax Horsfield, Trans. Linn. Soc., XIII, p. 178, 1821. Java.

One specimen from the highlands of Padang.

Cuculus intermedius Vahl.

Cuculus intermedius Vahl, Skriv. af Natur. Selsk., IV, 58, 1797. Tranquebaria.

Three specimens from Lampong.

The synonymy of this species as given in the *British Museum*

Catalogue of Birds, Vol. XIX, is very extensive, and it is probable that several forms are confused, but I have not the material at hand to warrant the consideration of this point.

Chalcococcyx xanthorhynchus (Horsf.).

Cuculus xanthorhynchus Horsfield, Trans. Linn. Soc., XIII, p. 179, 1821. Java.

One adult male from Lampong.

Cacomantis merulinus (Scop.).

Cuculus merulinus Scopoli, Del. Flor. et Faun. Insubr., II, p. 89, 1786. India.

One immature specimen from Padang and another from Lampong, the latter being much more rufous above. It is probable that several forms are merged under this species in the *British Museum Catalogue* which should be entitled to recognition.

Centropus javanicus (Dum.).

Centropus javanicus Dumont, Dict. Sci. Nat., XI, p. 144, 1818.*

One example from the highlands of Padang.

Centropus sinensis (Steph.).

Polophilus sinensis Stephens, Gen. Zool., IX, p. 51, 1815. China.

Three specimens from Lampong and one from the highlands of Padang.

Zanclostomus javanicus (Horsf.).

Phœnicophaus Javanicus Horsfield, Trans. Linn. Soc., XIII, p. 178. 1822. Java.

One example from Lampong.

Rhinortha chlorophæa (Rafil.).

Cuculus chlorophæus Raffles, Trans. Linn. Soc., XIII, p. 288, 1822. Sumatra.

Two male specimens from Padang, one from the highlands and one from near the coast, and a female specimen from Lampong.

Rhopodytes elongatus (S. Müll.).

Phœnicophaus elongatus S. Müll., Tijdschr. Nat. Gesch., p. 342, 1835. Sumatra.

Four specimens from the highlands of Padang, four from the coast and one from Lampong.

Urococcyx erythrognathus (Hartl.).

Phœnicophæus erythrognathus Hartlaub, Verz. Mus. Brem., 1844, p. 95.*

One example from the highlands of Padang and two from Lampong.

Calorhamphus hayi (J. E. Gray).

Bucco hayi J. E. Gray, Zool. Misc., p. 33, 1832. Molucca.

Four examples from Padang and one from Lampong.

Chotorhea chrysopogon (Temm.).

Bucco chrysopogon Temm., Pl. Col., III, 1824, p. 285.

Ten specimens from the highlands of Padang.

Cyanops oorti (S. Müller).

Bucco oorti S. Müll., Tijdschr., Nat. Gesch., II, p. 341, Pl. 8, fig. 4, 1835. Sumatra.

Male and female from the highlands of Padang.

Cyanops mystacophanes (Temm.).

Bucco mystacophanes Temm., Pl. Col., III, p. 315, 1824.

One young individual from Lampong.

Mesobucco duvauceli (Less.).

Bucco duvauceli Less., Traité, p. 164, 1831. Sumatra.

Two from the highlands of Padang and one from Lampong.

Xantholæma hæmacephala (Müll.).

Bucco hæmacephalus P. L. S., Muller, Syst. Nat. Anhang, p. 88, 1776. Philippines.

One specimen from Padang and two from the highlands of the same province.

Gecinus puniceus observandus Hart.

Gecinus puniceus observandus Hartert, Nov. Zool., III, p. 542, 1896. Sumatra.

One specimen from Lampong.

Chrysophlegma mentale humii (Hargitt).

Chrysophlegma humii Hargitt, Ibis, 1889, p. 231. Malacca.

Three males from the highlands of Padang and three females from Lampong.

Chrysophlegma miniatum malaccense (Lath.).

Picus malaccensis Latham, Ind. Orn., I, p. 241, 1790. Malacca.

One example from the highlands of Padang.

Yungipicus moluccensis (Gm.).

Picus moluccensis Gmelin, Syst. Nat., I, p 439, 1788. Moluccas.

Three specimens from Lampong and one from the Padang highlands.

Meiglyptes grammithorax (Mahl.).

Phæopicus grammithorax Mahlherb, Picidæ, II, p. 12, Pl. XLVIII, figs. 4 and 5, 1862. Malay Peninsula and Sunda Islands.

Two examples from Lampong.

Meiglyptes tukki (Less.).

Picus tukki Lesson, Rev. Zool., 1839, p. 167. Sumatra.

Two specimens from Lampong.

Micropternus brachyurus (Vieill.).

Picus brachyurus Vieillot, Nov. Dict. d'Hist. Nat., XXVI, p. 103, 1818. Java.

One example from the highlands of Padang. In the *Catalogue of Birds* Mr. Salvadori makes this a subspecies of *M. phæoceps* Blyth, published in 1845!

Tiga javanensis (Ljung).

Picus javanensis Ljung, Mem. Ac. Roy. Stockh., 1797, p. 134. Java.

Four specimens from the highlands of Padang.

Xylolepes validus (Temm.).

Picus validus Temm., Pl. Col., IV, 378 ♂, 402 ♀, 1825.

Two young birds from Lampong.

Thriponax javanensis (Horsf.).

Picus javanensis Horsfield, Trans. Linn. Soc., XIII, p. 175, 1821. Java.

Three from Lampong.

Calyptomæna viridis Raffl.

Calyptomæna viridis Raffles, Trans. Linn. Soc., XIII, p. 295, 1822. Sumatra.

Four specimens from Lampong.

Eurylaimus javanicus Horsf.

Eurylaimus javanicus Horsfield, Trans. Linn. Soc., XIII, p. 170, 1821. Java.

One specimen from Lampong.

Corydon sumatranus (Raffl.).

Coracias sumatranus Raffles, Trans. Linn. Soc., XIII, p. 303, 1822. Sumatra.

Seven specimens from Lampong.

Cymborhynchus macrorhynchos lemniscatus Raffl.

Eurylaimus lemniscatus Raffles, Trans. Linn. Soc., XIII, p. 296, 1822. Sumatra.

Seven specimens representing all three localities.

Eucichla boschi (Müll. and Schl.).

Pitta boschii Müller and Schlegel, Verh. Zool., Pitta, p. 16, t. 1, 1839–1844. Sumatra.

Three males and a female from Lampong.

Sharpe's description of this bird in Vol. XIV of the *Catalogue of Birds*, p. 447, fails to mention the bars of black on the breast. As a matter of fact, each feather is banded with black, orange and purple, always in this order, there being several bands of each, though the orange bands are obsolete toward the base of some feathers.

Hirundo rustica gutturalis (Scop.).

Hirundo gutturalis Scopoli, Del Flor et Faun Insubr., II, p. 96, 1786.

Three specimens from Lampong.

Hirundo javanica Sparrm.

Hirundo javanica Sparrman, Mus. Carls., II, Pl. 100, 1789. Java.

One from the Padang highlands and one from Lampong.

Terpsiphone affinis ("Hay," Blyth).

Tchitrea affinis "Hay," Blyth, Jour. As. Soc. Bengal, XV, p. 292. Malay Peninsula.

Two adults from Lampong.

Terpsiphone incei (Gould).

Muscipeta incei Gould, Birds of Asia, Pt. 4. Nov., 1852.

A pair of adults from Lampong. I am not at all satisfied that the relationship of the birds of this genus is properly understood. The seasonal plumages and those due to age seem so complicated that it is quite possible that more of the current species will have to be relegated to synonymy.

Siphia cantatrix (Temm.).

Muscicapa cantatrix Temminck, Pl. Col., III, Pl. 226 (♀).
Muscicapa elegans Temminck, Pl. Col., III, Pl. 596 (♂).

Three specimens from Lampong.

As the plate of the female was obviously issued long before that of the male, although now bound in the same volume, I see no course but to adopt the name based upon the former.

Artamides sumatrensis (S. Müll.).

Ceblepyris sumatrensis S. Müller, Verh. Nat. Geschied. Land und Völken, p. 190.*

Two females and one male from Lampong and a female from Padang.

Pericrocotus xanthogaster (Raffl.).

Lanius xanthogaster Raffles, Trans. Linn. Soc., XIII, p. 309, 1822. Sumatra.

One male from the highlands of Padang.

Lalage dominica (Müll.).

Turdus dominicus P. L. S. Müller, Syst. Nat. Anhang., p. 145, 1776. "St. Domingo."
= *Turdus terat* Boddaert, Tabl. Pl. Enl., p. 17, 1783.

Two specimens, one from Lampong and one from Padang.

Lalage culminata (Hay).

Ceblepyris culminatus A. Hay, Madr. Jour., XIII, p. 157. Malacca.

A female from Padang.

Chloropsis zosterops Vigors.

Chloropsis zosterops Vigors, App. Mem. Life of Raffles, p. 674. Sumatra.

Four specimens, three from Lampong and one from the highland of Padang, all males.

Chloropsis media (Bp.).

Phyllornis media "Müll." Bp., Consp., I, p. 396. 1850. Sumatra.

Two males and a female from Padang highlands.

Chloropsis icterocephala (Less.).

Phyllornis icterocephalus Lesson, Rev. Zool., 1840, p. 164. Sumatra, Borneo and India.

Two males and a female from Lampong.

Chloropsis cyanopogon (Temm.).

Phyllornis cyanopogon Temm., Pl. Col., 512, fig. 1.

Two from Lampong, one from Padang.

Irena criniger Sharpe.

Irena criniger Sharpe, Cat. Birds Brit. Mus., III, p. 267. Sumatra and Borneo.

Thirteen specimens from Padang highlands and the Lampong district, both males and females.

One specimen (No. 38,966, Acad. Nat. Sci. Phila.) from the Padang region differs from the series of females in having the plumage much bluer with little of the green cast, the tail and edge of the wings especially being dark-blue. This may be a young male, but it shows no signs of the black or enameled-blue feathers of the adult.

Euptilotus eutilotus (Jard. and Selby).

Brachypus eutilotus Jard. and Selby, Ill. Ornith., IV (n. s.), Pl. III. Singapore.

One specimen from Lampong.

Microtarsus melanoleucus Eyt.

Microtarsus melanoleucus Eyton, P. Z. S., 1839, p. 102. Malay region.

One example from Lampong.

Microtarsus melanocephalus (Gm.).

Lanius melanocephalus Gmelin., Syst. Nat., I, p. 309, 1788. Sandwich Islands.

Two specimens from Lampong and five from the Padang highlands.

Criniger phæocephalus (Hartl.).

Ixos (*Trichixos* Less.) *phæocephalus* Hartlaub, Rev. Zool., 1844, p. 401. Malacca.

Six specimens from Lampong.

Tricholestes criniger (Blyth).

Brachypodius (?) *criniger* Blyth, Jour. As. Soc. Bengal, XIV, p. 577. Malacca.

One from Padang.

Trachycomus ochrocephalus (Gm.).

Turdus ochrocephalus Gmelin, Syst. Nat., I, p. 821. Ceylon and Java.

Four from the Padang highlands and two from Lampong.

Pycnonotus simplex Less.

Picnonotus simplex Lesson, Rev. Zool., 1839, p. 167. Sumatra.

Four from Lampong and one each from Padang and the adjacent highlands. Three of these specimens are smaller and somewhat lighter than the others, but not appreciably different in other respects. They are possibly distinct.

Pycnonotus analis (Horsf.).

Turdus analis Horsfield, Trans. Linn. Soc., XIII, p. 147, 1821. Java.

Two from Lampong, five from the Padang highlands, and one from the coast.

Pycnonotus plumosus Blyth.

Pycnonotus plumosus Blyth, Jour. As. Soc. Bengal, XIV, p. 567. Malacca.

Two from Lampong.

Rubigula dispar (Horsf.).

Turdus dispar Horsfield, Trans. Linn. Soc., XIII, p. 150, 1821. Java.

Two from Lampong and two from the Padang highlands.

Copsychus saularis musicus (Raffl.).

Lanius musicus Raffles, Trans. Linn. Soc., XIII, p. 307, 1822. Sumatra?

Two from the Padang highlands and one from Lampong.

Raffles states that this is the "*Turdus mindanensis* of Gmelin and the *Gracula saularis* of Linnæus, now with more propriety placed in the genus Lanius. It is one of the few singing birds of India." Whether this name is not a pure synonym of *saularis* is an open question; though Raffles probably had the Sumatran bird in mind he does not say so, nor is his diagnosis sufficient to identify it.

Our specimens show considerable variation, one having only four black feathers in the tail, and the next pair white for a space of one inch. This bird exactly matches a Siam example in the Academy collection. From the material at hand this race does not seem very well defined.

Cittocincla macrurus suavis (Sclater).

Copsychus suavis Sclater, P. Z. S., 1861, p. 185. Borneo.

Five specimens from Lampong.

Sharpe (*Cat. Birds*, VII, p. 88) states that the name *C. macrurus* should not be used, as it is not identifiable; the white outer tail feathers of Latham's plate would indicate the Bornean bird, while the type locality, "Pulo Condore," would almost certainly yield true "*tricolor.*" The present series from Sumatra shows much variation in the extent of white on the outer tail feathers. In one it is $\frac{7}{8}$ in., measured along the mid-rib, and in another $2\frac{1}{2}$.

Hydrocichla ruficapilla Temm.

Enicurus ruficapillus Temminck, Pl. Col., III, Pl. 534, 1832.

Three specimens from the Padang highlands.

Hydrocichla velata Temm.

Enicurus velatus Temminck, Pl. Col., III, Pl. 160, 1823.

One from the Padang highlands.

Hydrocichla frontalis Blyth.

Enicurus frontalis Blyth, Jour. As. Soc. Bengal, XVI, p. 156, 1847. Malay Peninsula.

Three specimens from Lampong.

Garrulax bicolor Hartl.

Garrulax bicolor "S. Müll." Hartlaub, Rev. Zool., 1844, p. 402. Sumatra.

One from the Padang highlands.

Rhinocichla mitrata (Müll.).

Timalia mitrata S. Müller, Tijdschr, Nat. Gesch., 1835, p. 345, Pl. 5, fig. 3. Java.

Six specimens from the Padang highlands.

Mixornis gularis (Raffl.).

Motacilla gularis Raffles, Trans. Linn. Soc., XIII, p. 312, 1822. Sumatra.

Seven specimens from Lampong.

Mixornis erythroptera (Blyth).

Timalia erythroptera Blyth, Jour. As. Soc. Bengal. XI, p. 794, 1842. Malay region.

One specimen from Lampong.

Macronus ptilosus Jard. and Selby.

Macronus ptilosus Jardine and Selby, Ill. Ornith., Pl. 150, 1835. Java and Sumatra.

Three specimens from Lampong.

Trichastoma büttikoferi Vorderm.

Trichostoma Büttikoferi Vorderman, Nat. Tijdschr. Ned. Indie, 1892, p. 230. Lampong, Sumatra (Ref. from Büttikofer).

One specimen from the Lampong district which agrees exactly with the description of Vorderman's hitherto unique bird. The present specimen (No. 39,204, Coll. Acad. Nat. Sci. Phila.) measures: wing 70 mm., tail 54, tarsus 27, culmen 15. The "narrow black edgings" to the feathers of the crown, while clearly apparent, are really an optical effect produced by the loose-vaned feathers lying over one another.

In Mr. Büttikofer's excellent paper in *Notes from the Leyden Museum*, XVII, p. 65, 1895, I am unable to appreciate the importance of the character upon which he bases his primary division of the genus *Trichastoma* (p. 87), *i.e.*, the presence or absence of "concealed white longitudinal shaft streaks on the feathers of the back and rump."

The specimen above mentioned has the basal portion of the shafts of these feathers white, yet it is placed in the section with no white concealed streaks; while the type of *T. celebense* Strickland, which is now before me (No. 17,370, Coll. Acad. Nat. Sci.

Phila.), seems to show less of these white shafts than does *T. büttikoferi*, yet it falls in the other division.

Malacopteron erythrote of Sharpe I had already decided to be congeneric with *T. büttikoferi* before consulting Mr. Büttikofer's paper, and I find he has reached the same conclusion, regarding it as a synonym of *Trichastoma pyrrhogenys* Temm., which it evidently is. There may be some question, however, as to the geographic distribution of the species, as our two specimens are labeled Sumatra.

On p. 84 of Mr. Büttikofer's paper he refers *Brachypteryx polyogenys* Strickl. with a query to *Anuropsis malaccensis* (Hartl.). With Strickland's type before me I have no hesitation in confirming this identification. Another of Strickland's types, also in the Academy's collection, brings to light a curious error which has been perpetuated in all the works on the *Timaliæ*, and which involves a change in the name of the well-known *Rhinomyias pectoralis*. Among the many type specimens secured for the Academy by Dr. Thomas B. Wilson is the original of *Napothera umbratilis* "Temm." Strickland (*Cont. Orn.*, 1849, p. 128, Pl. 31). This name being quoted by Sharpe, Oates and Büttikofer as a synonym of *Trichastoma rostratum* Blyth, I made an examination of the Strickland specimen, regarding it as typical of the genus *Trichastoma*, but soon became convinced that it had nothing whatever to do with the latter, and subsequently, with the aid of Dr. C. W. Richmond, it was identified as *Rhinomyias pectoralis* Salvad.!

Strickland's name having many years' priority must be adopted, and the species will then stand as *Rhinomyias umbratilis* (Strickl.).

Dr. Richmond has sent me for comparison some specimens of *Rhinomyias* from the U. S. National Museum collection, collected in Linga and Mandalar Islands, Western Sumatra, which he had identified as "*R. pectoralis.*" These, however, differ from the type of *R. umbratilis*, of which *pectoralis* becomes a synonym, and seem worthy of separation as a distinct race, for which I would propose the name of

Rhinomyias umbratilis richmondi subsp. nov.

> Type 170,8 0, U. S. Nat. Mus., Mansalar Island, west coast of Sumatra, March 12, 1902. Dr. W. L. Abbott.

Size and proportions apparently similar to *R. umbratilis* (=*pectoralis* Auct.). Coloration similar, but of a decided olivaceous cast, which color is entirely lacking from the type specimen of *R. umbratilis.* Nearly uniform olive-brown above (intermediate between mummy-brown and olive of Ridgway's *Nomenclature of Colors*), edges of wings and tail more tawny; sides of the face and neck like the back, lores whitish and feathers behind the eye distinctly grayish. Below pure white, sides of body under the wings pale olive, and a pronounced pectoral band of olive-brown darkest at the sides. "Bill black. Iris brown. Feet purplish-fleshy" (Abbott).

Length (in flesh) 6⅜ inches = 162 mm.; wing, 74 mm.; tarsus, 18 mm.

Another specimen, obtained by Dr. Abbott on Linga Island, July 14, 1899, is essentially similar, and from both of them the type of *R. umbratilis* differs in its distinctly tawny-brown coloration.

Prinia olivacea (Raffl.).

Mo acilla olivacea Raffles, Trans. Linn. Soc., XIII, p. 313, 1822.

Two specimens from Lampong.

In his description of this bird in the *Catalogue of Birds,* Dr. Sharpe states that the head of the adult is brown, and again that in the young or winter plumage the head is "brown, not gray." The specimens before me, which I take to be adult, have the head distinctly gray all around in contrast to the olive back, throat pure white and a broad gray collar joining the gray of the sides of the neck and separating the white throat from the yellow abdomen. Two other examples from Java, kindly loaned by the U. S. National Museum, have the appearance of being young birds in juvenal plumage, with shorter bills and duller coloration. Head uniform olive-brown like the back, lores and stripe to the top of the eye white.

Orthotomus cineraceus Blyth.

Orthotomus cineraceus Blyth, Jour. As. Soc. Bengal, XIV, p. 589, 1845. Malacca.

A male and female from Lampong.

Orthotomus atrigularis Temm.

Orthotomus atrigularis Temminck, Pl. Col., III, text to livr. 101, 1836.

One female from Padang.

Lanius superciliosus Lath.

Lanius superciliosus Latham, Ind. Orn. Suppl., p. 20, No. 14, 1801.*

One adult male from Lampong.

Lanius tigrinus Drapiez.

Lanius tigrinus Drapiez, Dict. Class. Hist. Nat., XIII, p. 523, 1828.*

Two specimens from Padang and one from Lampong, representing young and adult in winter plumage.

Artamus leucorhynchus (Linn.).

Lanius leucorhynchus Linnæus, Mantissa, p. 524, 1771. Manilla.
Ocypterus leucogaster Valenc., Mem. Mus. d'Hist. Nat., VI, p. 21, 1820.

One from the highlands of Padang, two from the coast and two from Lampong.

Dicæum sumatranum Cab.

Dicæum sumatranum Cabanis, Jour. für Orn., 1878, p. 101. Sumatra.

One from the Padang highlands.

Anthreptes malacensis (Scop.).

Certhia malacensis Scopoli, Del Flor. et Faun. Insubr., II, p. 91, 1786. Malacca.

Two specimens from the Padang highlands and four from Lampong.

Cinnyris brasiliana (Gm.).

Certhia brasiliana Gmel., Syst. Nat., I, p. 474, 1788. "Brazil."
Nectarinia hasseltii Temm., Pl. Col., 376, 1825.

One from Lampong.

Motacilla boarula melanope (Pall.).

Motacilla Melanope Pallas, Reis. Russ. Reichs, III, App., p. 696, 1776. Dauuria.

One from Padang and another from the adjacent highlands.

Anthus rufulus malayensis (Eyt.).

Anthus malayensis Eyton, P. Z. S., 1839, p. 104. Malay region.

One specimen from the highlands of Padang and one from the coast.

Phyllopneuste borealis (Blas.).

Phyllopneuste borealis Blasius, Naumannia, 1858, p. 313.

One specimen from Lampong.

Uroloncha leucogastra (Blyth).

Amadina leucogastra Blyth, Jour. As. Soc. Bengal, XV, 286, 1846. Malay region.

Three adults from Lampong.

Uroloncha leucogastroides (Moore).

Munia leucogastroides Moore, Catalogue Birds East Ind., Comp. Museum, II, p. 510, 1856. Java.

One specimen from Lampong, which has the white belly mottled with brown transverse lines and crescents.

Munia punctulata nisoria (Temm.).

Munia nisoria Temminck, Pl. Col., III, Pl. 500, fig. 2, 1830.

One adult and two young from Lampong.

Munia maja (Linn.).

Loxia maja Linnæus, Syst. Nat., I, p. 301, 1766. India, Orient.

Two specimens from Lampong and one from Padang.

Ploceus megarhynchus Hume.

Ploceus megarhynchus Hume, Stray Feathers, 1875, pp. 153 and 406 (1878). Nynee Tal and Dacca.

Two females from the Padang highlands and one from the coast.

This bird is usually designated *Ploceus atrigula* " Hodgs." Gray, but I cannot see that Hodgson's unpublished drawings have any status so far as nomenclature is concerned, nor that Gray's published name, which is not accompanied by any description, can be considered. Eliminating these references the next name available is that of Hume, as given above.

Oriolus maculatus Vieill.

Oriolus maculatus Vieillot, Nov. Dict. d'Hist. Nat., XIII, p. 194. Java.

Five specimens from the highlands of Padang.

Oriolus xanthonotus Horsf.

Oriolus Xanthonotus Horsfield, Trans. Linn. Soc., XIII, p. 152, 1821. Java.

Two males and a female from Lampong.

Buchanga cineracea Horsf.

Edolius cineraceus Horsfield, Trans. Linn. Soc., XIII, p. 145, 1821. Java.

Six specimens from the Padang highlands.

Chaptia malayensis " Hay " Blyth.

Chaptia malayensis " Hay " Blyth, Jour. Asiat. Soc. Bengal, XV, p. 294. Malacca.

One from Padang.

Dissemurus platurus (Vieill.).

Dicrurus platurus Vieillot, Nov. Dict. d'Hist. Nat. IX, 1817, p. 588. Malabar?

Two specimens from Lampong and two from the highlands of Padang.

It does not seem clear just where Vieillot's bird came from, but from what material I have examined, it would seem that the birds of Java, Sumatra and Borneo are identical, and that the names *malayensis* Blyth and *brachyphorus* Bp. are consequently synonyms of the above.

Eulabes javanensis (Osbeck).

Corvus javanensis Osbeck, Voyage [English Transl.], p. 157, 1771.

Six specimens from Lampong.

I fail to see how this species can be cited from Osbeck's original work which dates from 1757. In the German translation (1765) the name is changed to *C. religiosa* Linn., but in the English translation (1771) the original name is restored, consequently, inasmuch as Linnæus' name seems applicable to the Indian bird, we can use *javanensis* Osbeck, 1771, for this one.

Lamprocorax chalybea (Horsf.).

Turdus chalybeus Horsfield, Trans. Linn. Soc., XIII, p. 148, 1821. Java.

Two examples from the Padang highlands and five from Lampong.

This species is described under three different names in the same volume of the *Linnæan Transactions.* On the same page as the above Horsfield describes the female as *Turdus strigatus*, but in accordance with the A. O. U. code, we should give precedence to the name based on the male, even though the other stands first.

Sturnopastor jalla (Horsf.).

Pastor jalla Horsfield, Trans. Linn. Soc., XIII, p. 155, 1821. Java.

Three specimens from Lampong.

Corvus macrorhynchos Wagl.

Corvus Macrorhynchos Wagler, Syst. Av. Corvus, Sp. 3. Sumatra and Java.

Two specimens from Lampong, just completing the post-juvenal molt.

Dendrocitta occipitalis (Müll.).

Glaucopis occipitalis Müller, Tijdschr, Nat. Gesch., 1835, p. 343, Pl. IX, f. 1.

Three specimens from the Padang highlands.

Platylophus coronatus (Raffl.).

Lanius coronatus Raffles, Trans. Linn. Soc., XIII, p. 306, 1822. Sumatra.

Four specimens from Lampong and one from the Padang highlands.

Platysmurus leucopterus (Temm.).

Glaucopis leucopterus Temminck, Pl. Col., 265.

Five specimens from Lampong and one from the highlands of Padang.

NOVEMBER 4.

Mr. ARTHUR ERWIN BROWN, Vice-President, in the Chair.

Thirty-one persons present.

A paper entitled "Synopsis of the Carditacea and of the American Species," by William Healy Dall, was presented for publication.

NOVEMBER 11.

The President, SAMUEL G. DIXON, M.D., in the Chair.

Fifteen persons present.

A paper entitled "Notes on the Orthoptera of New Mexico and Western Texas," by James A. G. Rehn, was presented for publication.

The deaths of Thomas C. Price and Dr. Frederick Packard, members, were announced.

NOVEMBER 18.

Mr. ARTHUR ERWIN BROWN, Vice-President, in the Chair.

Fourteen persons present.

A paper entitled "Hymenoptera from Southern California and New Mexico, with Description of a New Species," by H. Viereck, was presented for publication.

NOVEMBER 25.

The President, SAMUEL G. DIXON, M.D., in the Chair.

Twenty-six persons present.

Herman T. Wolf and Lilian V. Sampson were elected members.

The following were ordered to be printed:

A LIST OF THE REPTILES AND BATRACHIANS IN THE HARRISON-HILLER COLLECTION FROM SUMATRA.

BY ARTHUR ERWIN BROWN.

The reptiles and batrachians collected in Sumatra in 1901 by Mr. Alfred Harrison, Jr., and Dr. H. M. Hiller, through the generosity of these gentlemen are now the property of the Academy. They were obtained at Goenong Soegi, Lampong District, below the elevation of 500 feet; and at Batu Sangkar, Tanah Datar, in the forest region of Padang, between 1,500 and 3,000 feet. In the following list of the species represented, these localities are respectively indicated by the letters L. and P.

REPTILIA.

CHELONIA.

Trionyx subplanus Geoff.	L., P.
Trionyx cartilagineus (Bodd.).	L.

LACERTILIA.

Hemidactylus frenatus (Schl.).	P.
Draco volans L.	P.

In both of the specimens, ♂ and ♀, the color is very dark-brown, so dark as to render all markings obscure. The ventral surface and under side of the wing membranes have a purplish tinge, with black spots on the latter which tend to run together transversely. In all details of scutellation they correspond to undoubted specimens of the present species.

Draco fimbriatus Kuhl.	P.
Draco hæmatopogon Gray.	P.
Calotes cristatellus (Kuhl.).	L., P.
Varanus salvator (Laur.).	L., P.

In No. 15,032, 380 mm. long, the ventral scales are perfectly smooth. In No. 14,492, 440 mm. long, they begin to show faint keels.

Tachydromus sexlineatus Daud.	P.

OPHIDIA.

Tropidonotus trianguligerus Boie. L., P.

In seven specimens which present the scutellation of this species, there is considerable variation in color. No. 15,040, from Goenong Soegi, has the general color dark olive and the spaces between the black lateral blotches are colored like the back. This specimen has the postoculars $\frac{3}{5}$ and the temporals $\frac{1}{2}$–3.

Tropidonotus chrysargus Schl. P.
Macropisthodon rhodomelus (Boie). L.
Macropisthodon flaviceps (D. and B.). L.
Zaocys carinatus (Gunth.). L.
Zamenis korros (Schl.). L.
Dendrophis pictus (Gm.). L., P.
Dendrelaphis caudolineatus (Gray). P.
Calamaria leucocephala D. and B. P.

The single specimen of this species is blackish above, yellowish beneath, a broad band of the light ventral color extending across the nape and the parietals.

Psammodynastes pulverulentus (Boie). L.

Compared with Bornean examples, this specimen has the ventral surface thickly speckled with black, forming four quite regular series in longitudinal lines.

Dryophis prasinus Boie. L.
Dryophis fasciolatus (Fisch.). P
Chrysopelea ornata (Shaw). P.

No. 15,006 has each scale with a conspicuous yellow spot. Ventrals black-edged.

Platurus laticaudatus (L.). L.

BATRACHIA.

ECAUDATA.

Rana tigrina Daud. P.
Rana erythræa (Schl.). P.
Rana chalconota (Schl.) P.
Callula baleata (Müll.). P.

No. 14,981 is a *Callula*, a genus which, as far as I am aware, has not heretofore been reported from Sumatra. In the absence of specimens for comparison, I see no reason to separate it from *C. baleata*, which occurs in Java.

Bufo asper Graven. P.

Three of the four specimens show red on the throat, and in one of them it extends over the sides of the body.

Megalophrys montana (Kuhl.). P.

This specimen has the supraorbital and nasal appendages well developed, and may be the form known as *M. nasuta* Schl., which is very doubtfully distinct. The fingers are very slightly webbed.

SYNOPSIS OF THE CARDITACEA AND OF THE AMERICAN SPECIES.

BY WILLIAM HEALEY DALL.

This paper is in continuation of the series of similar synopses of groups of bivalve shells which the writer has prepared during the last few years, including the *Leptonacea, Tellinacea, Veneracea, Lucinacea, Cardiacea,* etc. The present paper contains a summary of the groups included in the *Carditidæ* and the *Condylocardiidæ,* and of the species reported to inhabit the Atlantic and Pacific coasts of America. Doubtless with a better exploration of the tropical and South American waters some additions may be expected to the list.

The group is intimately related to the *Crassatellitidæ, Astartidæ* and *Chamidæ,* as shown by its paleontologic history, anatomy and development. There are no siphons, the border of the mantle is pierced for the excurrent orifice, while the incurrent orifice may or may not be complete, but in most cases seems to be formed by the apposition rather than the organic connection, ventrally, of the edges of the mantle. The gills are coarsely reticular and usually united behind the foot. In many, if not all, cases the young are developed within the body cavity of the mother and retained there until some progress in secreting the nepionic shell has been made, in addition to the completion of the prodissoconch. This incubation in one group takes place in the atrium of the ovary, in another in a specially developed fold of the ventral part of the mantle lobes which secretes and lines a shelly marsupium which is absent in the shells of male individuals.

The species are usually sedentary, and mostly secrete a byssus by which they fix themselves when young, and in one large group this condition continues through life. The sculpture is predominantly radial and often strong, the periostracum conspicuous and frequently pilose; the valves, except in abyssal and minute species, are usually solid and heavy and their margins strongly crenate. The ligament in the *Carditidæ* is strong and wholly external; in the *Condylocardiidæ* the resilium is immersed and the ligament feeble or obsolete.

The hinge-formula, when fully developed, as in *Carditamera*, is $\frac{\text{L } 01.01010.01}{\text{R } 10.10101.10}$, but in many forms the laterals are obsolete and the distal cardinals very feeble, coalescent with valve-margin or nymph, and hardly to be made out, so that in such forms as *Venericardia* the formula may be reduced to $\frac{\text{L } 0.0101.0}{\text{R } 0.1010\ 0}$. The hinge has never more than two left cardinals, the posterior one invariably long-drawn-out, a characteristic feature of the family, while the *Veneridæ* never have less than three left cardinals, so that convergent forms may readily be referred to their proper family. The teeth are usually finely striated. It is evident that with part of the hinge armature so liable to degeneration too much stress in classification must not be laid on such mutable features, and as a matter of fact the generally accepted subgeneric and sectional groups are chiefly based on external form, a character which proves unexpectedly constant when the groups are traced back through the line of their fossil progenitors.

The lunule is usually small, or even obsolete, and frequently unequally distributed between the valves, but when present is usually circumscribed by a deep, narrow sulcus, the termination of which on the inner left hinge-margin is frequently marked by a small but distinct pustule received into a dimple in the opposite valve; this pustule may or may not coincide with the left anterior lateral lamina. In *Beguina* the sulcus is so extended by the torsion of the hinge as to become tubular, though this perforation is probably closed by an organic plug in the living shell. The escutcheon is frequently linear or obsolete; when present it is usually limited by a ridge or keel. The pallial line is almost invariably entire, but in *Cardiocardita ajar* there is a broad posterior scar in front of the posterior adductor which simulates an indentation of the line and is probably caused by some enlargement of the siphonal muscles.

The valves are usually white within and the color of the exterior is dull, except in a few tropical species.

The group is of ancient origin and has Mesozoic representatives, but only those of Tertiary and Recent horizons will be considered here.

The living species are largely shallow water forms, especially the byssiferous types, but some of the minute species occur at considerable depths; the Arctic type, *Cyclocardia*, occurs in 822 fathoms (1,707 meters), and *Calyptogena* in 322 fathoms (669 meters).

In America *Cardita* s.s. and *Venericardia* s.s., *Miodon*, *Calyptogena*, *Milneria* and *Carditella* are restricted to the Pacific coast; while *Pleuromeris* and *Pteromeris* are known, so far, only from the Atlantic. The Pacific coast has twenty-seven and the Atlantic coast only twelve species of *Carditacea*, *Carditamera* with seven and *Cyclocardia* with fifteen being the most prolific in species.

Of those enumerated in this paper seven are new. It seems that the world musters, as a whole, only about sixty species; the two Americas thirty-nine, and the Pacific coast nearly half of all that are known.

The *Carditacea* are divided into *Carditidæ*, with the ligament and resilium external and united, and *Condylocardiidæ*, with the resilium immersed and the hinge in a more or less permanently imperfectly developed state.

The *Carditidæ* comprise two subfamilies: *Carditinæ*, with the marsupium dorsal, or superior, and not reflected in the structure of the valves; and *Thecaliinæ*, with the marsupium ventral, or inferior, and protected by an infolding or indentation of the inner shelly layer of the valves. The subdivisions of these groups are as follows:

Subfamily **CARDITINÆ.**

Genus **CARDITA** (Bruguière, 1792), Lamarck, 1799.

Type *Chama calyculata* Linné (+ *Mytilicardita* Anton, 1839; *Mytilicardia* Herrm., 1847).

Valves elongate-quadrate, strongly radially ribbed, very inequilateral and with a narrow byssal gape.

Section **Cardita** s.s.

Hinge with two left and three right cardinals, the laterals obsolete in the adult.

Section **Carditamera** Conrad, 1838.

Type *Cardita arata* Conrad.

Valves with the laterals well developed in the adult, the right anterior cardinal often obsolete. *Lazaria* Gray, 1854, and *Lazariella* Sacco, 1899, are synonymous.

Section **Glans** Megerle, 1811.

Type *C. trapezia* Linné.

Valves short, quadrate, convex; shell small; the posterior right cardinal often obsolete.

Subgenus **BEGUINA** Bolten, 1798.

Type *Chama phrenetica* Born, 1780.

Shell large, mytiliform, subcompressed, with feeble, radial sculpture, the umbones terminal, the hinge arcuate and drawn out, the lunule tubular, the posterior cardinals much elongated, the laterals absent. *Azarella* Gray, 1854, is synonymous. A single Indo-Pacific species is known.

Genus **VENERICARDIA** Lamarck, 1801.

Type *V. imbricata* Lamarck, Parisian Eocene.

Shell rounded-trigonal, strongly radially ribbed, lunule minute and deep, escutcheon linear, the hinge with two transversely striated cardinals in the left and three in the right valve, a sublunular pustule sometimes present in the left valve, but the laterals absent or obsolete.

Megacardita Sacco, 1899, is synonymous.

Subgenus **CARDIOCARDITA** Anton, 1839.

Type *Cardita ajar* Bruguière.

Hinge like *Venericardia* s.s., pallial line with a broad scar in front of the posterior adductor scar; *Agaria* Gray, 1847; *Actinobolus* Mörch, 1853, and *Azaria* Tryon, 1872, are synonymous.

Subgenus **COSSMANNELLA** Mayer Eymar, 1897.

Type *Cardita ægyptiaca* Fraas, Eocene.

Shell elongate-oval, the cardinal teeth feeble, the ribs slender and distant, the pallial line entire.

Subgenus **CARDITES** Link, 1807.

Type *Cardita antiquata* Linné (sp.) = *C. sulcata* Bruguière.

Shell like *Venericardia* s.s., but the anterior right cardinal absent, the laterals obsolete.

Section **Cardites** s.s.

Shell with external coloration, frequenting the warmer seas.

Section **Cyclocardia** Conrad, 1867.

Type *Cardita borealis* Conrad.

Shell white, with a rude periostracum; frequenting the boreal seas or cold abysses. *Arcturus* Gray, 1839, not Cuvier, 1829; *Actinobolus* Morse, 1869, and *Scalaricardita* Sacco, 1899, are synonymous.

Subgenus **PLEUROMERIS** Conrad, 1867.

Type *Cardita tridentata* Say, not Reeve.

Shell small, subtriangular, subequilateral, the hinge like *Venericardia*, but the anterior and posterior right cardinals feeble, the left valve with feeble anterior and posterior laterals.

Subgenus **PTEROMERIS** Conrad, 1862.

Type *Astarte perplana* Conrad.

Shell small, high, oblique, with narrow umbones, radial ribbing, a well-marked lunule and escutcheon, the hinge as in *Cardites*.

Coripia De Gregorio, 1885, is synonymous.

Subgenus **MIODON** Carpenter, 1864 (not of Sandberger, 1870).

Type *M. prolongatus* Carpenter.

Shell not very different from *Pteromeris*, but not compressed, and with the posterior (instead of the anterior) right cardinal absent and a posterior right and anterior left lateral developed feebly.

Subgenus **NEOCARDIA** Sowerby, 1892.

Type *N. angulata* Sowerby, South Africa.

Shell small, wing-shaped, resembling *Pteromeris*. Hinge as in *Cardites* except that long posterior laterals are said to be present, with no anterior laterals, the cardinals diminutive.

Genus **CALYPTOGENA** Dall, 1891.

Type *C. pacifica* Dall. Pliocene and Recent.

Shell large, oblong, chalky, with only faint concentric sculpture, a well-marked escutcheon, but no lunule, the inner margins smooth, an anterior lateral in each valve; hinge formula $\frac{\mathrm{L}\ .1010.10}{\mathrm{R}\ .0101.01}$.

Subfamily **THECALIINÆ.**

Genus **THECALIA** H. and A. Adams, 1857.

Type *T. concamerata* Bruguière (sp.), South Africa.

Shell like a small *Carditamera* externally; the female has in each valve a funicular infold of the inner layer ot the shell to serve as a marsupium, which, when the valves are closed, is completely internal; the male only a small byssal gape in the same region. Hinge with two cardinals in each valve, the posterior right cardinal absent, the middle right cardinal large and produced behind; there is an anterior lateral in each valve. The eggs are discharged into the marsupium, which is lined by a fold of the mantle, and remain there until the young shells are well advanced beyond the prodissoconch stage.

Genus **MILNERIA** Dall, 1881.

Type *Ceropsis minima* Dall, 1871. Recent. California.

Shell very small and trapezoidal, flattened on the ventral side; the female with a dome-like indentation of the ventral margins of the valves, which is closed below only by a fold of the mantle and not included within the closed valves; hinge with two left and three right cardinals, the posterior left lateral, posterior and anterior right cardinals minute and recognizable only in the best-developed specimens, which have the formula $\frac{\mathrm{L}\ 1.01010.}{\mathrm{R}\ 0.10101.}$. The male is byssiferous and the species habitually nestles on flat surfaces, particularly the backs of *Haliotis* shells.

The name *Ceropsis* being preoccupied since 1839 in *Coleoptera* by Solier, it was replaced by *Milneria*. The young are incubated as in *Thecalia*.

Cabralia (*Schmitzii*) Boehm, 1899, from the Miocene of the Azores, was referred to the *Carditidæ*, but appears to belong in the *Veneridæ* near *Venerupis*, its hardly sinuated pallial line being paralleled in *Chione*, etc.

Family **CONDYLOCARDIIDÆ.**

Genus **ERYCINELLA** Conrad, 1845.

Type *E. ovalis* Conrad (not of S. Wood). Miocene of Virginia.

Shell small, oval, radially sculptured, with the ligament external; the resilium internal and placed medially between two cardinals in each valve, the lateral edges of the chondrophore slightly raised, so as to resemble in some specimens two feeble cardinals; feeble elongate posterior right and anterior left laterals fit into grooves in the opposite valve margins; the inner ventral margins crenulate.

Subgenus **CARDITELLA** E. A. Smith, 1881.

Type *C. pallida* Smith. Magellan Straits.

Valve trigonal, with strong radial sculpture with two cardinals in each valve, of which the right posterior is ill defined, the resilium sunken behind the two developed cardinals; the ligament is feeble, but there is a developed anterior and posterior lateral in each valve.

Subgenus **CARDITOPSIS** E. A. Smith, 1881.

Type *C. flabellum* Reeve. Chile.

Like *Carditella* except that the ligament is obsolete and the resilium sunken between the beaks as in *Erycinella*.

Genus **CONDYLOCARDIA** Bernard, 1897.

Type *C. pauliana* Bernard. Atlantic Islands.

Shell minute, with conspicuous prodissoconch, the hinge teeth only partially developed out of the nepionic state, so that it is difficult to decide what portions of a continuous lamina should be regarded as cardinal or lateral; subject to this caveat, the formula of the hinge of the type species is $\frac{\mathrm{L}\ 1.10\mathrm{r}101.0}{\mathrm{R}\ 0.01\mathrm{r}010.1}$; when compared with $\frac{\mathrm{L}\ 0.10\mathrm{r}01.1}{\mathrm{R}\ 1.01\mathrm{r}10.0}$, which is the formula of *Erycinella*, the relationship is fairly evident; the sculpture is variable in the different species, but predominantly radial as a rule, the animal viviparous, another link with the *Carditidæ*.

EAST AMERICAN SPECIES.

Cardita (Carditamera) gracilis Shuttleworth, 1856.

Blanquilla, Tortuga and Margarita Islands, Dautzenberg; Porto Rico, Blauner; Virgin Islands, St. Thomas, Swift; Tampa Bay, Florida, Coll. U. S. N. Mus., 54,141.

This is a small and delicate representative of *C. arata* of the Florida Pliocene.

Cardita (Carditamera) floridana Conrad, 1838.

Cape Canaveral on the east coast of Florida, thence south and west through the Gulf of Mexico to Yucatan, in shallow water.

Cardita gibbosa Reeve, 1843, is synonymous. Conrad, in 1832, figured an East Indian species on the strength of a valve said to come from Tampa Bay, which he identified with Sowerby's *C. incrassata,* and which was renamed *C. conradi* by Shuttleworth in 1856. This has been referred by Tryon, in 1872, to Tampa Bay, but the species was undoubtedly exotic and should be expunged from American lists.

? Cardita (Carditamera) pectunculus Bruguière, 1792.

Gulf of Paria, Guppy; South America, Hanley; Madagascar, Reeve (?).

I feel some doubt as to the species thus named by Guppy, having seen no specimens. Lister's shell so named by Bruguière may have been a large specimen of *C. gracilis.* The shell figured under this name by Reeve is almost certainly the West American *C. affinis* Broderip, and his locality erroneous.

?Cardita (Carditamera) minima Guppy, 1867.

West Indies; Trinidad ? Guppy. Also Pliocene.

A small, apparently immature species from Matura, Trinidad, is listed by Guppy in 1867 and 1874 among his Pliocene species, and noted as occurring also in the Recent state. These might well be the young of *C. gracilis.*

Cardita (Glans) dominguensis Orbigny, 1853.

Cuba and St. Domingo, Orbigny; Cape Hatteras, N. C., and southward to Florida and the Gulf of Mexico, in 36 to 124 fathoms; U. S. Fish Commission steamer "Albatross."

Readily recognizable by its squarish form with bright and variable yellow, red and brown coloration in the southern part of its range.

Venericardia (Cyclocardia) borealis Conrad, 1831.

Ashe Inlet, Hudson Strait, R. Bell; Labrador, Stearns, in 3 to 10 fathoms; and southward in gradually increasing depths of water, as the surface grows warmer, to the vicinity of Cape Hatteras, where it has been found living to the depth of 250 fathoms, and dead valves to 435 fathoms; the latter may, however, have been disgorged by fishes after the digestion of the soft parts.

This species has been referred to Say's *V. granulata,* a Miocene form which is smaller, more ventricose and less oblique, with fewer ribs. It is, in part, the *Arcturus rudis* of Humphrey (MS.), according to Gray in 1839, and the *Cardita vestita* of Deshayes, in 1854. The young are attached to stones in shallow water by a slender byssal thread, but the shells do not gape and the adults form no byssus. The females are viviparous, containing a multitude of young at the proper season, which are retained within the mother until the adult type of sculpture succeeds the smooth prodissoconch.

The type is elevated, oblique, rather convex, with the body of the valves subcircular, covered by a pilose periostracum on which small hairs are arranged in radiating lines. There are from fifteen to twenty-one low radial ribs, which in the young are usually more or less beaded. This species has not been reported from Greenland or Spitzbergen. The average temperature for seventy-four localities where it was found living was [illegible]° F., the lowest [illegible] and the highest [illegible]° F.

Venericardia borealis var. novangliae Morse, [illegible].

Newfoundland to Cape Cod, sparingly, with the typical form.

All the Venericardias have a normal and a more elongated form, which is usually more compressed. After the examination of a very large series I find no other characters by which this variety may be separated from the type, those mentioned by Prof. Morse in his diagnosis being inconstant. The tendency is, however, for the number of ribs in the variety to be slightly less than in the type.

Venericardia (Cyclocardia) procera Dall, [illegible].

Off the mouth of the Rio Negro, Argentina, Wilkes Exploring Expedition.

Remarkably like *V. borealis*, but more compressed and with about [illegible] ribs. It should be compared with *V. compressa* Reeve, 1843.

Venericardia (Cyclocardia) armilla Dall, [illegible].

Between the Mississippi delta and Cedar Keys, Fla., in [illegible] to [illegible] fathoms, mud and sand, the bottom temperature [illegible]° to [illegible]° F., U. S. Fish Commission steamer "Albatross."

Small, convex, elevated, with 17–21 rather sparsely beaded ribs with subequal, cross-striated channels and a smooth lunule of moderate size. It is much more elegantly sculptured than the young of *V. borealis* of the same diameter.

Venericardia (Cyclocardia) moniliata Dall, 1902.

East of Rio Janeiro, in 59 fathoms, mud, bottom temperature 57° F.; U. S. Fish Commission steamer "Albatross."

Small, with rather large, distinctly limited, smooth lunule and escutcheon, and about 24 slender, closely beaded radial ribs, with subequal striated interspaces.

Venericardia (Pleuromeris) tridentata Say, 1826.

Off Cape Hatteras, N. C., and southward to Florida and the Gulf of Mexico, in 36 to 124 fathoms.

This is not the species figured by Reeve in 1843 under this name. The latter is an exotic. The present species is also found fossil in the Miocene and Pliocene Tertiary marls of the Atlantic coast.

Venericardia (Pteromeris) perplana Conrad, 1841.

Cape Hatteras, N. C., and southward to Florida and the Gulf of Mexico, from near low water to 52 fathoms. Also Upper Miocene and Pliocene of the Carolinas.

Small, oblique, wing-shaped, compressed and radially ribbed; sometimes rather bright-colored and always variable. *V. obliqua* Bush, 1885, is synonymous, and Conrad, after describing the fossil as a *Cardita*, put it, in 1845, in the genus *Astarte*, and, because of an earlier *Astarte perplana*, changed the specific name to *radians*. A year later he named the recent shell from Tampa Bay *Astarte flabella*. A shorter, more feebly sculptured form from the Yorktown and Duplin Miocene he named *Cardita abbreviata*, but this while the ruling form in the earlier beds is gradually supplanted by *V. perplana*, and I have not seen it in the Recent state.

Carditopsis smithii Dall, 1896.

Bermuda.

This is figured under the name of *Cardita dominguensis* Orbigny in the list of marine mollusks added to the fauna of the Bermudas by Verrill and Bush in *Trans. Conn. Acad. Sci.*, X, p. 517, Pl. LXIII, figs. 6, 7, 8, 1900. It is a minute brownish shell, subtrigonal in shape, with beaded radial sculpture and an internal resilium. No species of *Cardita* or *Venericardia* has as yet been identified from Bermuda.

Notes.

I have not been able to find in the literature the *Cardita minima* of Sowerby, to which Guppy refers a Recent and Pliocene form from Trinidad. The *Cardita "affinis* Shuttleworth" of Mörch's Poulsen catalogue, from the West Indies, is probably due to a momentary mental confusion between *C. gracilis* Shuttleworth and *C. affinis* of the Pacific coast. At any rate, I have not been able to discover any such species in the literature. *Cardita dactylus* Bruguière and *C. carditoidea* Blainville, from the Antilles, belong to *Coralliophaga.* *Cardita incrassata* Conrad is exotic, and *Cardita ovata* C. B. Adams, 1845, is *Venus pygmæa* Lamarck, as I have proved by an examination of the types at Amherst. I regard the Miocene *Venericardia granulata* Say, to which Conrad's *V. borealis* has been referred by Verrill and Bush, as sufficiently distinct. *Cardita arctica* Bruguière is referable to *Saxicava.*

West American Species.

Cardita Grayi Dall, 1902.

Cape St. Lucas, the Gulf of California and south to Panama and the Galapagos Islands.

Trapezoidal and inflated, this is a very recognizable species. The *Cardita incrassata* cited by Carpenter in 1864 from the Galapagos Islands is probably this species. It is *Cardita crassa* Gray in *Beechey's Voyage*, 1839, but not of Lamarck, 1819.

Cardita (laticostata) Sowerby,[1] 1832.

Guaymas, Mexico, and south to Panama and Guayaquil.

This shell has the aspect of *C. floridana*, but the hinge is destitute of lateral teeth, unless we regard the lunular pustule as a tooth. *C. tricolor* Sowerby, 1832, is a color variety, and *C. angisulcata* Reeve, 1843, has been claimed by Tryon, 1872, to be only a variety with flatter ribs and narrower channels. *Cardita turgida* Valenciennes, 1846, not Lamarck, 1819, is synonymous, according to Carpenter.

Cardita (Carditamera) affinis Sowerby, 1832.

Margarita Bay on the west coast of Lower California, the Gulf of California, and southward to Panama.

Large, elongate, with small cardinal teeth; the northern speci-

---

[1] Not *Cardita laticostata* Pusch, 1837.

mens darker colored and larger, forming the variety named *Lazaria californica* by Deshayes in 1852. The ribbing is relatively stronger in the young, and in the adult is often obsolete anteriorly. The animals adhere by a strong byssus and, when crowded, the anterior end is arcuate and attenuated; but when growing freely this is much less marked. A specimen has been figured by Reeve for *C. pectunculus* Brug.

Cardita (Carditamera) radiata Sowerby, 1852.

Punta Arenas, Costa Rica, to Panama Bay and Guayaquil, in 6 to 12 fathoms.

Very similar to *C. affinis*, but with a very different hinge and more checkered coloration. The lunule is also larger and wider than in that species. *C. arcella* Valenciennes, 1846, figured on the plates of the *Voyage of the Venus*, but never described, may, perhaps, have been intended for this species.

Cardita (Carditamera) subquadrata Carpenter, 1865.

Skidegate Channel, Queen Charlotte Islands, in 20 fathoms, Newcombe; Straits of Fuca and southward to the Santa Barbara Channel and Todos Santos Bay, Lower California.

Small, solid, subquadrate, speckled with brown. The soft parts are yellow with brown spots on the mantle edge.

Cardita (Glans) sulcosa Dall, 1902.

Panama Bay, in 18 to 30 fathoms, sand; U. S. Fish Commission steamer "Albatross."

Small, quadrate, variegated in color, with a deep sulcus in the posterior end which emarginates the border of the shell.

Cardita (Glans) naviformis Reeve, 1843.

Valparaiso, Chile, in 25 fathoms, sandy mud, Cuming.

Small, rectangular, very inequilateral, the beaks almost terminal, the posterior end squarely truncate, with 12–15 scaly ribs.

Venericardia crassicostata Sowerby, 1825.

Gulf of California and southward to the Galapagos Islands.

This fine, variably colored species is *Cardita flammea* Michelin, 1830, *C. tumida* and *varia* of Broderip, 1832. The differences are merely of color, the form being very uniform. The *Cardita crassicosta* of Lamarck is a typical *Cardita*, but if the name given by Sowerby in the Tankerville catalogue be thought too close, Michelin's name must be adopted.

Venericardia Cuvieri Broderip, 1832.

Gulf of Fonseca, in 11 fathoms, 7 miles off shore, Cuming; and south to Panama.

C. michelini Valenciennes, 1846, is synonymous. This fine species with heavy crenate ribs can hardly be mistaken for any other. It appears to be exceptionally rare.

Venericardia (Cyclocardia) spurca Sowerby, 1832.

Iquique, Peru, and southward to the west coast of Patagonia, in 61 fathoms, bottom temperature 54° F.

An inflated rotund species with about 20 narrow beaded ribs, with wider interspaces and covered with an olivaceous gray periostracum.

Venericardia (Cyclocardia) velutina Smith, 1881.

Port Rosario and Wolsey anchorage, 17 to 30 fathoms, sand and rock, Smith; west coast of Patagonia and Magellan Straits, in 77 to 369 fathoms, mud, bottom temperature 46° to 48° F.; U. S. Fish Commission steamer "Albatross."

Much like *V. spurca*, but a thinner and lighter shell more delicately sculptured, with a larger and longer lunule and a very much more delicate hinge. It has about 20 ribs.

Venericardia (Cyclocardia) compressa Reeve, 1843.

Valparaiso, Chile; Portland Bay, West Patagonia, and in 20 fathoms, stony and shelly bottom, Boija Bay, Smith.

I have not seen this species, but from the figures it must be close to Gould's *V. procera*, and if the species extends in the cold water on both coasts of the southern part of South America, as some others do, they may be identical, and in that case Reeve's name has precedence.

Venericardia (Cyclocardia) barbarensis Stearns, 1890.

Station 2,840, in the Santa Barbara Channel, in green mud, at the depth of 276 fathoms, and at Station 2,909, in 205 fathoms, bottom temperature 45.2° F.; U. S. Fish Commission steamer "Albatross."

Shell very thin and delicate, with about twenty low ribs, slightly granular in the young and becoming obsolete distally in the adult, the lunule small and obscure.

Venericardia (Cyclocardia) ventricosa Gould, 1850.

Puget Sound, U. S. Exploring Expedition; Vancouver Island (Newcombe), and southward to Los Coronados Islands off Lower California, living in 31 to 252 fathoms, soft bottom, temperature 43 2° to 58° F.

A small, plump, rounded species, with 20–21 low, broad, radial ribs, with shallow narrower interspaces, crossed by flattish narrow concentric ridges, recalling basket-work, and covered by a gray or yellowish-brown velvety periostracum, the hairs of which are disposed in radial lines. Gould's types comprised two species, of which one which he figured is selected to carry his name. The other, represented by a single specimen, was unfortunately figured as his type in *Proc. U. S. Nat. Mus.*, XIII, Plate XVI, figs. 5 and 6, in 1890. It was not until this revision was undertaken that the discrepancy was observed. Gould's diagnosis refers partly to each species.

Venericardia (ventricosa var.?) **Gouldii** Dall.

Station 2,923, in 822 fathoms, mud, off San Diego, Cal., bottom temperature 39° F.; U. S. Fish Commission steamer "Albatross."

Shell ovate, subcompressed, with 23 ribs, sculpture similar to that of *V. ventricosa* but feebler, with concentric ridges only in front of the low beaks, and the color paler, the lunule much smaller, and the lunular cardinals thin and feeble. The animal was alive when dredged and appears, from the dried remains, to have had a much smaller foot than *V. ventricosa.*

Venericardia (Cyclocardia) stearnsii Dall, 1902.

Puget Sound, with *V. ventricosa*, U. S. Exploring Expedition under Wilkes.

Shell short, plump, strong, with very high prosogyrate beaks and about 19 strong, rudely nodulous radial ribs with narrower interspaces and a dark-brown pilose periostracum. It has been figured as mentioned under *V. ventricosa*, having been erroneously taken as the type of that species by the writer. It is a much shorter and higher shell with a very small deeply impressed lunule and strong hinge, in which the lunular pustule in the left valve is conspicuous.

Venericardia (Cyclocardia) monilicosta Gabb, 1861.

Pleistocene of Santa Barbara, Cal., Jewett.

This resembles *V. ventricosa* Gould, but is more compressed, very much more equilateral, and has the lunule and the interspaces between the ribs deeper, and the latter more channeled. It has 17-18 ribs crossed by rounded concentric ridges with the radial channels sharply cross-striated. There are also marked differences in the hinge, which is much more delicate than in *V. ventricosa.* It has not yet been reported living, but is noted here because it has been united with some of the recent species by Gabb and Cooper.

Venericardia (Cyclocardia) incisa Dall, 1902.

Aleutian region, from Unalashka to the Semidi Islands, in 6 to 75 fathoms, sand or mud, Dall.

Shell small, with a polished yellowish-olive periostracum, with 18–20 flat radial ribs separated by linear incised sulci, and crossed by similar concentric sulci; interior white, often with a yellow flush in the cavity of the valves.

Venericardia (Cyclocardia) alaskana Dall.

Arctic Ocean, north of Bering Strait, from Point Barrow south to the Strait and Bering Sea, the south coast of the Okhotsk Sea, the Aleutian Islands, and eastward and southward along the Alaskan coast as far as the harbor of Sitka, in depths varying from 7 to 313 fathoms, with a bottom temperature from 35° to 46.2° F. Also North Japan, in 4–7 fathoms

This species is that which from the Pacific has usually been named *V. borealis* Conrad, and I can only ascribe the long acceptance of this determination, made by Dr. Carpenter, to the absence of a good series of the Eastern shell. After comparing them no one can hesitate to separate them specifically. There is a distance of several thousand miles between their nearest points of approach to each other in range, as far as known. In a general way, until Dr. Stearns looked into the matter in 1890, all the Pacific Cyclocardias were lumped together under the name of *borealis* Conrad.

The present species is ovate, compressed, with 23–25 uniform and elegant radial ribs with narrower interspaces, distinct to the margin of the shell and covered with a dark yellow-brown velvety periostracum, the hairs in close radial lines. The ribs are slightly granular near the low beaks; the lunule narrow and long. The hinge is solid, with the right anterior and posterior cardinals nearly obsolete; the interior is chalky white and is figured in the *Proc. U. S. Nat. Mus.*, XIII, Pl. XVI, fig. 8, under the name of *C. borealis.*

It attains a height of 35, a length of 39, and a diameter of 16 mm. The animal is viviparous and incubates an enormous number of young shells until the adult sculpture is fairly initiated. The brood is fully ripe in August in the Arctic Sea, and about June 1 in the Aleutian Islands. The variability of the shell is chiefly in outline, some specimens being longer than others.

Venericardia (Cyclocardia) rudis Gray, 1839.

Off the Sea Horse Islands, between Point Barrow and Icy Cape, in 23 fathoms, E. E. Smith; south through Bering Strait and Sea, among the Aleutian Islands, and eastward to Kadiak, in 10 to 60 fathoms, bottom temperature 35° to 45° F., Dall.

Shell squarish, compressed, with high, almost posterior beaks; the lunular region deeply indented; the hinge broad and massive; the interior white or more or less tinted with livid purple; sculpture of 12–16 low radial ribs, distally obsolete, with narrower shallow interspaces, with no granulations, covered by a smooth horny brown periostracum, often rude and eroded; height 29, length 31, diameter 16 mm.

Gray, in his description of the shells of Beechey's voyage to the Pacific and Bering Strait, cites *Arcturus rudis* Humphrey, MS., as a synonym of the Pacific shells which he identifies with *Cardita borealis* Conrad. As this is the only name associated with the Bering Strait shells except *borealis*, and it is evident that Gray recognized only one species among them, I have revived the name for the ruder form of the two known to inhabit that region. In well-developed specimens the hinge plate is relatively almost as broad and heavy as in *V. planicosta* Lam. It is easily distinguished from *V. alaskana* by the fewer ribs, smooth periostracum, and prominent beaks with the resulting broad hinge plate.

Venericardia (Miodon) prolongatus Carpenter, 1864.

Middleton Island, Alaska, in Lat. 59° 35′ N., in 12 fathoms, gravel, and south to Neeah Bay at the entrance to the Straits of Fuca.

A small, elevated shell, of pale gray color, and very much the sculpture of *V. incisa*. It is notable for its prominent beaks and oblique form and was figured in the *Proc. U. S. Nat. Mus.*, XIII, Pl. XVI, figs. 7 and 9, in 1890. Like the other species, it is viviparous.

Calyptogena pacifica Dall, 1891.

Clarence Strait, Alaska, in 322 fathoms, muddy bottom, temperature 42.4° F.; U. S. Fish Commission steamer "Albatross." Also fossil in the Pliocene of Los Angeles, Cal.

An oblong, heavy, dull and chalky shell with no radial sculpture and with a grayish-green periostracum over a nearly smooth surface.

Milneria minima Dall, 1871.

Monterey, Cal., south to Cerros Island, Lower California, usually nestling on the backs of the shells of *Haliotis*.

Originally described as *Ceropsis minima*, the generic name being preoccupied, was changed to *Milneria* in 1881. A minute, trapezoidal white shell, of which the females have a dome-shaped indentation on the ventral surface lined and closed by an extension of the mantle, in which the young are incubated. It is figured in *Proc. U. S. Nat. Mus.*, VIII, Pl. XXIV, figs. 4 to 7, and also in Fischer's *Manual*.

Carditella pallida E. A. Smith, 1891.

Port Rosario, Western Patagonia, in 2 to 30 fathoms.

A small fan-shaped whitish shell with an internal resilium and 12 to 15 strong radial ribs. There is a small external ligament.

Carditella semen Reeve, 1843.

Off Mexillones, Atacama Desert, Bolivia, in three fathoms, Cuming.

Ovate, olive-brown, with flattish ribs, very minute.

Carditella tegulata Reeve, 1843.

Valparaiso, Chile, in 25 fathoms, Cuming.

Said by Smith to differ from *C. pallida* by being more inequilateral, less triangular and has only twelve ribs. It is certainly very closely allied.

Carditopsis flabellum Reeve, 1843.

Valparaiso, Chile, Cuming; and the western part of the Straits of Magellan, in 61 fathoms, bottom temperature 47.9°; U. S. Fish Commission steamer "Albatross."

Differs from *C. pallida* by the greater delicacy of the lateral teeth, a larger resilium, and the absence of any external ligament, according to Smith.

NOTES.

Cardita nodulosa Lamarck is a Japanese species, but on Valenciennes' plates of the *Voyage of the Venus*, 1846, according to Carpenter, a West American species, probably *C. affinis* Sowerby, 1832, is so named by Valenciennes. In this citation and Carpenter's reprint by the Smithsonian Institution the name is misprinted *modulosa*, both in text and index. In Carpenter's *Report to the British Association*, 1864, p. 287, a "*Cardita incrassatus* Pfeiffer" is cited from the *Proceedings of the Zoological Society* for 1852, p. 157. No such species occurs in the locality mentioned, or anywhere in the *P. Z. S.*, or elsewhere that I have been able to discover. It is, perhaps, a case of misplacement of an index slip in the original MS. *C. incrassata* Conrad is said to be a variety of *C. antiquata*, and is not West American.

DESCRIPTIONS OF NEW SPECIES.

Venericardia (Cyclocardia) armilla n. sp.

Shell small, rounded, moderately inflated, nearly equilateral, white with a pale brownish periostracum; sculpture of from 17 to 21 well-marked, rounded ribs with subequal interspaces; these ribs are beaded with rounded or ovate nodules and continue to the ventral margin of the valves, the interspaces are conspicuously cross-striated; beaks full, elevated, prosogyrate, with a small, slightly impressed smooth cordate lunule and very narrow escutcheon; inner margins strongly crenate. Height 9, length 8, diameter 6 mm.

U. S. Fish Commission stations 2,399, 2,400 and 2,407, in the northern part of the Gulf of Mexico between the Mississippi delta and Cedar Keys, in 24 to 196 fathoms, bottom temperature 51° to 66° F. U. S. Nat. Mus., No. 93,370.

Venericardia (Cyclocardia) moniliata n. sp.

Shell small, rounded, moderately inflated, nearly equilateral, white, with 20 to 24 radial narrow ribs with wider, cross-striated interspaces; the ribs are sculptured with fine, small, sharp, close-set tubercles, the beaks small, nearly erect, the lunule lanceolate and smooth, the escutcheon similar but longer; internal margins minutely crenate; there is a distinct lateral and socket in each valve, the anterior lateral being in the left valve. Height and length 6.5, diameter 4 mm.

Off Rio Janeiro, Brazil, in 59 fathoms, bottom temperature 57° F. U. S. Nat. Mus., No. 96,132.

Venericardia (Cyclocardia) Gouldii n. sp.

Shell thin, ovate, inequilateral, moderately inflated with about 23 low, broad, rounded ribs with much narrower shallow interspaces, the anterior ribs slightly crenulated by fine transverse ridges, the ribs behind the umbones nearly smooth, covered by a yellowish-brown periostracum; lunule very small and impressed, escutcheon linear; inner margin crenulated below, hinge plate delicate, narrow, without marked laterals. Height 13.5, length 16.5, diameter 8 mm., the beaks somewhat eroded.

This species may possibly be a variety of *V. ventricosa*, corresponding in its relation to that species with *V. novangliæ* Morse, in its relation to *V. borealis*. But the probabilities are against it. The measurements of the two most related and geographically most adjacent forms are as follows:

V. ventricosa, height 17.5, length 19, diameter 15.5 mm.

V. stearnsii, height 14.5, length 13.5, diameter 11 mm.

Only one, a living specimen, of *V. Gouldii* was obtained at a depth of 822 fathoms, off San Diego, Cal. U. S. Nat. Mus., No. 109,270.

Venericardia (Cyclocardia) incisa n. sp.

Shell small, polished, with a smooth lively olive-green periostracum over 18 to 20 flat radial ribs separated by linear incised sulci and crossed by similar concentric sulci, about as distant as the ribs are wide, lunule almost obsolete, no escutcheon visible; beaks moderately high, somewhat anterior; hinge delicate, internal margins strongly crenate; siphonal end of the valves usually overgrown by a commensal minute hydroid; height 10, length 9.5, diameter 5.3 mm.

Numerous specimens were obtained at different localities. The types were compared with the Carditas in most of the Museums of Northern Europe and appeared distinct. Type from Unalashka in 16 fathoms. U. S. Nat. Mus., No. 109,267.

Venericardia (Cyclocardia) stearnsii Dall.

Venericardia ventricosa Gould, Proc. U. S. Nat. Mus., XIII, p. 216, 1890, *ex parte;* and Pl. XVI, figs. 5, 6.

Puget Sound

Venericardia (Cyclocardia) alaskana Dall.

Venericardia borealis Conrad, Proc. U. S. Nat. Mus. XIII, p. 216, 1890, *ex parte ;* and Pl. XVI. fig. 8.

Bering Sea.

Cardita (Glans) sulcosa n. sp.

Shell small, trapezoidal, with small elevated prosogyrate beaks, the lunule small and deeply impressed, escutcheon linear; from the beaks a wide and shallow sulcus extends to the lower posterior margin which it distinctly emarginates; sculpture of about 23 flat-topped ribs with much narrower channeled interspaces ; the ribs are crossed by concentric elevated ridges, thus producing annulations which are more conspicuous on the sides than at the top of the ribs; the coloration is of dark-brown, red-brown and white, more or less articulated on the ribs; interior white, the margins strongly crenulated. Height 7.5, length 8.5, diameter 6.5 mm.

The only form with which this might be confused is the young of *C. cuvieri*, which is less quadrate and has coarser sculpture and fewer ribs.

BIBLIOGRAPHY.

For the majority of the citations in the text, reference may be had to the bibliographical list in the synopsis of the Lucinacea, *Proc. U. S. Nat. Museum*, XXIII, pp. 781–784, but for those especially important for the *Carditacea* the following list is offered :

1792. BRUGUIÈRE, Encyclopédie Méthodique, I, p. 401.
1801. LAMARCK, Système des Animaux sans Vertébres, p. 123.
1807. LINK, Beschreibung der Rostock Sammlung, p. 153.
1824. BLAINVILLE, Dictionnaire des Sciences Naturelles, XXXII, p. 326.
1832. BRODERIP, Proceedings of the Zoological Society of London, pp. 55–56.
1832. SOWERBY, Proceedings of the Zoological Society of London, pp. 194–195.
1838. CONRAD, Fossils of the Medial Tertiary, p. 11.
1839. ANTON, Verzeichniss der Conchyliensammlung, p. 10.
1839. GRAY, Zoology of Beechey's Voyage to the Pacific, Mollusca, p. 152.
1840. GRAY, Synopsis of the Contents of the British Museum.
1841. CONRAD, American Journal of Science, XLI, p. 347.
1843. REEVE, Conchologica Iconica, I, Monograph of Cardita.
1845. CONRAD, Fossils of the Medial Tertiary, p. 74.
1847. GRAY, Proceedings of the Zoological Society of London, p. 194.
1852. DESHAYES, Proceedings of the Zoological Society of London, pp. 100–103.
1853. MÖRCH, Catalogus Conchyliorum . . . . comes de Yoldi, II, pp. 37–8.
1854. GRAY, Annals and Magazine of Natural History, XIV, p. 22.
1857. H. AND A. ADAMS, Genera of Recent Mollusca, II, pp. 486–488

1863. Conrad, Proceedings Academy of Nat. Sciences of Philadelphia for 1862, p. 578.
1864. Carpenter, Supplementary Report to the British Association, 1863, p. 642; and Annals and Magazine of Nat. History, 3d series, XIV, p. 424.
1866. Conrad, Checklist of Eocene Fossils of North America, p. 5.
1867. Conrad, American Journal of Conchology, III, pp. 12, 191.
1869. Morse, Annual Report Peabody Academy of Sciences, Salem, Mass., p. 76.
1870. Sandberger, Land und Süsswasser Conchylien der Vorwelt, p. 35.
1871. Dall, American Journal of Conchology, VII, p. 152.
1872. Tryon, Proceedings of Academy of Natural Sciences of Philadelphia, pp. 249–258.
1881. Dall, American Naturalist, p. 718.
1881. E. A. Smith, Proceedings of the Zoological Society of London, p. 42.
1885. Dall, Proceedings U. S. National Museum, VIII, p. 549.
1885. DeGregorio, Bollettino Società Malacologica Italiano, X, p. 153.
1890. Stearns, Proceedings U. S. Nat. Museum, XIII, pp. 214–220.
1891. Dall, Proceedings U. S. Nat. Museum, XIV, p. 189.
1892. Sowerby, Marine Shells of South Africa, p. 63.
1895. Dall, Proceedings U. S. Nat. Museum, XVII, p. 713.
1896. Dall, State University of Iowa, Natural History Bulletin, II, p. 16.
1896. Bernard, Bulletin Musée d'Histoire Naturelle à Paris, II.
1897. Bernard, Journal de Conchyliologie, XLIV, p. 197.
1897. Mayer Eymar, Journal de Conchyliologie, XLIV, p. 367.
1899. Boehm, Verhandlung. d. deutschen geol. Gesellschaft, Vol. 50, p. 37.
1899. Sacco, Bollettino dei Musei de Zoologia, Università di Torino, XIV, No. 349, pp. 111-112 (May); and Moll. dei terrene terziare del Piemonte e della Liguria, XXVII, pp. 5–23 (September).

NOTES ON THE ORTHOPTERA OF NEW MEXICO AND WESTERN TEXAS

BY JAMES A. G. REHN.

The great part of the material on which this study is based was collected for the Academy in the spring and early summer of 1902 by Mr. H. L. Viereck and the author. All specimens from Ysleta and El Paso, Tex., and Alamogordo, Cloudcroft and Highrolls, N. M., were thus collected. A general geographical and biotic study of the localities in the Sacramento mountain region, New Mexico, will be published later in these *Proceedings*.

Specimens belonging to the United States National Museum were examined in conjunction with the Academy material, and such specimens are designated in this paper by the initials of that institution. The loan of this material was secured through the kindness of Mr. W. H. Ashmead. The fine recent work by Messrs. Scudder and Cockerell[1] on the Orthoptera of New Mexico has proven of great value in studying this collection.

Family BLATTIDÆ.

Homœogamia subdiaphana Scudder.

Ten males, one female.

Alamogordo, Otero county, N. M. April 11, May 5 and June 6 and 7, 1902.

Highrolls, Otero county, N. M. June 8, 1902.

As the female of this species has not been described I append a short description:

Form ovate, the abdomen very broad. Pronotum similar to that of the male in general outline. Supraanal plate transverse, the posterior margin rounded and centrally emarginate.

General color wood-brown, edged on the pro- and mesonotum with ochraceous. Pro-, meso- and metanotum centrally ornamented with blotches of ochraceous, the penultimate abdominal segment bearing lateral blotches of the same tint.

---

[1] *Proc. Davenport Acad. Sci.*, IX, pp. 1–60, 1902.

Measurements.

Total length,	11.5 mm.
Length of pronotum,	4 "
Width of pronotum,	6 "
Width of abdomen,	8 "

The first specimen of this species secured was taken while flitting along a roadside through mesquite (*Prosopis*) and greasewood (*Larrea*) brush. Several specimens were subsequently taken near the same spot, but the remainder were all taken at light.

Family MANTIDÆ.

Litaneutria minor (Scudder).

One immature specimen.

Alamogordo, Otero county, N. M. May 1, 1902.

Family PHASMIDÆ.

Diapheromera sp.

One immature specimen.

Alamogordo, Otero county, N. M. April 23, 1902.

Family ACRIDIDÆ.

Subfamily Acrydiinæ.

Paratettix toltecus (Saussure).

Male and female.

Highrolls, Otero county, N. M. May 29 and 31, 1902.

Tettigidea lateralis (Say).

One female.

Sacramento mountains, N. M., 5,000 feet elevation. October 4, collected by C. H. T. Townsend (U. S. N. M.).

Subfamily Acridinæ.

Opeia obscura (Thomas).

Two females.

Sacramento mountains, N. M., 6,000 feet elevation. October 2, C. H. T. Townsend (U. S. N. M.).

Cordillacris[2] **occipitalis** (Thomas).

One female.

Alamogordo, Otero county, N. M. April 9, 1902.

---

[2] For use of this name in place of *Alpha* Brunner, see Rehn, *Canad Ent.*, XXXIII, p. 271.

Orphulella salina Scudder.

One female.

Sacramento mountains, N. M., 5,000 feet elevation. October 4, C. H. T. Townsend (U. S. N. M.).

Gomphocerus clavatus Thomas.

One male.

Cloudcroft, Otero county, N. M. May 24, 1902.

Psolœssa maculipennis Scudder.

Three males.

Alamogordo, Otero county, N. M. May 8 and 30, 1902.

One male.

La Cueva, Organ mountains, Donna Ana county, N. M., about 5,300 feet elevation. August 30, C. H. T. Townsend.

Psolœssa ferruginea Scudder.

Two males.

Alamogordo, Otero county, N. M. May 5 and 30, 1902.

Stirapleura pusilla Scudder.

Four males, eight females.

Alamogordo, Otero county, N. M. April 14, 24 and 26, May 9 and 30, 1902.

Highrolls, Otero county, N. M. June 3 and 11, 1902.

Stirapleura mescalero n. sp.

Type; ♀.

Highrolls, Otero county, N. M. June 9, 1902.

Allied to *S. tenuicarina* and *pusilla* Scudder, but differing from the former in the non-sulcate frontal costa, the carinate vertex, rectangulate fastigium and the shorter wings, and from the latter in the non-sulcate frontal costa, the carinate vertex, the subtrigonal lateral foveolæ and the shallower mesosternal lobes.

Form rather heavily built. Head with the vertex slightly tumescent and bearing a marked median carina; fastigium subelliptical and considerably excavated, the margins well raised and rectangulate anteriorly, the carina of the vertex being continued forward over the greater portion of the fastigium; lateral foveolæ subtrigonal, the antero-superior angle being subobsolete; frontal costa strongly constricted superiorly and also to a slight degree above the ocellus, lateral margins expanding inferiorly and becoming obsolete, the entire length plane and non-sulcate, the section inferior to the ocellus being rather heavily punctate; eyes subovate, but slightly longer than the infraocular portion of the genæ; antennæ not equaling head and pronotum in length. Pronotum moderately constricted mesially, the lateral carinæ being considerably expanded both anteriorly and posteriorly; median carina distinct, cut very slightly before the middle; posterior margin of the pronotum obtuse-angulate, the apex well rounded; lateral lobes subequal in width, the lower margin sinuate anteriorly, the surface finely granulate. Tegmina slightly exceeding the abdomen in length. Mesosternal lobes rather deep, considerably deeper than half the width of the interspace.

General color reddish-brown, the sides of the head, upper portions of the lateral lobes of the pronotum, pleuræ and V markings on the upper surface of the hind femora much darker in intensity than the general upper surface. Lower surface pale yellowish. Tegmina with traces of quadrate maculations in the distal half.

Measurements.

Length of head and body,	24.5 mm.
Length of pronotum,	4 “
Length of tegmina,	15.5 “
Length of hind femora,	12.5 “

Subfamily Œdipodinæ.

Arphia teporata Scudder.

Twenty-one males, nine females.

Alamogordo, Otero county, N. M. April 30, May 4, 5, 6, 8, 9, 12 and 16, 1902.

Highrolls, Otero county, N. M. May 29, June 2, 3, 12 and 13, 1902.

Encoptolophus costalis (Scudder).

One male.

Ysleta, El Paso county, Tex. April 2, 1902.

Encoptolophus parvus Scudder.

Twenty-four males, twenty-five females.

Sacramento mountains, N. M., 6,500 feet elevation. C. H. T. Townsend (U. S. N. M.).

Hippiscus corallipes (Haldeman).

Three males, four females, one immature.

Highrolls, Otero county, N. M. May 29, June 1 and 2, 1902.

Hippiscus zapotecus (Saussure).

One male, three females.

Highrolls, Otero county, N. M. June 11, 1902.

This species is very closely related to *H. corallipes* and quite difficult to separate.

Hippiscus pumilus Scudder.

Fourteen males, one female.

Cloudcroft, Otero county, N. M. May 21, 22, 23 and 24, 1902.

Only previous New Mexican record from Taos Valley, northern New Mexico.

Tropidolophus formosus (Say).

One female.

Luñas Well, Sacramento mountains, N. M. September 29, C. H. T. Townsend (U. S. N. M.).

Dissosteira carolina (Linnæus).

One male, two females.

Sacramento mountains, N. M., 5,000–6,500 feet elevation. October 3 and 4, C. H. T. Townsend (U. S. N. M.).

Lactista boscanus n. sp.

Type; female.

Ysleta, El Paso county, Tex. April 2, 1902.

Apparently allied to *L. pellepidus* Saussure, but differing in the lineato-rugose pronotum, the acute-angulate posterior process of the pronotum, and in the hyaline and unclouded margin of the apex of the wing.

General form deep, compressed. Head with the fastigium broad and very shallow, the margins but slightly elevated, anteriorly truncate; vertex rugose and bearing a central carina, which extends a considerable distance forward on the fastigium; frontal costa rather broad, expanded above the ocellus, non-sulcate, heavily punctate; eyes ovate, about equal to the infraocular portion of the genæ. Pronotum with the metazone lineato-rugose, the lateral lobes with comparatively slight rugosities; median carina low, most elevated on the prozona, the transverse sulcus well marked; posterior angle acute, the margin subconcave; posterior angle of the lateral lobes rotundate. Tegmina elongate, the costal field strongly developed basally. Posterior femora robust, the lower carina well developed but not strongly arched; posterior tibiæ shorter than the femora.

General color dull ashy-brown, dirty yellowish beneath; limbs and eyes suffused with reddish brown; antennæ dull brownish, finely punctate with a darker tint. Tegmina with faint traces of basal, median and pre-apical bands. Wings with the disk pale yellowish, the fuscous band rather broad, involving the posterior margin and sending out a rather broad but short humeral spur; apex hyaline, the nervures fuscous, the margins unclouded except the costal portion. Posterior tibiæ grayish-blue, with a dull glaucous pre-genicular annulus ; spines basally glaucous, terminally black.

Measurements.

Length of head and body,	21	mm.
Length of pronotum,	6	"
Length of tegmina,	22	"
Length of hind femora,	12.5	"

Mestobregma asperum (Scudder).

Twenty-four males, twenty-five females.

Sacramento mountains, N. M., 6,500 feet elevation. October, C. H. T. Townsend (U. S. N. M.).

Trimerotropis melanoptera McNeill.

Two males.

Sacramento mountains, N. M., 6,500 feet elevation. October 3, C. H. T. Townsend (U. S. N. M.).

Only previous record is the type locality—Silver City (Bruner).

Trimerotropis vinculata Scudder.

Seventy-five males, fifty females.

Sacramento mountains, N. M., 6,000–6,500 feet elevation. October 2 and 3, C. H. T. Townsend (U. S. N. M.).

Alamogordo, Otero county, N. M. April 9–30, May 1–16, June 7 and 9, 1902.

Highrolls, Otero county, N. M. May 29, 31, June 2 and 11, 1902.

Cloudcroft, Otero county, N. M. June 18, 1902.

El Paso, Tex. April 5 and 6, 1902.

Circotettix undulatus (Thomas).

Six males, twenty-four females.

Cloudcroft, Otero county, N. M. June 16–20, 1902.

Beulah, San Miguel county, N. M. August 17, 1901. Dr. Henry Skinner.

Heliastus aridus (Bruner).

Forty-one males, nineteen females.

Alamogordo, Otero county, N. M. April 10–May 16, 1902.

Highrolls, Otero county, N. M. May 31, 1902.

Ysleta, El Paso county, Tex. April 2, 1902.

This species exhibits an enormous range of color variation, varying from an extreme rusty form with a bluish cast to the tegmina, to a dull bluish-black form with an ashy suffusion on the head. Some specimens have the hind femora, wings and pronotum with strong maculations, while others are almost immaculate.

When at rest on the *Larrea* and mesquite plains this species is very hard to detect, and is frequently unnoticed until it is almost trampled under foot. The habitat of this species appears to be a purely desert one.

Brachystola magna (Girard).

One male, two females.

Organ mountains, Donna Ana county, N. M. September 27, C. H. T. Townsend (U. S. N. M.).

Sacramento mountains, N. M., 6,500 feet elevation. October 3, C. H. T. Townsend (U. S. N. M.).

Phrynotettix[3] **tshivavensis** (Haldeman).

One male and one female.

Alamogordo, Otero county, N. M. May 13, 1902.

El Paso, Tex. March 31, 1902.

Subfamily **Locustinæ**.

Campylacantha vegana Scudder and Cockerell.

One female.

Las Vegas, N. M. August, T. D. A. Cockerell.

Æoloplus elegans Scudder.

One male and one female.

Mesilla valley, Donna Ana county, N. M. October 8, C. H. T. Townsend (U. S. N. M.).

Æoloplus crassus Scudder.

One female.

White Sands, between the Sacramento and San Andreas mountains, N. M. September 30, C. H. T. Townsend (U. S. N. M.).

---

[3] For use of this name in place of *Haldemanella* see Rehn, *Proc. Acad. Nat. Sci. Phila.*, 1902, p. 595.

Melanoplus lakinus (Scudder).

One male.

Sacramento mountains, N. M., 6,500 feet elevation. October 3, C. H. T. Townsend (U. S. N. M.).

Melanoplus atlanis (Riley).

Two males, three females.

Sacramento mountains, N. M., 6,500 feet elevation. October 3, C. H. T. Townsend (U. S. N. M.).

Melanoplus altitudinum (Scudder).

Three females.

Cloudcroft, Otero county, N. M. May 22 and 26, June 17, 1902.

Melanoplus sapellanus Scudder.

One female.

Top of Las Vegas range, San Miguel county, N. M. June 28, 1902, H. L. Viereck.

Melanoplus femur-rubrum (De Geer).

Two males, six females.

Sacramento mountains, N. M., 5,000 feet elevation. October 4, C. H. T. Townsend (U. S. N. M.).

Melanoplus corpulentus Scudder.

Fourteen males, ten females.

Sacramento mountains, N. M., 6,500 feet elevation. October 2 and 3, C. H. T. Townsend (U. S. N. M.).

On comparison with Mexican specimens in the collection of the Academy these prove indistinguishable.

Melanoplus bivittatus (Say).

Two females.

Sacramento mountains, N. M., 6,500 feet elevation. October 3, C. H. T. Townsend (U. S. N. M.).

Melanoplus thomasi Scudder.

Two males, five females.

Sacramento mountains, N. M., 5,000 feet elevation. October 4, C. H. T. Townsend (U. S. N. M.).

This species was recorded from Tularosa only by Scudder and Cockerell (*Proc. Davenport Acad. Sci.*, IX, p. 51), and the locality given above is probably not very far distant from Tularosa, which latter lies about twenty miles to the north of Alamogordo.

Dactylotum variegatum (Scudder).

One female.

Luñas Well, Sacramento mountains, N. M. September 29, C. H. T. Townsend (U. S. N. M.).

The collection of the United States National Museum also contains specimens from Ojo Caliente, Rio Arriba county, N. M., and Huachuca, Cochise county, Ariz.

On a comparison of this species with *D. pictum* (Thomas), it will be seen that practically the only important diagnostic character is the shape of the tegmina.

a.—Tegmina elongate-ovate, at least twice as long as broad, *pictum* (Thomas).

aa.—Tegmina ovate, not more than half as long again as broad, *variegatum* (Scudder).

Family TETTIGONIDÆ.

Ceuthophilus uniformis Scudder.

One male and one female.

Beulah, San Miguel county, N. M. July 10, 1902, T. D. A. Cockerell.

Ceuthophilus pallidus Thomas.

Eighteen males, nineteen females.

Cloudcroft, Otero county, N. M. May 21, 23 and 26, June 19, 1902.

Udeopsylla vierecki n. sp.

Type; male (?).

Cloudcroft, Otero county, N. M. May 27, 1902, H. L. Viereck.

Differing from both previously known species of the genus in the smooth upper surface of the anterior tibiæ and the abbreviate character of the posterior tibiæ, which latter are shorter than the femora. This specimen was found dead and is rather badly mutilated, the extremity of the abdomen, the palpi, the median limbs, the labrum and clypeus, antennæ and the apical joints of the tarsi being badly damaged or gone.

I take great pleasure in dedicating this rather striking form to my friend and fellow-worker, Mr. H. L. Viereck, to whose tireless energy and perseverance the large entomological collection of the Alamogordo and Cloudcroft regions is entirely due.

General form heavy and obese. Head with the vertex but very slightly raised; eyes subtrigonal, flat. Pronotum broad, the anterior margin slightly emarginate centrally, truncate posteriorly. Metanotum deep, exceeding the mesonotum in lateral depth. Abdomen compressed, subcarinate superiorly. Anterior femora with a well-developed inferior median sulcus, the inner margin bearing one large and two small spines on the distal section; tibiæ flat above, heavily punctate and unarmed, below subsulcate and with three pair of spines, spurs four in number, the anterior external one very short and blunt. Posterior femora stout, the lower sulcus deep, the margins strongly beset with innumerable small teeth, the internal margin bearing the greatest number; tibiæ slightly bowed, the superior surface flat, with four to five pair of spines of the first and a few irregularly scattered spines of the second order, distal portion of the inferior surface with six recumbent spines, the upper pair of spurs slightly the longer.

General color ochraceous, suffused above with reddish-brown, the segments with their posterior borders blackish.

Measurements.

Length of head and body (approximately), ...	23	mm.
Length of pronotum, ...	9	"
Breadth of pronotum, ...	10.2	"
Length of hind femur, ...	19	"
Length of hind tibia, ...	17	"

Family **GRYLLIDÆ.**

Subfamily **Gryllinæ.**

Gryllus integer Scudder.

Four males, four females.

Highrolls, Otero county, N. M. May 31, June 2, 11, 13, 1902.

Gryllus alogus n. sp.

Type: ♀; Albuquerque, Bernalillo county, N. M., 1902. Collected by T. D. A. Cockerell.

Apparently allied to *G. armatus* Scudder,[4] but differing in the shape of the anterior and lateral margins of the pronotum, and in the different proportions of the calcaria of the hind tibiæ, as well as the coloration. No relationship exists with *G. personatus* Uhler,[5] or with *mexicanus* Saussure.[6]

---

[4] *Psyche*, IX, p. 293.

[5] *Proc. Ent. Soc. Phila.*, II, p. 547.

[6] *Miss. Sci. Mex., Orthopt.*, p. 402.

Size rather small and form comparatively slender. Head moderately large, slightly tumid, both on the occiput and genæ ; vertex declinate, broad and flattened; eyes oval. Pronotum about once and a half as broad as long, emarginate anteriorly, the posterior border slightly arcuate ; lateral margins tumid, surface obscurely punctulate ; lateral lobes shallow, the anterior angle obtuse, the lower margin sloping upward and backward to the rounded posterior angle. Tegmina moderately long, not much more than twice as long as the pronotum, the mediastinal view with three branches. Anterior and median limbs rather slight, compressed. Posterior femora moderately heavy, rather attenuate apically; tibiæ two-thirds as long as the femora, armed with 6–8 spines on each margin, the upper inner calcar distinctly shorter than the intermediate one. Ovipositor reaching to the apex of the outstretched metatarsus.

General color blackish-brown, the infraocular portion of the genæ and the humeral angle of the tegmina ochraceous, the veins of the mediastinal area being of the same color. Posterior femora orange-red, becoming dull-brownish posteriorly.

Measurements.

Length of head and body,	17.5	mm.
Length of pronotum,	4	"
Length of tegmina,	9	"
Length of hind femora,	11	"
Length of ovipositor,	15	"

Miogryllus lineatus (Scudder)?

One immature male.

Alamogordo, Otero county, N. M. April 25, 1902.

This specimen is very questionably assigned to this species, and a number of characters show considerable difference from the description. Considering the apparently immature condition of the specimen I think this the best course to adopt.

Subfamily **Œcanthinæ.**

Œcanthus sp.

One immature female.

Alamogordo, Otero county, N. M. June 9, 1902.

This species is in all probability undescribed and shows closest relationship with *Œ. niveus* and *angustipennis*.

HYMENOPTERA FROM SOUTHERN CALIFORNIA AND NEW MEXICO, WITH DESCRIPTIONS OF NEW SPECIES.

BY H. VIERECK.

This paper is the result of a study of material collected in the year 1901 and received for identification from Prof. Cockerell. Unless otherwise stated, he is the collector of the specimens under consideration.

Melissodes montana Cress.

Three ♀♀, 10 to 12 mm. in length. The abdominal fasciæ vary from ochreous to whitish.

San Pedro, July 4, 11.

Specimens in the Coll. Am. Ent. Society represent the originals only and are from "Colorado" and "New Mexico" (Cresson Coll.).

One ♂, La Jolla, August, has the dorsum of thorax covered with an ochraceous pubescence. The clypeus is all yellow, a black dot on each side.

Diadasia rinconis opuntiæ Ckll. (Det. Ckll.).

San Pedro, July 27, at flowers of *Opuntia.*

Diadasia australis Cress.

One ♂, San Bernardino, July 6, on sunflower. Specimens in Coll. Am. Ent. Society represent only "Colorado" and "Texas."

Nomada formula n. sp.

Black, marked with yellow; apex of wings cloudy; metathorax with a bare, satiny, triangular area.

♀.—Length 8 mm. Labrum closely indistinctly punctured. Clypeus closely punctured, the yellow area above clypeus and the yellow areas on the sides of the face more distinctly punctured, the punctures a little wider apart. The black part of the head closely distinctly punctured. Cheeks dullish, indistinctly sculptured. Head covered with a fine silvery pubescence, not so heavy as to obscure any characters. First joint of flagellum at least one-fourth longer than the second. Pronotum punctured on the anterior margin. Dorsulum sub-opaque, closely punctured. Tubercles apparently impunctate. Tegulæ with well-separated punctures. Mesopleuræ punctured much like dorsulum. Scutellum with a median longitudinal impression, covered with shallow punctures. The parts of the posterior face of metathorax adjoining the area covered with a thin whitish appressed sort of pubescence. The rest of the thorax and the greater part of the legs covered with pubescence similar to that on the head. The pubescence on the inner sides of the tarsi of a pale golden tint. Wings hyaline, apical and marginal cell smoky, stigma pale brown, nervures dark brown, transverse median nervure interstitial. Abdomen finely closely punctured, covered with whitish pubescence in the same degree as the head and thorax, apical dorsal segment silvery.

Black; labrum, clypeus, base of mandibles, supraclypeal mark, lateral face marks which border the eye extending nearly to the top and over to the insertion of antennæ, apical dot on scape, pronotum, tubercles, tegulæ, a dot below, an almost rectangular mark below this on the mesopleuræ, a dot on scutellum at each corner of scutellum, the scutellum, postscutellum, a spot on each side on the under side of mesothorax, the four posterior coxæ in front, an apical mark on all femora, the tibiæ chiefly on the outside, the tarsi in front, an almost even band on the first segment separated from the apex by a narrower brown band, second segment with an emarginate band, third, fourth and fifth segments with regular bands, *yellow.* Flagellum beneath light brown, above dark brown. The four anterior legs with their coxæ, femora and tibiæ in part testaceous to almost ferruginous.

Type, Coll. Acad. Nat. Sci. Philadelphia.

Type locality, San Pedro, Cal., July 11.

One ♀. This comes near *modesta,* but is distinguished at once by the characters in the diagnosis. Cotype, one ♀, same place and date as the type.

Sphecodes mandibularis Cress.

One ♀, San Pedro, July 11 (T. D. A. Cockerell).

Previously recorded from Texas (Belfrage); Ottawa, Can. (Harrington); Carlinville, Ill. (Robertson); Mesilla valley, N. M. (Cockerell).

Colletes californicus Prov.

Two ♂♂, La Jolla, August.

Provancher's description is very brief, but this is doubtless the species he had before him; a fuller description is submitted.

♂.—Length 8 mm. All of face below antennæ hidden by a long white pubescence. Above the antennæ the face is closely punctured, opaque, the pubescence sparser, yellowish. Cheeks with whitish pubescence, space between eyes and base of mandibles a little less than width of the latter at base, labrum polished, divided into five ridges, the one in the middle broadest, with a dent near its base. First joint of flagellum apparently a little shorter than the second. Dorsulum closely punctured, opaque, shiny in front, the punctures a little larger than those on top of head. Pubescence on dorsum of thorax the same color as that on top of the head. Mesopleuræ as closely punctured as possible without being confluent, punctures about the same size as those on dorsulum, pubescence white like on the cheeks. Disk of metathorax divided into about eight deep, shining, square pits, by narrow longitudinal ridges. Enclosed space on posterior face of metathorax not exactly smooth nor highly polished, triangular in shape and wider at base than long. The adjoining areas indistinctly sculptured, subopaque. Legs covered with loose white hairs. Wings perfectly clear, the nervures and stigma dark brown. First recurrent nervure received in about the middle of the second submarginal cell, the same cell about three-fourths as long on the radius as on the cubitus. Transverse median nervure interstitial, curved out. Abdomen subopaque, closely finely punctured. The first segment with loose hairs, those on remaining segments sparser. All the segments, except the apical, with an apical distinct fascia of appressed pubescence. On top of the abdomen the pubescence is pale yellowish, to the sides whitish. The apical segment is covered with a fine appressed, whitish pubescence.

Black; spurs white, claws dark brown.

The other specimen has the pubescence above, whiter, and the dent on the middle ridge of labrum continued into a longitudinal fovea; otherwise identical.

Ceratina dupla Say.

One ♀, 5 mm. in length. Alpine Tavern, Mt. Lowe, August 12.

Spilomena foxii Ckll.

One ♀, San Pedro, July 16 (W. P. and T. D. A. Cockerell). The only other record, that of the unique type, is Santa Fé, N. M. (T. D. A. Cockerell).

Stigmus fulvipes Fox.

Three ♀♀ found burrowing in a sandbank at San Pedro, July 6 (W. P. and T. D. A. Cockerell). Only the unique type from Los Angeles, Cal. (D. W. Coquillet), was heretofore known.

Notogonia nigripennis occidentalis n. subsp.

♀.—Length 16 mm. Differs from the typical form by the smoother sculpture and short longitudinal impressed line on each side of dorsulum, by the duller and more finely sculptured scutellum and by the medial longitudinal impression of the postscutellum. The flagellum is approximately as long as head and thorax. The flagellum of *N. æqualis* is distinctly longer than the head and thorax, measuring 10 mm. in the type (♀) and consequently 2 mm. longer than length of head and thorax (8 mm.).

The only specimen of *N. nigripennis* heretofore recorded is the unique type in Coll. Am. Ent. Society, from "New York." This is a most interesting find, and shows how little we know of the distribution of certain species.

Eucerceris insignis Prov.

Eucerceris insignis Prov. Add., Hym. Queb., p. 418, 1888 (♂ not ♀).
Cerceris provancheri D. T., Wien. Ent. Zeit., IX, 1890, p. 204.

One ♂, La Jolla, August, at flowers of *Erigonum fasciculatum*. It is evident from Provancher's description that he described a ♂ and not a ♀.

Cerceris cockerelli n. sp.

Entire tegument strongly, more or less closely punctured.

♂.—Length 7.5 mm. Clypeus dullish with small punctures and large, close, somewhat indistinct punctures, the rest of the face below the insertion of antennæ with large, rather indistinct punctures more separated than on clypeus, the spaces between the punctures minutely punctate; area in the middle of the face broad, flat anteriorly, abruptly and decidedly keeled posteriorly between the insertion of antennæ, the face below antennæ covered with a close, fine, silvery pubescence and sparser longer hairs, head above the antennæ with strong, separated punctures, the space between them polished. Space between posterior ocelli a little less than that between them and nearest eye margin, cheeks with deep separate punctures, not as strong as on top of head, the space between the punctures rather opaque, minutely punctured. The head and cheeks with fine long hairs. First joint of the flagellum about one and a half times as long as the second. Pronotum, dorsulum and scutellum covered with large, distinct, separated punctures, the space separating them polished, postscutellum sparsely punctured, shining, mesopleuræ strongly and coarsely punctured. Enclosed space of metanotum triangular with longitudinal sulcæ medially, polished transverse striæ radiating to each side of anterior half of sulcus, the rest of the metanotum deeply, almost confluently punctured and shining, mesopleuræ punctured, becoming impunctate near the suture; from the base of the metapleuræ rise two oblique raised lines, joining to form an acute angle, the apex pointed forward; the margins of the metapleuræ make this a triangle, with the base incurved anteriorly. Entire thorax pilose like the head around the ocelli, legs ciliate and more or less distinctly covered with a fine appressed pubescence. Wings subhyaline, nervures at base reddish, nervures and stigma brown, apical cell especially infuscated. First segment of abdomen with a small polished triangular impression, abdomen dorsally uniformly sculptured, with deep separated punctures, shining. Pygidial area practically oblong, strongly margined, deeply punctured, shining, covered with sparse hairs. The abdomen sericeous, all the dorsal segments distinctly pilose.

Black; base of mandibles, all of the face below the insertion of antennæ, a short distance above bordering on the eyes, front of scape, interrupted band on pronotum, tegulæ, spot on mesopleuræ, two spots on scutellum, postscutellum, apical third of femora, posterior trochanters, tibiæ except apical spot on posterior ones, first joint of tarsi, two spots on first dorsal segment almost united, a band on first dorsal segment almost united, a band on all the other dorsal segments (except apical) narrow medially and lateral spots on ventral segments three, four and five, *yellow*. Flagellum beneath orange, apical tarsal joints more or less testaceous.

Related to *C. insolita* Cress., from which it is distinguished by its uniformly different sculpture.

Type locality, La Jolla, Cal., August, 1901 (T. D. A. Cockerell).

Type, Coll. Acad. Nat. Sci. Philadelphia. Cotype, one ♂, same place and date.

Philanthus crabroniformis Sm.

Philanthus crabroniformis Sm., Cat. Hym Brit. Mus., IV, 474, 1856, ♂.
Philanthus multimaculatus Cam., Biol. Cent. Am. Hym., II, 133, 1891, ♂.
Philanthus anna Dun., Ent. News, VIII, 68, 1897 (♂ not ♀).
Philanthus cleomæ Dun., Can. Ent., XXX, 152, 1898, ♀.

One ♂, La Jolla, August. Two ♂♂, San Pedro, July 10. A variable species, but distinguished from its relatives by the produced front of male, the sparse deep punctures of dorsum and the closer deep punctures of abdomen common to both sexes. In the male the front has a medial longitudinal impression, or is smooth, or with a slightly raised line; an analogous variation appears in the front of the ♀, the color pattern is also variable, more elaborate or less than the pattern described by Smith. This species is recorded from Colorado, Washington, New Mexico, California (type locality), Oregon and Montana. The Colorado specimens are the more strongly colored.

Philanthus pacificus Cress.

Two ♂♂, San Pedro, Cal., July 9.

Diploplectron brunneipes Cress.

One ♀, identical in size, structure and sculpture with the type from Nevada; it differs in color of the prothorax which is black, and in the darker antennæ, tegulæ and legs; the abdomen is black with exception of the apex of pygidium.

San Pedro, July 11.

Mygnimia ustulata Dahlb.

One ♂, La Jolla, August.

Cryptocheilus flammipennis Sm.

Two ♀♀, San Pedro, July 27. Another ♀ in Coll. Am. Ent. Soc. from Palo Alto, 1891 (Leland Stanford, Jr., Univ.).

Hemipogonius subopacus Cress.

One ♀, San Pedro, July 28 (A. Springer). Pennsylvania is the only locality so far known for this species represented by the unique types ♀ and ♂. It seems quite strange that it should be found on the Pacific coast. A careful comparison reveals no specific difference between this specimen and the type: the wings are merely darker with a stronger violaceous reflection. One ♂ at the same place and time (T. D. A. Cockerell).

Agenia accepta Cress.

One ♀, La Jolla, August. Wings uniformly fuscous, apical border paler. Specimens from Atco, N. J., June, 1897 (C. W. Johnson), Dakota, Texas, Las Cruces, N.M., October 19, found dead (Ckll.), have wings mottled as in the type from Georgia.

Agenia euphorbiæ n. sp.

♂.—Length 4 mm. Head apparently impunctate, opaque, face below antennæ covered with appressed silvery pubescence, space between posterior ocelli a little less than that between them and nearest eye-margin, first joint of flagellum as long as or a little shorter than the second. Thorax dull, covered with very fine silvery pubescence, apparent only in certain lights. Wings almost uniformly darkened, pale brown, nervures and stigma dark brown Abdomen shining, somewhat compressed, covered with a finer and less apparent pubescence than the thorax. First segment not distinctly petiolate, about twice as long as broad at apex. Legs very finely sericeous. Second submarginal cell along the cubitus a little longer than the first.

Black, tibiæ and tarsi brownish. Apical dorsal segment with a white spot.

Type, Coll. Acad. Nat. Sci. Philadelphia.

Type locality, San Pedro, Cal. Related to *A. petiolatus* Cress., from Illinois, but smaller and without a distinctly petiolate first abdominal segment.

One ♂, July 27, on *Euphorbia.*

Anoplius (Pompilinus) padrinus n. sp.

♂.—Length 4.5 mm. Head impunctate, subopaque, face below antennæ covered with appressed silvery pubescence, on the rest of the head the pubescence is so fine as to be almost invisible. Space between posterior ocelli about equal to that between them and nearest eye-margin, first joint of flagellum distinctly shorter than the second. The entire tegument has a bluish sheen to it, the thorax is covered with a very fine silvery pubescence apparent only in certain lights, on the under side and on the coxæ it is heaviest. A faint furrow down the middle of the metathorax. Abdomen polished, slightly dull, with a very fine pubescence. Legs silvery sericeous. Second submarginal cell almost narrowed to a point on the cubitus. Wings smoky, bluish and iridescent in certain lights. Black with a bluish cast. The legs black.

Type, Coll. Acad. Nat. Sci. Philadelphia.

Type locality, San Pedro, Cal.

One ♂, July 27, on *Euphorbia*. Much like *A. cylindricus* Cress., but that is duller and has a petiolate submarginal cell.

Anoplius (Pompilinus) marginatus Say.

One ♂, San Pedro, July 11.

Pedinaspis planatus Fox.

Two ♂♂, La Jolla, August. First record of the ♂. Aside from the ordinary sexual characters this is just like the female.

Vespa occidentalis Cress.

La Jolla, August. One ♀.

Ancistrocerus halophila n. sp.

Clypeus finely, head and thorax above closely, coarsely punctured. Sides of metathorax produced, but not into a sharp point. Black on second abdominal segment hour-glass pattern.

♂.—Length, 9 mm. Clypeus bidentate, sparsely punctured, slightly produced across the middle, with sparse rather long slender hairs. Front and vertex with close coarse punctures, dull pilose, space between posterior ocelli a little larger than that between them and nearest eye-margin, head posteriorly bounded by a strong margin which joins the malar space close to the margin of the eye. First joint of flagellum about one and a half times as long as the second. Angles of the pronotum, produced though not sharply. Pronotum, mesonotum and dorsulum almost uniformly, coarsely and closely punctured, pilose like head, the dorsulum with a median impressed line anteriorly; tegulæ shining, sparsely punctured, mesopleuræ more closely punctured and less distinctly than mesonotum, pilose, metapleuræ rugulose dull, the middle of the margin produced into a short blunt tooth. The posterior face or basin of metathorax enclosed by well-defined margins laterally, roughened, dullish, a median raised line extending up three-fourths its height, and diverging into two raised lines before the upper margin of the basin. Tarsal claws cleft. Wings subfuscous, marginal cell and an apical margin near the marginal cell deeply clouded, nervures of basal half of wing and stigma yellowish ferruginous to ferruginous, nervures of apical half dark brown, second submarginal cell narrowed about one-half on the radial nervure, the third hardly narrower on the radial than on the cubital nervure. Punctures of first dorsal segment coarser and closer than on the others, a median longitudinal line on the sides and apically, face of truncation shining, sparsely punctured. The succeeding dorsal segments becoming almost smooth basally, finely punctured before the maculated border, the latter distinctly closely punctured.

Black; mandibles except base and apex, clypeus, a short line bordering eyes below emargination, a spot between antennæ, front of scape, a small spot behind the eyes, a broad line on pronotum, a spot on mesopleuræ, greater part of tegulæ, a spot on each side of scutellum, a line on postscutellum, tibiæ, tarsi, part of femora, an apical band on first dorsal segment dilated at the sides, an apical band on second dorsal segment and a cuneiform mark extending in obliquely from the lateral border of the apical band, second ventral segment with an undulated apical band, separated narrowly from a large blotch which takes up nearly all the area, the other segments (apical one excepted) with an apical band, *yellow*. Hook and part of the eighth, ninth and tenth joints of the flagellum ferruginous, apical tarsal joints and claws more or less darkened.

Type, Coll. Acad. Nat. Sci. Philadelphia.

Type locality, San Pedro, Cal.

Type and one paratype July 9, another paratype July 27. One, La Jolla, August. The La Jolla specimen has a yellow line on the lateral margin of metathorax. Allied to *A. sulphureus* Sauss., but distinct by the closely arranged punctuation of head and thorax and the more opaque appearance of these parts.

Odynerus rufobasilaris Ashm.

One ♀, Alpine Tavern, Mt. Lowe, altitude 5,000 feet, August 12, on flowers of *Eriogonum polifolium*. Beside the characters given in the original description this species has the lateral angles of the metathorax produced into two long, sharp points.

Tetrachrysis nortoni Aar.

One ♀, San Pedro, July 11.

Elis plumipes Dru.

One ♀, two ♂♂, Coronado, July 31.

Photopsis unicolor Cress.

La Jolla, August. One ♂. An interesting variation, having the posterior half of thorax and the legs blackish. This is the first time the species is recorded from any definite locality.

Photopsis lingulatus n. sp.

Allied to *albicincta*, but distinct by the more sparsely haired abdomen and the almost impunctate second abdominal segment.

Length, ♂, 11.5 mm. Clypeus truncate, the truncation slightly rounded. Mandibles obliquely truncate, slightly notched near the middle of the inferior edge, the truncation tridentate, the apical tooth strongest, the middle one weakest, front with a median furrow extending down from the anterior ocellus to between the insertion of antennæ, front almost smooth, polished like the rest of the head, which has shallow, indistinct punctures. Space between posterior ocelli greater than that between them and the anterior ocellus and greater than the space between them and nearest eye-margin. Lower margin of eyes almost contiguous with the insertion of mandibles. First joint of flagellum about three-fourths the length of the second. Prothorax rather coarsely reticulated, only on the sides is there a small area almost smooth. Mesonotum with deep, good-sized, separated punctures; parapsidal groove distinct, deep, extending back almost to the posterior margin. The lateral furrows merely indicated by faint lines. Scutellum convex, with shallow, almost confluent punctures; postscutellum dullish in contrast to the other parts of the thorax which are shining, sculpture indefinite. Disk of metathorax with a broad almost quadrate polished area, the rest of the metathorax, excepting the greater part of the metapleuræ, very distinctly netted, the meshes large, the pits shining. Mesopleuræ bulged outward along the middle, the bulged surface irregularly reticulated, bounded by an irregular ridge formed by the termination of the reticulation. The depressed portion of the mesopleuræ with shallow punctures on the greater part, partly smooth, mesopleuræ below with a few obscure punctures, above smooth and shining. Petiole not strongly convex, about twice as long as broad at apex, shining, roughened on the basal half, with a few indistinct punctures on the apical half. Second segment polished dorsad, the punctures are fine and well separated or sparse. Ventrad the punctures are seemingly stronger, on the basal half no distinct punctures. Rest of the segments finely sculptured to polished on basal half, the apical half hairy, a small puncture seems to be at the base of each hair. On the basal two-thirds of the third segment in the middle there is a curious area like a transverse half of an ellipse, with the rounded portion pointed toward the apex of the segment, this has a subtle surface, neither shining nor exactly dull, with an opalescent cast. A furrow of grayish felt-like pubescence close to the margin of the second dorsal segment. There is no furrow with felt-like pubescence on the second ventral segment. The wings have the third submarginal cell very faintly indicated, except at the lower corner, where it is altogether erased, not a trace of a second recurrent nervure. The insect is almost uniformly covered with a moderately abundant fine, long, pale pubescence, that on the abdomen sparsest, pubescence of dorsulum stronger, shorter, of a golden tint.

Rather brownish testaceous; space between ocelli, tips of the mandibles, and parts of the femora almost black. Flagellum brownish. Tibiæ and tarsi very pale brownish. Stigma very dark brown, nervures smoky testaceous.

Type, Coll. Acad. Nat. Sci. Philadelphia.

Type locality, La Jolla, Cal.

One ♂, August.

ODONTOPHOTOPSIS n. g.

Erected for the reception of those species having the anterior margin of the mesosternum armed with two processes.

Type, *Odontophotopsis exogyrus* n. sp.

Odontophotopsis exogyrus n. sp.

Process of mesosternum in the shape of a broad projection pointed straight down, having the appearance of being bidentate, one tooth sharper than the other.

Length, ♂, 12.5 mm. Clypeus concave, polished. The entire head almost uniformly covered with well-separated medium punctures, an indistinct furrow extends from the anterior ocellus to between the insertion of antennæ. Posterior ocelli more than twice as far apart as they are distant from the anterior one, the distance between the posterior ocelli less than that between them and nearest eye-margin. Lower margin of eyes almost contiguous with insertion mandibles. Mandibles strong, decidedly curved, with a strong uperior and inferior margin, deeply emarginate on the lower margin, the emargination extending in, one-half of the width, the part of the mandible beyond this narrow, oblique, strongly margined. First joint of flagellum about three-fourths the length of the second. Prothorax rugose. Dorsulum with strong separated punctures, the furrows of about the same degree, none strong, merely impressed lines, starting about one-third the distance from the anterior margin of the dorsulum and extending back to the posterior margin. Scutellum large, coarsely sculptured, postscutellum indistinctly sculptured, propleuræ rough above, smooth below, mesopleuræ with indistinct shallow punctures on the depressed part, the bulged part reticulated but not margined, on the posterior border smooth and polished. Disk of metathorax with an oblong area bisected by a longitudinal ridge. An almost triangular area to each side of the enclosure, the rest of the metathorax except the lower half of metapleuræ reticulated, the meshes on the posterior face largest, the lower half of metapleuræ deeply depressed, making a channel which is smooth and shining. A median raised line extends from the deepest part of the impression back almost to the posterior coxæ, where it helps to make a narrow channel, which is thus separated from the rugose area adjoining the coxæ. Third submarginal cell entirely obliterated, as is the second recurrent nervure. Petiole nearly twice as long as broad at apex, convex but not strongly so, punctures rather shallow, not sharply defined, rather close together near the margins, more separated above, second segment polished, the punctures distinctly finer than those on the first, a long line with felt-like golden pubescence extending along the dorsal segment near the margin ; on the ventral segment this line is shortened almost to a spot. The rest of the segments very finely punctured.

Covered in greater part with a golden pubescence ; the pubescence of the metathorax, sides of thorax and the first segment pale, silvery.

Testaceous ; flagellum brownish, legs paler than rest of the insect. Stigma deep brown, nervures much paler, the membrane slightly, uniformly clouded.

Type, Coll. Acad. Nat. Sci. Philadelphia.

Type locality, La Jolla, Cal.

Two ♂♂, taken in August. In the paratype there is a very faint indication of a third transverse cubitus.

Odontophotopsis clandestinus n. sp.

Mesosternum with the processes of a quadrate character flattened, with the anterior margin pointing inward and forward, the posterior margin backward and outward. The lower margin slightly emarginate.

Length, ♂, 9 mm. Head covered with closely arranged deep punctures, closer between anterior ocellus and the insertion of antennæ than elsewhere. Posterior ocelli about twice as far apart as they are distant from the anterior one, the distance between the posterior ocelli about equal to the distance between them and the nearest eye-margin. Lower margins of eyes almost contiguous with the base of mandibles. The mandibles not so strong, more gently curved, having a superior and inferior margin, the lower margin strongly notched. First joint of flagellum about three-fourths the length of the second. Prothorax with contiguous punctures almost rugose, the punctures more distinct dorsally than on the sides. Dorsulum with almost contiguous coarse punctures, the middle pair of furrows deeper than the lateral pair, the latter a shining line. Scutellum and postscutellum opaque, roughened, not distinctly sculptured. Propleuræ closely punctured. Mesopleuræ depressed about one-half from front to back, the depressed part almost impunctate below, closely punctured above, the bulged part of mesopleuræ covered with closely arranged shallow punctures, the face directed backward and outward, shining, almost impunctate. Metathorax with a somewhat oblong enclosure extending to base of disk. This area is about one and a half times as long as wide, a little broader at apex than at base, also not square at apex. The shining surface is bisected by a longitudinal raised line, on each side of this area is a triangular area with one side on the base of the metathorax. The rest of the disk is covered with moderately large, almost hexagonal or round, shallow pits. The sides of the metathorax have one-half deeply depressed, almost a broad channel, which is in greater part shining and without sculpture, the rest of the side is closely reticulated. Wings somewhat yellowish hyaline, stigma brown, nervures paler, a pale-brown stain on the lower half of the wings. A short stump of a vein extends beyond the insertion of the second transverse cubitus on the cubital nervure. Third submarginal cell outlined by faint nervures, which are not continuous; a very faint line extending half-way up to the cubitus stands for the second recurrent nervure. Petiole of abdomen a little less than twice as long, as broad at apex, convex but not strongly, on the disk the punctures are distinct, rather deep, large and separated. The sides of the petiole are rather moderately rugulose; second segment shining, punctured, the punctures closer together on the sides than on the disk and not as large as those on the disk of the first segment or petiole, the rest of the dorsal segments finely punctured on the apical half, second ventral segment more coarsely and closely punctured than the second dorsal segment. In the middle of the base of the exposed portion of the third dorsal segment is visible an area with a subtle surface, in outline like a U. The second dorsal segment has a lateral line appressed-like pubescence near the margin silvery, in some lights of a dirty appearance; on the second ventral segment is a similar line, but less than one-half the length of the one on the dorsal segment. The entire insect is almost uniformly covered with a moderate amount of long, fine, white, erect pubescence; that on the dorsulum and margins of the segments is shorter and lies rather close.

Brownish testaceous; legs pale testaceous, antennæ dull, dirty testaceous, tips of the mandibles dark brown.

Type, Coll. Acad. Nat. Sci. Philadelphia.

Type locality, Mesilla, N. M.

One ♂, taken at light, July 31 (T. D. A. Cockerell). In the shape of the mesosternal process this species comes close to the type of the genus, but it is quite different in many respects.

Odontophotopsis succineus n. sp.

Process of mesosternum a sharp tooth, in outline an acute angle. The tooth is short, as in *mellicausus* and *brevicornis*, but sharper.

Length, ♂, 7.5 mm. Clypeus slightly concave, shining. Head polished, punctures small and sparse. Instead of a furrow running from the anterior ocellus to between the insertion of the antennæ there is a dent a short distance below the anterior ocellus, and from this a rather indistinct impressed line appears to extend to the margin of the clypeus. Hardly any space between the base of mandibles and the lower margin of eyes. Posterior ocelli about twice as far apart as they are distant from the anterior ocellus, the space between the posterior pair distinctly less than that between them and nearest margin of the eyes. First joint of flagellum a trifle shorter than the second. Mandibles not so strong, gently curved, a distinct superior and inferior margin, the latter emarginate, but not very deeply. Prothorax rugulose, a small tuft of appressed hairs on each side of the pronotum. Dorsulum shining, the punctures indistinctly outlined, well separated. Parapsidal grooves almost absent, only one pair faintly apparent. The greater part of the anterior half of mesopleuræ depressed, shining, almost impunctate, the bulged part reticulated, its posterior border shining and almost impunctate. Scutellum and postscutellum closely sculptured, opaque. The enclosed area on metanotum shining, almost twice as long as broad at base, parallel-sided, bisected by a raised line, the rest of the metanotum reticulated, the meshes large and of irregular outline, the sides of the metathorax channeled, smooth, shining and reticulated in parts. Wings slightly smoky, stigma light brown, nervures paler, third submarginal cell practically absent, a short stump of a vein on the radius is all there is of the third transverse cubitus, a stump, a continuation of the cubitus, extends a short distance beyond the insertion of the second transverse cubitus. First segment of abdomen about twice as long as broad at apex, convex but not strongly, shining, sparsely punctured with poorly defined punctures, the sides closely punctured or rugose. Second segment polished, the punctures on it very fine and widely separated. The rest of the segments very finely sculptured, finely punctured near the apex. The area on the third dorsal segment is highly polished and extends to the punctured margin of the segment, the high polish is confined to a deltoid anterior portion of the area, in back of which is a transverse band of a more subtle character or between polished and opaque, at the base of the segment this area is about one-third as wide as the entire width of the segment. The second dorsal segment has a line of appressed silvery pubescence near the margin, and about half as long as the margin, but equally removed from base and apex, the representative of this line on the second ventral segment is about one fourth the length of that on the dorsal segment. The pubescence is erect, long and fine silvery to pale golden and almost equally moderately distributed.

Brownish testaceous, like some specimens of amber. Posterior legs pale to dark brown, anterior legs whitish-brown. Flagellum dark brown, mandibles tipped with deep brown.

Type, Coll. Acad. Nat. Sci. Philadelphia.

Type locality, La Jolla, Cal.

Two ♂♂, August. In the paratype the enclosure of metanotum is not so distinctly marked and more quadrate and the enclosure of the third segment is uniformly subtle.

Sphærophthalma harpalyce Fox.

One ♀, La Jolla, August.

Sphærophthalma pacifica Cress.

Three ♀♀, La Jolla, August, and San Pedro, July 10. Two ♂♂, San Pedro, July 25; La Jolla, August. This is the first record of the ♂. In shape and color it is much like the ♀. There can be no mistake about its identity. The wings are almost black.

DECEMBER 2.

The President, SAMUEL G. DIXON, M.D., in the Chair.

Seventeen persons present.

DECEMBER 9.

MR. ARTHUR ERWIN BROWN, Vice-President, in the Chair.

Seven persons present.

DECEMBER 16.

J. CHESTON MORRIS, M.D., in the Chair.

Eleven persons present.

A paper entitled "Five New Species of Trachilomonas," by T. Chalkley Palmer, was presented for publication.

Minerals from Santiago Providence, Cuba.—MR. S. HARBERT HAMILTON exhibited some of the minerals met with during his recent explorations of portions of Cuba, and described the manner of their occurrence. He called attention to increments of raise shown by the southern coast of Cuba from Maysi to Santiago de Cuba (Puerto de Cuba). All along this coast are to be seen remains of from three to five terraces, and around the harbor of Santiago de Cuba are a series of amphitheatre-like benches, which, with the Sierra Maestre, give a very peculiar and picturesque effect to the landscape. These benches are fossiliferous, but the shells are usually only represented by casts.

This part of Cuba has unquestionably suffered an extensive subsidence, possibly about the beginning of Tertiary time. The peculiar shape of Santiago Bay is to be accounted for as an old valley, which the sinking of the land has allowed the sea to encroach upon. Since its submergence this portion of Cuba has gradually been raising; the raised beaches attesting to the increments of raise. It is believed that the floor of the bay is rising to-day, as it is only by constant dredging that it is possible for vessels of moderate draught to come to the dock, many of the larger steamers having to discharge their cargoes in the bay. It is said that formerly any vessel could dock without difficulty.

The coral rock of the seashore is being carved into huge sea caves, one of the most prominent being under the old Morro Castle at the entrance to the harbor. Further up the coast are two large caves, or rather, a series of caves, that are now above tide and a considerable distance inland. They are known as Cuevas de Caribiss, and are within a few miles of the bay of Aserradero, where lies the wreck of the "Viscaya," adjacent to a cocoanut grove, a few huts of fishermen and charcoal burners and the ruins of a diminutive Spanish fort. The caves were evidently originally carved out by sea action, just as the one under Morro is being formed to day. They present another proof of the raise of this coast. They are now tenanted by millions of cave bats, *Artibeus*

Stalactite showing cup method of growth.

parvipes Rehn, and *Brachyphylla nana*, whose guano was once exported, but is now untouched. It is stated that aboriginal remains have been found in them, but several days of excavation with five assistants yielded no return. It may be that further excavation would be more productive.

In these caves, in the Cuevas de Guano particularly, occur the most beautiful stalactites and stalagmites. They are not of the yellowish tinge so common in our limestone caverns, but of a snowy whiteness. When seen by the light of torches, wet, and covered with little shimmering crystals, they present a very beautiful appearance as they stand out from the black gloom of the cave. One huge growth, fancifully called the "Elephant's Head" by his companions, was successfully photographed by Capt. Jos. Priest. A stalagmite known as the "Grandificencia Casa Blanca" (the glorious white house) was removed with partial success and is now in the American Museum of Natural History. Their manner of growth was somewhat peculiar. Numerous little cups are formed from a quarter to a half-inch in size, arranged with the bowl upward, and lined with small crystals. As the water-carrying calcium bicarbonate slowly trickled from the roof, it was caught by the cups on the stalagmites and stalactites and gradually changed to the normal carbonate. This is an adaptation of inorganic economy he had not seen previously recorded. Several hundreds of pounds of these cave-growths were transported with danger and difficulty to Santiago and brought north.[1]

On an extension of the Ferro-Carril y Almacenes de Santiago that goes from Santiago de Cuba to Alto de Songo are the manganese mines of Ponupo owned by the Ponupo Mining and Transportation Company. The ore is a loose amorphous pyrolusite mined in open cuts and washed before shipping. The deposits seem to be enormous, but he had not explored much more than in the immediate vicinity of the works. The mineral is said never to have been found crystallized, but usually occurs in the amorphous condition in nodules, and sometimes in beautiful stalactitic masses called "Flor de Manganese. He was permitted to bring away the best examples of this interesting mineral, which had been conserved in the company's offices. Associated with the manganese are remains of a limestone formation containing oxide of manganese and a fossil which Mr. Vaughan has referred to the Eocene as *Obitoides forbesii*. It is possible that the manganese oxide may have been precipitated in

---

[1] Since the above was written it has been noticed that some of the stalactites brought back have gradually assumed a darker shade. This is doubtless to be accounted for by the oxidation of salts of the heavy metals, which while in the subterranean chambers had but a deficient supply of oxygen. $CaH_2(CO_3)_2 = CaCO_3 + H_2O + CO_2$. Being now removed from the cave atmosphere, oxidation of the trace of iron has occurred.

the Eocene ocean, where this foraminifer dwelt, just as the dredgings of the *Challenger* and other deep sea explorers have found it in the oceans of to-day. This resulted in the formation of a manganiferous Eocene limestone, which tropical conditions have largely removed as soluble bicarbonate of calcium, concentrating the binoxide of manganese as the present pyrolusite ore deposit.

In 1524 the copper mines of the Sierra Cobre were opened. As high as fifty tons of ore a day have been mined from them, and the shafts are said to extend vertically for twelve hundred feet. The breaking out of the "Ten Years' War" put an end to the working. From 1867 to 1901 nothing was done. The workings are said to be the largest in the world. This is to-day indicated only by the hundreds of tons of ruined machinery, huge buildings and dumps with innumerable abandoned shafts and tunnels. Owing to the dilapidated and extensive nature of the Cobre deposits, a detailed study of them was impossible. The principal copperiferous veins seem to perpendicularly cut, a shale whose dip is 70°, strike S. 20° W. Of course many offshoots occur, adding to the complexity. The ore at present mined and shipped seems to be an intimate mixture of oxide, carbonate and silicate of copper. Sulphides exist further down as they were found in the old dumps. Azurite and chalcopyrite were found in place. Oxide of iron, pyrite, crystals of quartz of peculiar habit, oxide of copper and other minerals forming a gossan, are met with, but not in good specimens. The water now filling the mines is highly charged with chalcanthite and melanterite, rude plants are in operation removing the copper from solution. Chalcanthite and brochantite are often found deposited in unexposed places.

A mile or so upstream from the village, on the Rio Cobre, there is an interesting mineral occurrence. Here a pyritiferous dike or vein cuts a calcareous rock. The pyrite is oxidized to sulphate of iron and the iron precipitated as hydroxide by vegetable matter, producing in the reaction sulphuric acid. This in acting on the calcium compounds has produced gypsum. The gypsum thus formed is not crystallized in the usual shapes, but by a multiple growth along certain axis, produces unusual forms and combinations. In many instances the crystalline masses are of limpid pureness, free from inclusions. Again the molecules in their arrangement seem to include as much foreign matter as possible.

In the valley of the San Juan, near the hill famous in history, which is a coarse conglomerate gravel, are deposits of clay which yield a rather inferior brick. Here are also deposits of sand and gravel extending to a considerable depth, as the experimental wells put down by Mr. LaBelle preliminary to operations on the new Santiago waterworks indicated. This sand and gravel is mostly too coarse for building. The valley of the San Juan was evidently much deeper and has been filled since this portion of the island sunk. The same phenomenon is illustrated on the Santa Ynase road north of the town.

At Dos Bocas a dark-gray rock has been quarried for road metal. It is probably a fine-grained trap. Dip? 30° to S.W.

The strata exposed in the magnificent gorge of the Rio Guaninicum near Santa Ana is in some places suitable for building. The new schoolhouse at Santiago and the piers of the Cuba companies railroad bridge are of this stone. Dip 20° S.E. There appears, however, to be a dearth of good building material in this district.

Some local mining men in Santiago de Cuba, who had visited the summit of the Gran Piedra, 3,700′ A.T., suggested that it showed signs of former local glaciers. In company with Captains Erwin and Priest the ascent was made with some hardship, owing to inclement weather. The summit is composed of two huge granite-like masses worn very smooth, suggesting possible ice action, but there were no scratches to be seen or anything to indicate moranic material. The evidence obtained was purely negative, but owing to the incessant rain and rank plant-growth chances for observation were limited.

An attempt to ascend the Pico Tarquino failed. A height of 5,875 ′ A.T. was attained, but owing to the severe meteorological conditions, lack of suitable companions and supplies, at the end of several days it was necessary, on account of the illness of his companions, to abandon collections and return as best they could. The mountain, consisting of three peaks apparently, are heavily wooded. The speaker was only able to observe that tree ferns do not occur below about 1,000′ A.T., and that considerably above this altitude two species of snail, *Helicina pulchra* and *Pleurodonte bayamensis*, occur, which are not found at lower levels.

Mt. Magota, 850′ A.T., was also ascended. The start was made from Santa Ana through an interesting primeval forest. The mountain is capped by a limestone mesa about 350′ thick. The top is only to be attained by a narrow cleft which would not have been found but for the assistance of the Cuban guide. The limestone top has been carved by the elements into holes and pinnacles of exceeding sharpness so as to make passage of its summit dangerous and difficult. This annoying structure of rock is known as "dent de Perro" (teeth of the dog), and is certainly well named.

In this rock are caves where General Macco dwelt under Spanish régime. Surrounded by sisal and other thorny plants this place must have been impregnable. The caves are now given over to bats and an occasional brigand. Fine examples of *Pleuradonte marginella rostrata* Pfr. and *Zachrysia proboscidea* Pfr. were here obtained, but the mountain is overrun with a species of iguana which feeds on the snails.

Near Magota mountain is a good indication of copper which has never been touched. The new railroad will make it available. In connection with copper and the supposed indication which the presence of certain plants are said to give of the existence of metals, it may be mentioned that only here and at Cobre had he met with the cycad *Zamia* It may only be a coincidence.

While in Cobre he received specimens of chromite said to have come from the neighborhood of Holguine. The deposit was not seen.

The speaker said in conclusion that he desired to return thanks for the courtesies he had received from the many Americans and natives he had met while collecting and studying on the island.

DECEMBER 23.

Mr. ARTHUR ERWIN BROWN, Vice-President, in the Chair.

Ten persons present.

A paper entitled " On the Terrestrial Vertebrates of Portions of Southern New Mexico and Western Texas," by Witmer Stone and James A. G. Rehn, was presented for publication.

DECEMBER 30.

The President, SAMUEL G. DIXON, M.D., in the Chair.

Thirty-six persons present.

The following were ordered to be printed:

THE DEVELOPMENT OF GONIONEMA MURBACHII.

BY HENRY FARNHAM PERKINS.

Gonionemus A. Agassiz, 1862, Contrib. Nat. Hist. U. S., IV, p. 350.
From *γωνιο*, angled, and *νημα*, thread, "kneed tentacles."
Gonynema Haeckel, 1879, System der Medusen.
Gonionemus Murbach, 1895, Journal Morph., XI, 2.
Gonionemus Murbachii Mayer, 1901, Brooklyn Inst. Sci. Bul., I, 1.
Gonionema A. Agassiz, MSS.
Gonionema Murbachii Perkins, Johns Hopkins Un. Cir., May, 1902.

INTRODUCTION.

The genus *Gonionema* was established by Dr. Alexander Agassiz to include a medusa which he discovered in 1862 in the Gulf of Georgia, Washington Territory. Its most striking character, anatomically, is the peculiar form of the tentacles, which are bent at an angle near the tip, and at the angle bear a sucking organ by means of which the medusa makes itself fast to any favorable object. This peculiarity in the form of the tentacles suggested to Agassiz the name which he proposed. The form of the name which is now used is that which Dr. Agassiz offers in correction of the original one, which was in error as to its ending.

For a long time the Gulf of Georgia was the only locality from which this genus was described. In 1894, however, another habitat was discovered far distant, at Woods Hole, Massachusetts. Since then members of the genus have been found at the widely separated localities of the Fiji Islands and Alaska. A closely allied genus has been described from the coast of Brazil and from the Bahamas. Mayer says that he found a new species of *Gonionema* ("*aphrodite*") in the Bahamas, but as a matter of fact this medusa possesses rather the characters of the Olindiadæ, two distinct kinds of tentacles and papilliform gonads.

The history of the Woods Hole *Gonionema* is interesting. In spite of the fact that the "eel-pond" at the centre of the village of Woods Hole, a small body of water connected with the outer harbor by a narrow inlet, is easy of access to collectors, and that numerous students of jelly-fishes had investigated the waters around

Woods Hole summer after summer for a number of years, *Gonionema* was never found in the Atlantic Ocean until 1894. During that summer a number of specimens were taken from the eel-pond, the creature having made an astonishingly sudden appearance upon the scene. It seems incredible that *Gonionema* could have been living in this small body of water for any time previously, or at any rate that any number of individuals had been there. But the jelly-fish at once secured a good " foothold," and since the first summer it has been very plentiful; its numbers remain undiminished by the wholesale raids of collectors, in spite of the keen anxiety of some of those interested in it. During the summer of 1894, when *Gonionema* was first found at Woods Hole, Prof. W. K. Brooks secured a number of specimens and made drawings both from live medusæ and from sections of preserved material. Some of these drawings, Pl. XXXIII, figs. 21, 22, Pl. XXXIV, fig. 25, are now published, with Dr. Brooks' generous permission, for the first time.

The first printed account of the Woods Hole species of *Gonionema*, since recognized as distinct from the *G. vertens* of Agassiz, was published in 1895 by Dr. L. Murbach.[1] In several instances the species has been mentioned as identical with *G. vertens,* and it was not until 1901 that the specific name *Murbachii* was bestowed upon it by Dr. A. G. Mayer.

The work which I have done on the life-history of this form was originally undertaken and has since been prosecuted with Dr. Murbach's kind encouragement, and I have received from him many favors in the way of material and helpful suggestions. The research has been carried on during 1900 and 1901 at the U. S. Fish Commission Laboratory, where I have had the great privilege of working during the summer, and under the direction of Prof. W. K. Brooks at the Biological Laboratory of the Johns Hopkins University. I wish to acknowledge my obligations to Dr. Bumpus, Dr. H. M. Smith and Dr. Whitman for courtesies which they have extended to me in my work.

NOTE ON THE ONTOGENY OF THE "TRACHOMEDUSÆ."

According to Haeckel's classification *Gonionema* falls into his third order, the " Trachomedusæ." Haeckel characterized this

---

[1] L. MURBACH, 1895, " Preliminary Note on the Life-History of Gonionemus," *Journal of Morphology*, XI, 2.

order as follows: "Development, hypogenesis (not metagenesis), but usually with metamorphosis." Subsequent research into the life-history of this group has shown that each clause of this statement is open to emendation. In the first place, the "usually" is superfluous. The exceptions which Haeckel supposed to exist and which caused him to say "*usually* with metamorphosis" have been shown to be no exceptions, but cases of somewhat easily misunderstood metamorphosis. Such, for example, was the case of *Liriope*, which has been studied by Metschnikoff[2] and Brooks.[3] The larva is a true hydra, although its free swimming mode of life and its superficial aspect caused it to be mistaken, formerly, for a gonosome. My study of a jelly-fish which Haeckel includes in his order "Trachomedusæ" leads to the conclusion that the first part of Haeckel's statement also requires revision, and that *metagenesis does occur* among medusæ of this order. Although there may be different interpretations of the terms "metagenesis" and "hypogenesis," the following notion of the process of alternation of generations may be safely accepted as that which is generally held by students of this group. The production by a larva of offspring unlike itself, and its own ultimate death without undergoing metamorphosis, are frequent accompaniments of the intermediate as of the primary process of multiplication; but they are by no means essential to the process of metagenesis or alternation of generations. Creatures which multiply sexually at one point of their life-history, and at another point non-sexually by budding or fission, are said to have a metagenetic development. In *Gonionema* a large number of adult individuals are produced from a single egg through an intermediate process of multiplication (text-figs. 2–10); buds are developed upon the body of the hydra-like larva, become detached and, beginning as planulæ, follow exactly the same course of development as the sexually produced parent. Both parent and offspring later change into fully developed medusæ. *Gonionema* has, then, a metagenetic form of development. It is, of course, a mistake to regard the mere presence of a hydrula stage enough to constitute alternation of generations (Murbach, 1895, p. 496).

These emendations of Haeckel's description of the order add

---

[2] METSCHNIKOFF, *Embryologische Studien an Medusen*, 1886.
[3] BROOKS, *Life-History of the Hydromedusæ*, 1886.

evidence to that already put forward by Brooks (1886, p. 300), and others, to show that the hard and fast lines drawn by Haeckel and the Hertwigs separating the "Trachilinæ" and the "Leptolinæ," on the ground of anatomical differences or developmental features, are not borne out by the facts. The Hertwigs (1878) hold that "the marginal sense organs (Gehörorgane) alone furnish characteristics which enable us in every case to distinguish the Trachomedusæ (Trachomedusæ and Narcomedusæ of Haeckel) from the Vesiculatæ (Campanularian medusæ) without knowledge of their development." Dr. Brooks has, however, described a species of *Laodice* which unites in its anatomical features the characters of both the Leptolinæ and the Trachylinæ, having the ocelli of the former order and the chitinous gonangium containing medusa buds,[4] while Prof. Brooks has demonstrated (1886) that it also possesses the true endodermal sense clubs of the Trachylinæ.

It may be that the present record of observations on *Gonionema* will be of interest as contributing some new points to the present meagre knowledge of the manifold forms and types which are exhibited in the developmental processes of this great group.

GONOSOME.

Gonionema is a very attractive feature of the Woods Hole fauna. Its exquisite glassy umbrella, marked with a cross of yellow or brown by the four radial canals and the gonads, a brilliant row of closely set spots of gleaming phosphorescent green outlining its edge, a fringe of delicate streaming tentacles strung with bead-like clusters of thread cells, are all more or less familiar to many American biologists (Pl. XXXI, fig. 1).

On cloudy days or toward nightfall the medusa is very active, swimming upward to the top of the water and then floating back to the bottom. In swimming it propels itself upward with rhythmic pulsations of the bell-margin, the tentacles shortened and the bell very convex (Pl. XXXI, fig. 2). Upon reaching the surface the creature keels over almost instantly, and floats downward with bell relaxed and inverted and the tentacles extended far out horizontally in a wide snare of stinging threads which carries certain destruction to creatures even larger than the jelly-fish itself (fig.

---

[4] AGASSIZ, 1865, p. 125.

1). *Gonionema* continues this fishing, with little respite, all day long in cloudy weather. Occasionally it fastens itself to a blade of eel-grass or some other object near the bottom (Pl. XXXI, fig. 3), or stops midway in its course with tentacles extended, as in my figure (1). In this position it is well-nigh invisible, but a deadly foe to small fish or crustaceans which cross its path.

Gonads.

In the mature *Gonionema* the sexual organs are "frill-like lobes, passing from one side to the other of the chimiferous canal" (Agassiz, 1865). Their form and position are shown in Pl. XXXI, figs. 3, 4 and 5. The free edge of the ribbon of tissue is thickened and rounded, and is bent backward and forward across the radial canal. The color of the gonads has been supposed to afford means of discriminating between the sexes, the males differing from the females in the brighter yellow of the gonadial tissue. But this distinction does not hold, and it is necessary to examine the individual medusæ with a lens in order to separate the sexes. The ovarian eggs, enclosed in the ectoderm of the gonads in the female, give them a granular appearance as contrasted with the more homogeneous and translucent tissue of the male. When a large number of the jelly-fish are separated into two vessels, one containing the males and the other the females, the general color tone of the males is brighter and more lively than that of the females, but the specimens in each dish range all the way from light straw color up through orange, ochre, sienna, to dark brown.

Embryology.

It is my purpose to give in outline the main points in the early part of the life-history of *Gonionema*. I have not discovered that this genus exhibits any notable peculiarities in the development of the egg, and I shall therefore lay the greater emphasis upon certain features of the later developmental stages, which have more significance in so far as they are less familiar.

A. Dehiscence.—The eggs are imbedded in the ectodermal tissue of the gonad as in a gelatinous matrix (Pl. XXXI, fig. 5). The round thickened edge of the ribbon contains the riper eggs, but the thinner portion is well packed with maturing ova. Dehiscence takes place by the breaking down of the superficial ectodermal investment of the gonad and the liberation of the eggs or spermatozoa imbedded in its substance. The contractions of the umbrella in swimming put a strain upon the subumbral walls and help to rupture the epithelium of the gonads. What the cytological change is which precedes the extrusion of the sexual elements or the nature of the causes which effect this change are matters of uncertainty. We know only that these conditions can be artificially induced by means to be mentioned presently. The process of dehiscence occupies only a very few moments. Most of the eggs which are ready for fertilization are extruded all at once, coming out of the bell-cavity in a cloud at each contraction of the marginal ring. Two or three minutes after dehiscence begins only a few belated eggs remain to be loosened from the gonads and expelled from the subumbral cavity one at a time. Pl. XXXI, fig. 5, is drawn from a sketch of a medusa in the act of spawning. The specimen was held inverted under the microscope in a watch-glass. Although not free to swim it went through the motions, contracting the bell rhythmically. In this way the softened ectodermal tissue of the gonads was ruptured and the eggs expelled. Little round pits are left by the eggs, like bullet-molds.

The earliest date at which fertile medusæ have been found was the first of July; the latest, the last week of September. The period of maximum sexual activity is from the middle of July to the middle of August.

B. Periodicity.—As stated by Murbach (1895), the eggs of *Gonionema* are deposited with great regularity. During the earlier part of the summer dehiscence takes place at about 8 P.M., but later in the season, when dusk comes earlier, the medusæ spawn at 7 or even as early as a quarter past 6. Extrusion of the eggs may be artificially induced. In this respect *Gonionema* differs markedly from some other marine animals which exhibit equal definiteness in the spawning time. Dr. Murbach found that after the medusæ had been shut up in a dark place for an hour, even during the daytime, they would deposit eggs and sperm. My experiments show that this is more likely to be the case in the afternoon than earlier in the day; before 2 o'clock in the afternoon, an hour in the dark would sometimes bring about a deposition of a small number of eggs, and if the period was lengthened to an hour and a half, a slightly larger number of eggs were found in the water.

But after 2 o'clock the hour's shutting away from the light brought about an apparently normal spawning. I found that the withdrawal of light brings about surprisingly definite results. The condition of the tissues arrives at the point requisite for the release of the eggs almost on the minute. This constancy is not appreciably affected by moderate changes in the temperature. A large number of experiments and observations have been made to educe the exact time of stimulation (if we may so speak of an influence which seems to be purely negative) and the results are summarized in the following table. Record was kept of experiments carried on during the whole of the fertile season, partly in one summer, partly in the next. The stimulation-time varies somewhat with the season; the table gives the results obtained during the last week in July, when the eggs were being discharged in the greatest numbers.

Before 2	P.M.	small number	eggs laid after	90	minutes'	darkening.
2–3	"	almost normal no.	" " "	75	"	"
3–4	"	fully " "	" " "	65	"	"
4–5	"	" " "	" " "	60	"	"
5–6	"	" " "	" " "	60	"	"
6–7	"	" " "	" " "	50	"	"
At 8	"	eggs laid normally, without artificial darkening.				

As the hour approached the normal time for the deposition of the eggs, the precision with which they were discharged became more and more marked. Between 4 and 7 P.M. the time of darkening necessary to produce spawning does not vary more than four minutes on either side of the hour.

Some experiments were tried with a view to inhibiting the normal deposition of eggs, or at least of hindering it, by keeping the eggs in strong artificial light. The results were not conclusive, as the electric lights in the laboratory were not in use until after dusk, when part of the stimulus had already been received. The experiments showed a certain degree of retarding of the process of spawning as a result of the strong illumination. It would be interesting to determine whether the use of stronger light, applied at the commencement of evening dusk, would result in complete inhibition of the process.[5]

---

[5] Subsequent experiments show that brilliant illumination has a stupefying effect on medusæ, inhibiting contraction of the bell and almost preventing spawning, though not altogether or in all instances.

It is evident from the above statements that *Gonionema* is exceedingly sensitive to external conditions. Not all cœlenterates are affected in the same degree, and some are apparently not affected at all by changes in illumination. Some medusæ always lay their eggs early in the morning, while others of nearly related genera choose the evening or night. Experiments carried on by Wilson and Donaldson under Prof. Brooks' direction, at Beaufort, N. C., showed that in the case of *Renilla* and some sea anemones, at any rate, changes in light and temperature did not affect the precision with which the regular physiological processes took place. It is well known that a great many marine animals show more or less definiteness in the habit of spawning. Metschnikoff gives a table[6] showing the time of spawning of a large number of different genera of jelly-fishes. In other groups the same tendency is manifest. This phenomenon is probably the result of the working of natural selection, the habit of laying the eggs at a certain definite time having proved of value to the different species. The fact that in some forms this precision of periodicity is not dependent upon external influences, while in others there is manifest a marked degree of sensitiveness to such stimula, seems to me to indicate that the tendency has been arrived at by different processes, and may be due to quite different requirements in the various creatures.

But to return to the dehiscence of *Gonionema:* not all the eggs, by any means, which the ovaries contain are liberated at one time. Medusæ have been seen to deposit eggs every night for a week, and while specimens kept in captivity are not very reliable in drawing inferences as to natural processes, this period of sexual activity would, it would seem, be more likely to be shortened than otherwise by the unnatural conditions. After the first three or four days on which spawning took place, a small number of ova were left in the gonads, and on the three successive evenings these were extruded a few at a time. Late in the summer the specimens taken are usually devoid of sexual products, and the gonads small and shriveled.

C. Egg-Envelope.—In freshly laid eggs the polar bodies are only rarely to be found. They are normally given off and lost in the gonads previous to dehiscence. Before fertilization the eggs

---

[6] METSCHNIKOFF, 1886, *Embryologische Studien.*

float in a cloud through the water, each one surrounded by a very soft thick gelatinous envelope. If the egg is not fertilized the surrounding mass of semi-fluid jelly slowly shrinks up and the increased specific gravity causes the egg to sink to the bottom. Blister-like vacuoles appear in its substance, puffing out the jelly, and in the course of several days the protoplasm becomes disintegrated and the egg goes to pieces.

When fertilization takes place, the shrinking of the egg-envelope is more immediate and greater in degree, so that the egg sinks at once and sticks to the bottom by means of the viscid substance surrounding it.

Methods.—It may be well to digress at this point in order to mention some of the methods employed in the preparation of material. The adhesive property above referred to is of great assistance in making mounts of the segmenting eggs, as they may be allowed to settle on glass slides, which are afterward run up through all the reagents, without danger of washing off. For sectioning, the best way of securing the eggs was found to be by stirring about in the water with a camel's-hair brush and preventing them from gluing themselves down to the bottom of the dish. They would then stick together in masses, and being protected from too much pressure by the gelatinous covering, they were found to segment normally. The bunches of eggs were large enough to see with the unaided eye, and could be easily transferred to the killing fluid, and afterward stained and cut.

The best reagents that were used for killing were corrosive-acetic, three per cent. glacial-acetic in saturate solution of bichloride of mercury, and the full strength (forty per cent.) solution of formalin. Corrosive-acetic was satisfactory for most purposes, both segmenting eggs and adult medusæ being fixed in this mixture. They were immersed for from one to ten minutes, according to the bulk of the tissues. Pure (forty per cent.) formalin was used very successfully for the younger stages, giving good cytological fixation of segmenting eggs and of larvæ. Fifteen to forty seconds is sufficient to fix the tissues thoroughly. In working with *Gonionema* I have experienced none of the difficulty that seems to be met with in other cœlenterates in getting uniform results with formalin material. I have used this reagent, both for fixation and for permanent preservation, with the best results. For narcotizing the larvæ and adult medusæ, I find menthol crystals the most convenient and rapid chemical to use.

It may be well to mention the method of keeping *Gonionema* alive in the laboratory. Running water is not desirable, and it is of no benefit to either medusæ or larvæ to change the water frequently, as I have learned after much laborious effort to keep the specimens alive in this manner. Balanced aquaria furnish the best environment for these creatures. I succeeded in keeping a large number of larvæ in healthy growing condition for six months in aquarium jars in the laboratory. The quantity of water was kept constant by adding fresh water to make up for the loss by evaporation. Food was furnished in the form of protozoans and other microscopic organisms. Oxidation was secured by means of large quantities of diatoms which were reared for the purpose. Cultures were made from the scrapings of eel-grass, etc., and the diatoms which accumulated from them, collecting in clumps on the bottom of the dish, were scraped into the water with the larvæ. At the end of January, the polyps, which came from eggs laid the preceding August, died without undergoing metamorphosis. Their death was probably due to a lack of food supply sufficient for the requirements of their growing tissues.

D. Segmentation.—The egg is spherical, averaging .07 mm. in diameter. It consists of yellowish, rather cloudy protoplasm, sufficiently transparent to permit one to observe the more conspicuous changes which take place in the substance of the living egg.

Segmentation is total and equal, of the type which is designated by Metschnikoff as "*durschneidende Furchung.*" The cleavage-furrow appears at one side of the egg first and cuts through its substance until it reaches the opposite side, dividing it into two hemispheres (Pl. XXXI, fig. 6). The point at which the furrow starts is that nearest the nucleus, which lies eccentrically in the granular substance of the egg. The first indication of the furrow is a shallow groove, which deepens rapidly and at the same time lengthens so as to embrace the egg meridianally. The furrow is finally completed, superficially, a short time before it has entirely separated the egg into two distinct halves. The last point to be cut off corresponds in position almost exactly with the nucleus, but on the opposite side of the egg. The first cleavage is completed one hour after fertilization. The two daughter-nuclei now lie at the plane of fission, and at the same distance from the surface of the egg as the original nucleus. The second furrow normally starts on the same point of the surface as the first, and again divides the egg meridianally in a plane at right angles to the first. Sometimes the second furrow starts irregularly, at a point around the egg from the origin of the first furrow. One of the hemispheres is thus divided before the other, as in fig. 7. Fifty minutes elapses between the completion of the first and second furrows. Successive segmentations come in at intervals of forty-five to fifty minutes.

With the eight-cell stage rotation of the blastomeres occurs. The four upper cells turn through an angle of 45° upon the lower ones, so that they come to lie in the valleys between the lower ones, instead of being superimposed upon them. Segmentation continues until a hollow blastula (Pl. XXXI, fig. 8) is produced, a layer of thick cells surrounding a small cleavage cavity. The cells are of uniform thickness, and their outer ends give rise to cilia which drive the egg round and round by their motion within the membrane, sometimes in one direction, sometimes in the opposite.

During this stage the *formation of the endoderm* takes place. The inner ends of the blastomeres are delaminated, the process going on at an equal rate on all sides, until a uniform layer of endoderm cells lies within the ectodermal layer (Pl. XXXI, fig. 9). By increase in size of these endodermal cells the cavity of the egg comes to be entirely obliterated. During the subsequent life-history of the larva no cavity exists within the body until after several marked changes have taken place.

THE PLANULA.

By the rupture of the egg membrane the nearly spherical ciliated larva makes its escape, and starts upon the stage in which it is a swimming planula (Pl. XXXI, fig. 10). Its shape soon changes, becoming narrower and longer at one pole than the other; this narrower pole is to be the future oral extremity of the larva. The cilia serve to propel the planula in a slow rotating progression through the water, usually not far from the bottom. The larger end is directed forward in swimming. The time at which the planula appears is in the morning, about twelve hours after the egg was fertilized. The length of the larva is now between .1 and .15 mm. (Pl. XXXI, fig. 10). This condition persists for a varying time. Toward the end of this time the first indications of a *cœlenteric cavity* appear in the arrangement of the cells at the posterior end of the swimming larva (Pl. XXXI, fig. 11, *P*). Their inner margins come to lie in a straight line, following the long axis of the larva (Pl. XXXI, fig. 11, *C*). This process is better understood when we notice that in changing its shape from the spherical morula to the elongated planula the larva also underwent a slight rearrangement of its cells. The endoderm was first formed as a spherical mass, and its cells were all conical, radiating from the centre to the surface. But as elongation took place in the formation of the planula, the cells were stretched out into a cylinder and their inner ends overlapped irregularly, as is shown at the anterior end (*A*) of fig. 11. When the cœlenteron begins to be developed, the inner ends of these upper endodermal cells change their position somewhat and, as above stated, meet along a continuous line. At the same time a change is to be noticed in the cells at the surface of the oral pole. The cell walls at this point become less distinct (Pl. XXXI, fig. 11, *O*), and finally a disintegration of the boundaries leaves the tissue an undifferentiated layer of protoplasm. Before separation of the tissue to form the definitive cœlenteric cavity, the larva stops swimming, loses its cilia, and settles down upon the bottom. The larger end, which was directed forward in swimming, is downward. Between the free-swimming stage and the sessile hydra-stage there frequently, though not always, intervenes a condition which reminds one of a minute planarian in its shape and movements. The planula settles down upon the bottom and slowly glides along by a rhythmic wave-like progression. This condition seems to take the place of the last part of the ordinary and evidently more normal free-swimming stage, and is perhaps due to the unfavorable conditions of the laboratory. This condition is not at all like the pathological plasmodial forms to be mentioned below. Its changes in shape are slight, and its manner of movement rather a glide than a protoplasmic flowing None of the definiteness of structure is lost, and these larvæ transform into hydras as soon as those which change directly from the free-swimming planulæ. It is, then, not a phenomenon of degeneration, nor, on the other hand, an essential phase in the life of the animal, but rather an intermediate and probably accidental condition.

THE HYDRA.

As soon as the planula-stage has given place to the settled hydra-stage the cœlenteron becomes complete. The mouth appears at the free end where the tissue has previously showed indications of disintegration, at the end of the axial line formed by the endodermal cells. At first the mouth is visible only when the specimens are killed and cleared or sectioned. Soon, however, it becomes large enough to see in the live animal by focussing down from above with a high-power lens. It then appears as a minute pit in the ectoderm. The cœlenteron is more distinct at the upper end than below, where it disappears into the loosely constituted cell-mass of the interior. The definite cavity of the cœlenteron is somewhat later in making its appearance. When finally established it is lined with a thick layer of columnar endodermal epithelium. At its bottom it flares out in following the contour of the body-wall, as it appears in Pl. XXXII, fig. 15, which shows a late stage, but the same condition of the cœlenteron as exists in the newly transformed larva. The figure also shows a thickened core of endoderm which projects upward into the cœlenteron as a *gastric peduncle.* This conical mass of cells develops during the latter part of the hydra-stage.

A. Tentacles.—In the later transformation of the developing *Gonionema* no definitely determinate periods separate the times of active change. The development time is variable, depending upon external conditions of food, temperature, etc. In an average larva, however, the first tentacles make their appearance during the third week after the fertilization of the egg, or a week after the larva becomes attached. Two tentacles appear opposite one another at a level about one-quarter of the distance from the upper pole of the hydra (Pl. XXXII, fig. 12). They are knob-like when they appear, but grow rapidly to a considerable length, the few endodermal cells which form the core of each tentacle increasing in number. Fig. 12 shows a vertical section of a two-tentacled polyp of the fifth week. The manner of origin of the tentacles will be described in the section on the origin of tentacles under "The Medusa."

The second pair of tentacles (Pl. XXXII, fig. 14) appear soon after the first, and by their rapid growth soon become as large as the first pair, from which they are then no longer distinguishable.

Irregularities are common in the appearance of the tentacles of the polyp, as in the adult. It frequently happens that only one of the second pair ever makes its appearance. Or one may be slow in arising, and always remain smaller than the other. On the other hand, an abnormally large number are frequently developed, individuals with five or six being not uncommonly found (Pl. XXXII, fig. 13).

B. Form of Cœlenteron.—The appearance of the tentacles is accompanied by alterations in the form of the cœlenteric cavity. The rapid growth of the cells at the points where the tentacles arise and the outpushing of the tissue in the process seem to affect the contour of the body-wall over a considerable area, so that diverticula of the cœlenteron and of the mouth extend in the direction of each of the tentacles. A stellate arrangement results, the mouth being in the form of a cross. This corresponds exactly with the condition in the medusa, especially in young specimens (Pl. XXXIII, fig. 19), in which the twisting which in older individuals obscures somewhat the true relation of parts has not yet taken place. In the three- or five-tentacled hydra the number and arrangement of the oral lobes corresponds with the number and arrangement of the tentacles. Fig. 13, Pl. XXXII, represents a polyp with five radial parts, in which one lobe of the mouth is bifurcated. This condition is very similar to that frequently met with in adult medusæ (text fig. 1). The whole aspect of the hypostome of the *Gonionema* polyp is very similar to that of the manubrium of the young medusa. The ectoderm at the edges of the mouth becomes thickened and armed with nematocysts, which have by this time made their appearance, in a manner to be described later, over a large part of

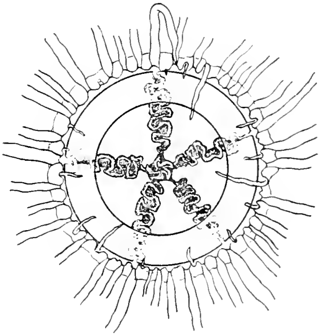


Fig. 1.

Abnormal five-parted medusa, showing agreement in plan between oral lobes and radial canals.

the body of the hydra. Below the mouth the hypostome becomes narrow and tubular and distinct from the rest of the body, a decided angle separating them at the level of the tentacles.

HABITS.

One of the most striking habits of the adult jelly-fish is its prehensile propensity. The adhesive organ at the "knee" of the tentacle is composed of long slender glandular cells, packed into a thick cushion which is inclosed within a strongly muscular rim or collar (Pl. XXXIII, fig. 20). This organ is located on the aboral side of the tentacle. When at rest the jelly-fish lies on the bottom with inverted bell, the tentacles widely extended horizontally and attached to the bottom by means of the combined cement gland and vacuum cup near the tip (Pl. XXXI, fig. 3). How this habit of inverting itself could have come to be acquired primarily by the adult medusa it is hard to see. But if, as I shall give my reasons for believing, the medusa arises by direct metamorphosis from the hydra, the habits of the hydra would naturally be more or less permanent in the adult. It may be that this particular habit is more likely to be first acquired by the larva than by the adult. The tentacles of the hydra reach a relative length greater than in the case of any other known hydroid polyp. They frequently stretch out in the water for a distance three or four times the height of the polyp. Fig. 14, Pl. XXXII, shows a hydra with the tentacles fully extended, their tips touching the ground in the characteristic attitude. The drooping of the tentacles is evidently caused by their extraordinary length, and is almost as unusual an occurrence among the hydromedusæ. At the points where the tips of the tentacles come in contact with the bottom they spread out somewhat, forming a sole-like surface which is closely applied to whatever object the polyp is settled upon (Pl. XXXII, fig. 14). This smearing out of the tentacle tips is like that which occurs in live specimens of hydra held between slide and cover-glass for examination. Both polyp and medusa remain when at rest with the mouth expanded, the manubrium stretching upward, the tentacles widely extended and drooping to the bottom. When an animal swims against one of the tentacles, the reactions are much the same in the polyp as in the adult. The feeding habits of *Gonionema* have been described at length by Yerkes.[7] His account would apply almost as well to the process in the hydra. The tentacle which comes in contact with the prey is contracted with a suddenness and vigor which belies the apparent inertia of the moment before. The victim is seen to be firmly spitted on the microscopic lances of the nematocysts, and it is evident that the first thing that happened when the animal touched the tentacle was the discharge of all the thread cells in that region. The tentacle in contracting carries the food, protozoan or minute worm, or whatever, toward the mouth. The long manubrium then moves about slightly as if in search of the morsel. Finally the tentacle places the food directly upon the mouth (Pl. XXXII, fig. 16), which proceeds to turn itself over the object and work it downward until it vanishes into the gastric pouch of the polyp.

Degeneration Phenomena.[8]

For some reason or other, not understood at present, the larvæ in one of my aquarium jars began when three months old to exhibit most singular forms and activities. All appearance of the hydra form was lost, ectoderm and endoderm becoming indistinguishable and cell outlines dissolved. The larva in this condition had very much the appearance of an amœba. The specimens slumped down on the bottom of the aquarium in a shapeless mass, and by protoplasmic flowing changed their shape through an endless variety of forms, moving slowly from point to point. Thin pseudopodia were sent out, along which the substance of the organism flowed, and by the breaking of the connecting isthmus divided into two. The fragments became smaller and smaller until no longer recognizable. These abnormal larvæ remained alive for six weeks, after which no trace of them was to be seen.

Budding in the Larvæ—Metagenesis.[9]

Contrary to Haeckel's statement that in the group of jelly-fish which he calls the "Trachomedusæ" metagenesis does not occur, in

---

[7] R. M. Yerkes, "The Sensory Reactions of Gonionemus," *Am. Journ. Physiology*, February, 1902.

[8] More fully described in the *Biological Bulletin of the Marine Biological Laboratory, Woods Hole*, August, 1902.

[9] An earlier draft of this section appeared in the *Johns Hopkins University Circulars*, June, 1902.

Gonionema, which falls into that group, this process does take place. By a form of non-sexual multiplication different from any which has previously been described for any member of the hydromedusæ, an intermediate process of reproduction is introduced into the life-history of *Gonionema*, whereby a large number of adults are produced from a single egg. Asexual multiplication in the larvæ of Scyphomedusæ has been known since 1841, when Sars saw and described the formation of buds in a scyphistoma of uncertain identity, but probably either an *Aurelia* or a *Cyanea*. Since that time several analogous cases have been made known. The scyphistoma larvæ of *Cassiopea*, for example, were found producing eggs in large numbers by Bigelow (1900), who gives a detailed account of the method of budding in a monograph on this Rhizostome. It may be further stated that in general the non-sexual process of production of buds by the larvæ is an important method of multiplication among the Discomedusæ. The buds usually develop, after detachment from the parent polyp, into a second generation of scyphistomas, identical in form and fate with the original ones. Buds may arise on the body of the scyphistoma, or upon stolons from its base, and either singly or several at a time. In *Cotylorhiza* the buds develop so rapidly and remain attached so long that large clusters accumulate about the base of the scyphistoma. According to some authors, Goette for example, the distal end of the bud in *Aurelia* and *Cyanea* is destined to become the oral end of the detached larva, developing mouth and tentacles. Friedemann, on the other hand, says[10] that in *Aurelia* he has found the opposite condition, the mouth being invariably developed at the *attached* end of the bud. This is the common relation in other forms.

In *Cunina*, which falls into Haeckel's order the "Narcomedusæ," the ciliated tentacled larva multiplies by buds produced from an aboral stolon. These buds are not detached until mouth, digestive cavity and tentacles are well developed. Several are produced simultaneously, and are attached to the parent by the oral extremity. The description of this remarkable process is given by Prof. W. K. Brooks in *The Life-History of the Hydromedusæ* (1886).

---

[10] Postembryonal Entw. von Aurelia aurita, *Zeitsch. f. w. Zoologie*, LXXI, 2, 1902.

It is my purpose in this section to give an account of a process of budding in a medusa very different from *Cunina,* one in which the asexual multiplication takes place very differently. In *Gonionema* the buds are produced in a manner which reminds one very strongly of the similar process in *Cassiopea.*

In the course of my general study of the development of *Gonionema* I came upon the budding larva (text figs. 2–10). From a lot of eggs obtained at Woods Hole, in August, 1901, a large number of polyps developed and were kept alive in a balanced aquarium for several months. This lot was left at Woods Hole in as nearly natural conditions as possible until the last of November. The water was kept fresh by frequently renewed supplies of diatoms and ulva, and occasionally changed by carefully adding a quantity taken from the natural habitat of the medusa in the eel-pond. A low temperature was maintained. When these larvæ were received from Woods Hole (November 28) they were apparently thriving well. They had all settled upon the Minot watch-glasses which had been placed in the bottoms of the dishes. These were easily removed without disturbing their contents. The watch-glasses were numbered and the positions of the polyps carefully noted and mapped. Successive examinations showed that the number of polyps was increasing, and on December 3 it was seen that one or two of the largest specimens had rounded knob-like bodies upon them; these were at once recognized as buds. The specimens were examined as frequently as it was thought safe to remove them from the jar, and camera drawings were made of the growing buds. Observations were made of the different stages in the development of fourteen buds; their phases agreed in all the main particulars.

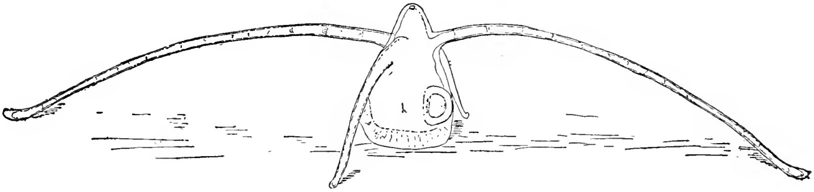


Fig. 2.

Five months old polyp with bud just forming.

The first indication of the appearance of a bud upon any individual polyp was a rounded eminence upon the hydrocaulus (fig. 2). It was usually located at a level about half-way between the base of the polyp and the ring of tentacles, as in the figure, and interradially—*i.e.*, at the end of a radius which bisects the angle between two tentacles (fig. 6). Never more than a single bud appeared at one time upon any polyp.

All three body-layers—ectoderm, endoderm and mesoglœa—of the parent are involved in the formation of the bud. The cells of both ectoderm and endoderm multiply rapidly in the region of the wall of the polyp where the bud is about to be formed. The endoderm pushes out as a rounded protuberance, covered by the ectoderm in a layer of constant thickness (fig. 3). A thin supporting lamella of mesoglœa lies between the two. As the bud increases in size it bulges out at its base, around the stalk which connects it with the polyp, and it also develops rapidly at the tip of the free end. In this way it becomes pear-shaped (fig. 4). As the drawings indicate, the ectoderm is of the same thickness in the bud as in the parent (fig. 3). Indeed, so nicely regulated is the rate of growth of the two tissue-layers that the thickness of the ectoderm does not change appreciably during the entire growth of the bud, previous to its detachment. The cells of the endoderm are irregular, loosely constituted and coarsely granular, and their walls are hardly discernible. No cavity exists in the bud until considerably later. The endoderm of the bud now becomes separated from that of the parent, by the constriction of the ectoderm and the cutting off of the core of endoderm which filled it. Its appearance is as represented in fig. 5, an isthmus of clear elastic ectodermal tissue uniting the bud to the parent. By rapid

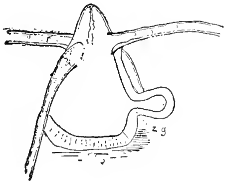


Fig. 3.
Same bud eight hours old.

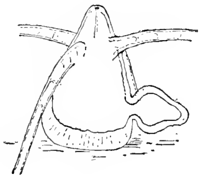


Fig. 4.
Bud one day old.

centrifugal growth the bud becomes sausage-shaped, and as long as the diameter of the polyp (fig. 6). Soon after the bud reaches the stage shown in this figure, it becomes detached from the polyp.

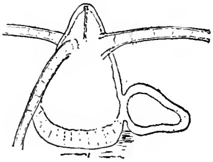


Fig. 5.

Bud three days old. Endoderm isolated from that of parent by constriction of ectoderm.

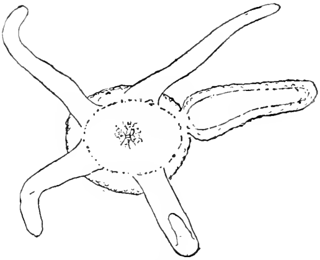


Fig. 6.

Bud four days old. Ready for detachment. Showing interradial position.

In only one instance was I so fortunate as to see this process taking place. In this individual the bud was drawn out into a long finger-like body, its distal end drooping almost to the ground. Soon the ectodermal isthmus began to stretch out and dwindle in diameter, until it was merely a thin stem of transparent protoplasm (fig. 7). The bud seemed to be reaching out and trying to free itself from the limitations of its connection with the parent. This stretching of the isthmus was brought about by constriction of the tubular ectoderm, as by circular muscle fibres. When this stretch-

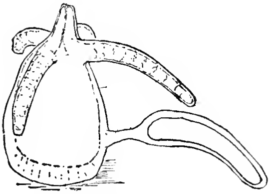


Fig. 7.

Another individual. Bud in process of detachment, showing elongated ectodermal isthmus.

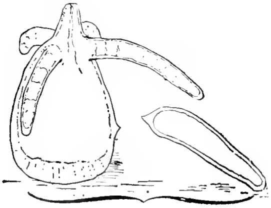


Fig. 8

Same bud fifteen minutes later. Bud settling down on distal end.

ing had gone on until the isthmus was a quarter as long as the entire bud (fig. 7), it began to grow still thinner at its middle, and finally, just half an hour after it first began to stretch out, it broke in two and the bud fell away from the parent (fig. 8). The two ends of the connecting stalk shrank back into the tissues of the bud and of the parent, appearing for a time as minute points of protoplasm, as in the drawing. After separation from the polyp this particular bud settled down at once upon the previously free or distal end, and began an independent existence (fig. 9). Other observations, however, indicate that the usual course of development is slightly at variance with this instance, and that it includes a motile period of from three to four days, intervening between the detachment of the bud and its settling down as a hydra. A bud which was growing upon the body-wall one day would be gone the next, and for some time could not be found. Then it would suddenly appear in some previously vacant spot, at a distance from the polyp, perhaps in an entirely different watch-glass on the bottom of the aquarium, with its tentacles just beginning to appear. In one case the bud was drawn and measured when it seemed to have reached its full size and to be ready to drop off. This was done one evening, and the next morning no bud was to be seen upon the parent polyp. Three days afterward a small polyp was found upon a spot which certainly had been unoccupied up to that time, according to diagrams made at short intervals. This was a larva like that in fig. 10. It was measured, and

Fig. 9.

Detached larva, just settled down, three days after detachment.

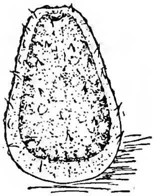


Fig. 10.

The same four days later. Basal ectoderm thickened.

although somewhat different in shape, as nearly as one could estimate its bulk, it corresponded exactly with the bud which had disappeared. Similar observations were so numerous that it seems unavoidable to consider the motile form a normal phase in the non-sexual as in the sexual process of multiplication. The precise nature of this intermediate condition is not yet determined. It seems probable that it is a creeping unciliated form, although my first conjecture, that it was a ciliated planula, has not yet been proven erroneous.[11] This peculiar phase is an interesting case of reversion in the non-sexually developed larva to a condition earlier, in point of ontogenetic order, than that of the parent at the time of budding.

The subsequent history of the bud has been definitely followed. After settling down upon the bottom it repeats the changes which occur in the sexually produced polyp. The newly arisen larva (fig. 9) loses its planula shape, becoming shorter and thicker, especially at the base, on account of the plastic character of the tissues (fig. 10). It has now secured a firm hold upon the bottom, being so closely applied that it is quite hard to dislodge it. The cells at the base increase in thickness until they form a columnar epithelium. After the first day a slight pit indicates the point at which the cœlenteron is to open externally. This process, as observed in a number of cases, is exactly the same as in the sexually produced polyp. The tentacles also make their appearance in the same manner as described for the hydra which developed from the egg.

The length of time required for the complete development of a bud, from its first appearance on the hydrocaulus of the parent as a simple knob until the completion of the formation of the cœlenteron and the appearance of the tentacles, is from ten to fourteen days: (*a*) the first period, including as far as the detachment of the bud, 5 days; (*b*) motile form, 2 to 4 days; (*c*) from attachment to appearance of tentacles, 3 to 5 days. These periods refer, of course, to specimens in captivity.

Pl. XXXII, fig. 17, shows a specimen from an entirely different lot of polyps from those which exhibited the budding phenomena shown in the text figures. This polyp was killed when 23 days old. It may not be a normal individual, but as it shows a tendency to divide transversely it seems worth while to call attention to it. The

---

[11] Perkins, *loc. cit.*

cœlenteron has completely divided into two, and the endodermal wall of the pouch has grown in as a solid partition between the two new pouches. The aboral portion of the body, or hydrocaulus, is seen to be considerably longer than is usually the case. It is interesting to compare, in this connection, Dr. Murbach's account[12] of the transverse fission of *Hypolytus*.

Transformation of the Polyp.

Up to the present time all efforts to secure specimens of the larval *Gonionema* in their natural habitat have been well-nigh fruitless. Although the eggs are laid in enormous numbers during four to six weeks of the summer, and even when kept in the laboratory a large proportion develop, it has yet been impossible to find the polyps in the eel-pond where the medusæ are so plentiful. Many speculations have been hazarded as to the condition in which the larvæ pass the cold months of winter, and no small energy and time have been expended in attempting to get at the secret. And yet I am much more ready to believe that the difficulty has been with our methods of search than that any extraordinary transformation in form or change in habitat should render the success of such search impossible. This seems the more likely from the fact that during the summer when the medusæ are laying their eggs most plentifully, and within a few days after an egg is laid it has developed into a fixed polyp with tentacles, the extreme minuteness of size and transparency of substance of the polyps hide them completely; and yet they must be present in great numbers on the stones and in the mud at the bottom of the eel-pond. Very few specimens have been found, although careful search has been made by others than myself. It is quite out of the question to suppose that the larvæ which develop into the medusæ appearing each year in great numbers in the eel-pond, have undergone their transformation in deep water, having been swept out to sea from their birthplace. In such case the adults would appear in much wider range of habitat—in some of the bays and inlets of the coast where the conditions seem almost the same as in the eel-pond. The fact is that only a few stragglers are ever found in the vicinity, not

---

[12] L. Murbach, Hydroids from Wood's Hole," *Quarterly Journal*, Vol. XLII, Pt. 3.

more than would be swept out of the shallow water by the tide. Not only these considerations, but all the other indications seem to point to a direct transformation of the polyp to the adult gonosome without leaving the eel-pond. The habit of the polyp of resting with tentacles extended and adhering to the bottom, the feeding reactions, the form of cœlenteron, manubrium and oral opening, the manner of origin of the tentacles, all resemble the corresponding conditions in the adult so closely that it is easy to regard this as the most likely theory. May it not be that the same type of metamorphosis as that which takes place in *Liriope* (Brooks, 1895) is passed through in this genus as well? In *Liriope* the cœlenteron is transformed into the system of chimiferous tubules by the growth of fusion areas which unite the upper and lower walls of the cavity, except where they are to be left separate along the lines of the canals. Pl. XXXII, fig. 18, is a camera drawing of a twelve-tentacled gonosome of *Gonionema*, which has very much the appearance of the newly metamorphosed *Liriope*.[13] The transformations which are necessary to bring about the adult from the larval form are a change in the cœlenteron to a system of tubes; the centralizing of the diffuse nervous system to form the two nerve-rings; the appearance of new tentacles provided with adhesive disks, and of tentacles modified to the form of sense-organs, from the expanded tentacular ring; and the growth of the velum. The relative size of the fully developed polyp and the youngest medusa offers no contradiction to such a conception of direct metamorphosis; if the polyp grows as rapidly in the natural environment of the eel-pond as in the laboratory, even allowing for a long period of absolute quiescence during the cold weather, the discrepancy in size is easily accounted for.

Youngest Medusæ—Arrangement of Tentacles and Sense-Organs.

During the last of June, 1900, a number of very small specimens of *Gonionema* were taken in a tow net at the surface of the eel-pond. Several of these had sixteen tentacles, some had twelve, one had only eight. A careful study of these very young and evidently recently metamorphosed gonosomes has brought out some exceedingly interesting points.

---

[13] Brooks, 1895, Pl. 41; Haeckel, *Die Russelqualllen*, Pl. 12.

Hargitt, in his paper, *Variations Among Hydromedusæ*, discusses the arrangement of tentacles in *Gonionema*. He approaches the question as a student of variations, and unfortunately lacks the young material from which I have found it possible to educe very definite rules in the arrangement of marginal organs and their order of appearance. As a natural result Hargitt comes to the conclusion that so much irregularity occurs as to render it impossible to discover any definite order of appearance or ultimate arrangement in these organs. It is true that the abnormal specimens which he studied most closely do show very little regularity, as would indeed be expected. But in normal individuals quite a remarkable degree of precision is manifest in the position and order of appearance of tentacles and sense-organs, with reference to each other and with reference also to previously arisen organs of the same kind. This is particularly true in the younger stages.

If we examine the eight-tentacled medusa the following points are noticeable: First, the tentacles are evidently of two cycles, in order of appearance. The four at the ends of the radial canals, or the *perradials*, are equal in size, and larger than the four *interradials*, which are also of equal size. These tentacles are very similar in appearance and structure to the larval tentacles, and there seems little reason why the larger perradials may not be the permanent larval tentacles.[14]

Second, the sense-organs are four in number and placed in definite positions, relative to the tentacles. If we look at the bell-margin from the oral side, the newly arisen tentacles in the four quadrants have apparently crowded in between the sense-organ and the perradial tentacle, which comes before it as the hands of a watch go. Fig. 11 shows this stage, and is made from a camera drawing of the eight-tentacled medusa. The relation which is here exhibited in the youngest stage of the free-swimming gonosome is the same throughout the growth of the medusa: *wherever a rudimentary or newly arisen tentacle lies on the bell-margin, it will always, normally, be found to lie just in front of a newly arisen sense-organ, and just after a larger tentacle*, i.e., one of an earlier cycle.

Much has been written to show that cœlenterates, and especially

---

[14] This conclusion is strengthened by work done since this paper was written.

members of the hydrozoa, show bilateral symmetry, either in the normal condition or when they depart from the normal form and may be supposed to revert to a more primitive type (Mayer, 1901, *e.g.*). *Gonionema* shows a very different plan from that of bilateral symmetry. It is rather a certain sort of radial symmetry which has nothing bilateral about it—one in which the radial parts correspond exactly to each other, and are superimposable, but none of which is the reflected image of any other. I shall call this relation one of *cyclic symmetry.* With reference to the order of appearance of the marginal organs I shall speak of *cyclic sequence.*

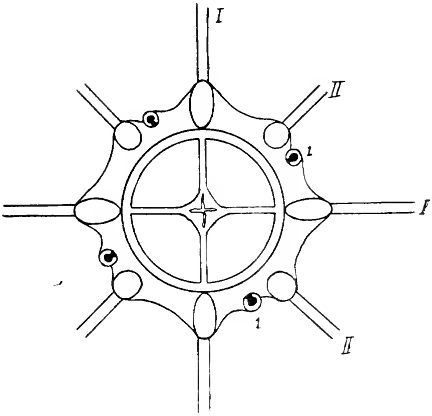


Fig. 11.

These terms were suggested by Prof. Morley, of the mathematical department of Johns Hopkins University.

New tentacles make their appearance four at a time, or, so to speak, in quartets; they are 90° apart, so that they occupy identical positions in the four quadrants of the marginal ring. But while the tentacles, and the sense-organs as well, appear to rise in fours, the condition in the larva, and in frequent instances among the adults, indicates that a paired origin is more primitive and fundamental. It is the rule in the early larvæ that two tentacles appear opposite to one another (Pl. XXXII, fig. 12), and later the second pair of the quartette. It often happens that in the adult medusa two members of a quartette, in opposite quadrants, are retarded in making their appearance. In *Aurelia* Claus established the theory that while the larval tentacles seem to come in fours after the earliest stage, the first four tentacles appear first two, then two more, as is the case in *Gonionema* (*v.* Claus, 1892). Goette (1887) has examined a great number of specimens of the younger stages of *Aurelia,* and has come to the same general conclusion as Claus with regard to the primitive paired condition and the significance of this in the philogeny. Haeckel (1881), however, regards the appearance of two tentacles in advance of the second two as an accidental and insignificant occurrence; he takes four for the primary number. While this tendency to a paired origin of the tentacles disappears after the earliest stages in *Aurelia, Gonionema* exhibits this tendency in frequent instances during the whole life of the animal. Its occurrence in the appearance of the sense-organs is of the same significance, because, as will be pointed out below, these organs are modified tentacles. Pl. XXXIII, fig. 19, shows this condition in the sense-organs, quadrants *A* and *C* having five, while in quadrants *B* and *D* only four are developed. It is true that other variations than these do occur in the appearance of the tentacles and sense-organs in the adult, and of the tentacles of the larva. Polyps with three, five or six tentacles are not uncommon (Pl. XXXII, fig. 13). It is noticeable that departures from the normal number correspond very closely in polyps and adults. This would be expected from the evidence that the larval tentacles are permanent, and that they determine the position of the four radial canals in the normal medusa, or of the three, five or six in aberrant specimens. This inference seems a likely one from the fact that in the adult medusæ the tentacles which, from their larger size, are presumably of the first cycle are always, normally, located at the ends of the radial canals. The inference is that five-parted medusæ were five-tentacled polyps. This is borne out by comparison of the relative numbers of each kind of variation among medusæ and among polyps. Hargitt (1901) has tabulated the number of medusæ that have come under his notice having three, five and six radial canals; and he finds that about five per cent. are irregular in this regard, *i.e.*, vary from the normal four-parted condition.

While I have not had a great number of specimens of the polyps from which to compute averages, my counts show quite a striking similarity to those which are given by Dr. Hargitt for the adults.

Among all the varieties of geometrical figures which appear in the arrangement of parts among the various orders of cœleuterates, there is none, so far as I can find, which is at all comparable with that which appears in the arrangement of tentacles and sense-organs in *Gonionema.* The only suggestion of such a plan of arrangement as this is given in a paper on the later development of *Aurelia,* by Friedemann (1902). In the course of the paper this author describes the origin of the eight tentacles which follow the first eight. Four of these appear at once, the other four later. In the appearance of the first four, two possibilities arise, according to Friedemann. Either the four arise in bilaterally symmetrical positions in the four quadrants, the two halves of the tentacle-ring being reflected images one of the other, and the new tentacles appearing one on either side of the two opposite perradial tentacles (fig. 12); or else they appear in identical positions in the four quadrants, one appearing next in front of each perradial tentacle, as the hands of a watch move (fig. 13). Friedemann's figures do not make it clear that he actually found specimens in exactly this stage. It appears more probable that he interpreted older stages by this theory. But it may easily be true that in other groups than that to which *Gonionema* belongs the tentacles originate according to a plan of cyclic symmetry, or that such a condition sometimes appears, irregularly, as may be the case in *Aurelia.* In *Gonionema* the rule holds with remarkable constancy.

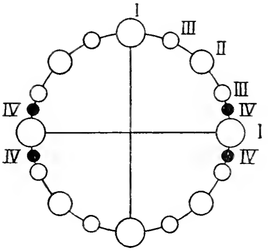


Fig. 12.

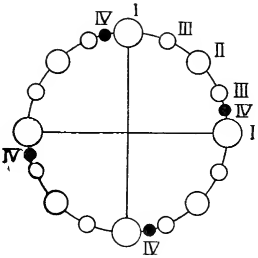


Fig. 13.

From a study of successive stages of growing medusæ the following table is compiled to show the relation in time of appearance of tentacles and sense-organs. The numbers in brackets in the column of sense-organs indicate half-quartettes, the corresponding pair in each case having been delayed in appearance. Since the sense-organs are only half as numerous as the tentacles, they appear with half the rapidity, and are therefore more frequently found in this condition of incomplete quartettes. That is, if a jelly-fish were killed when the tentacles and sense-organs were in the precise stage indicated by the line *a b*, for instance, the fifth quartette of sense-organs would be found only half formed—five sense-organs appearing in two opposite quadrants, and only four in the other two. This is just the condition which exists in the specimen shown in Pl. XXXII, fig. 19. The numbers indicating the sense-organs are put at the intervals between those indicating tentacles, to show that while the eight tentacles between the eight-tentacled and the sixteen-tentacled stages, for instance, are appearing, the four sense-organs which make up the second quadrant are appearing.

	TENTACLES.	SENSE-ORGANS.
Larval	2	
		(2)
	4	
		4
Adult	8	
		(6)
	12	
		8
	16	
		(10)
	20	
		12
	24	
		(14)
	28	
		16
	32	
		(18)
a		*b*
	36	
		20
	40	
		(22)
	44	
		24
	48	

Another rule is followed by the marginal organs in their order of appearance. Each new tentacle arises not only just in front of a sense-organ, but in a definite relation to the older tentacles. And the same thing is true for the sense-organs. It is therefore possible, from a study of successive stages, to predict where each new quartette of tentacles or sense-organs will arise. The diagrams shown in the text-figures are from camera drawings of mounted whole medusæ. If we examine text-figure 14 we see that T. (tentacle)

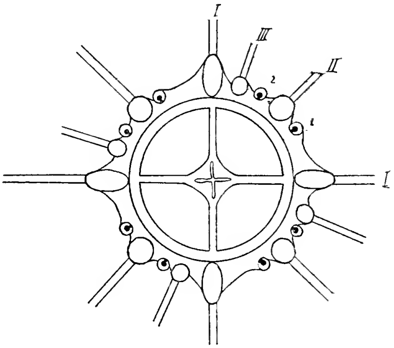


Fig. 14.

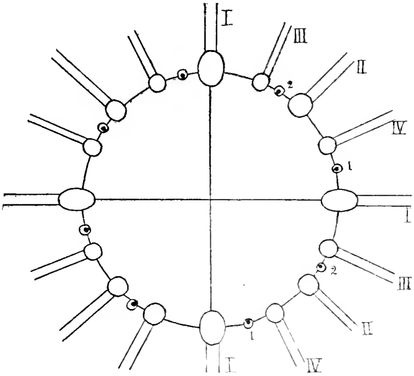


Fig. 15.

III follows T. I; and text-figure 15 shows T. IV following T. II.

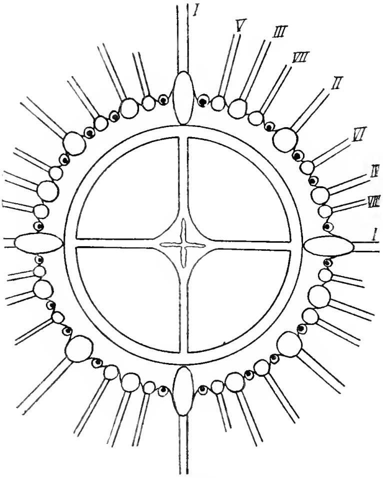


Fig. 16.

Thus T. III and T. IV form a series, arising in corresponding

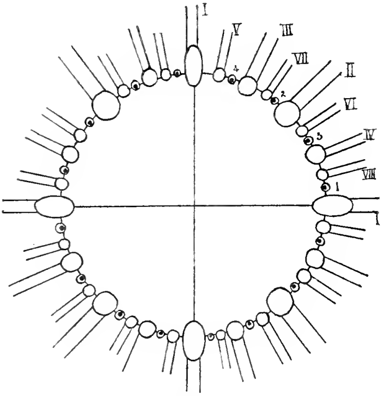


Fig. 17.

positions in the quadrant relative to the tentacles already present.[15] The next series consists of four tentacles in each quadrant, T. V. to T. VIII. This brings us to the thirty-two-tentacled stage (text-figures 16 and 17). In this it will be seen that T. V follows T. I, T. VI follows T. II, T. VII follows T. III, T. VIII follows T. IV, *i.e.*, four numbers intervening in each case. The next

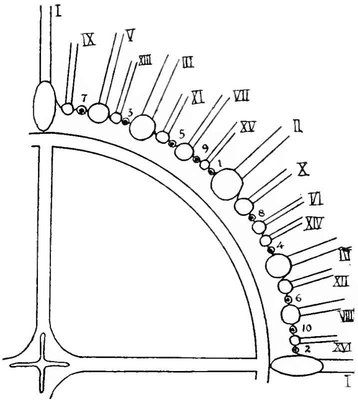


Fig. 18.

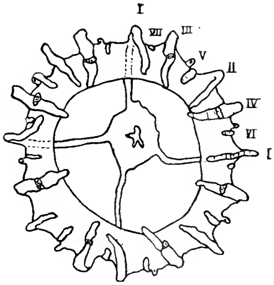


Fig. 19.

---

[15] By "series" is not meant "cycle," with the idea of simultaneous appearance; the notion is one of relative position simply.

series comprises T. IX to T. XVI, which follow the same plan in order of appearance, T. IX following T. I, etc., eight numbers intervening in each case (fig. 18).

While this may seem more like a fanciful exercise of the imagination than an actual condition in nature, the truth is that the larger the number of specimens in which one tests the arrangement of the marginal organs by this rule, the more will one be convinced of the remarkably constant adherence to it. Given a specimen with, say, twenty-eight tentacles, such as that represented in fig. 19—this is a drawing of a specimen of *Olindias* from the Bahamas, a genus which follows the same rule in the order of appearance of the tentacles as *Gonionema*—the sense-organs are not so numerous in *Olindias*. In this specimen the most recently arisen tentacle in each quadrant is evidently the one numbered VII, lying just after each perradial tentacle. Then, if the rule which we have educed applies in this case, we should expect to find the eighth tentacle in each quadrant arising in a corresponding position with relation to the interradial tentacle.

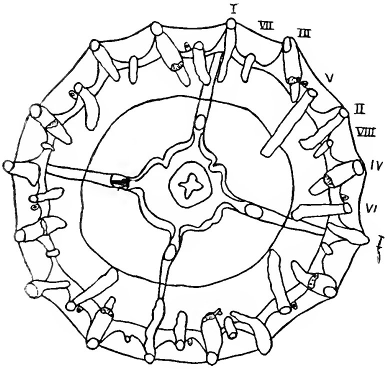


Fig. 20.

And such we find to be the case. Fig. 20 shows a slightly older specimen of the same species in which we plainly see the eighth tentacle in each quadrant lying in its appointed place (VIII).

It would be singular indeed if there were no exceptions at all to this general rule. Many variations from the regular cyclic symmetry do occur, but only as many as would be expected from the marked tendency to variability in all parts of the medusa. These variations no more obscure the normal definiteness of plan than the occurrence of six or seven-rayed star-fish obscure the normal pentamerous form in echinoderms. Text-figure 21 shows an irregular condition, the fourth tentacle in each quadrant having arisen aberrantly, following instead of preceding the first sense-organ (1).

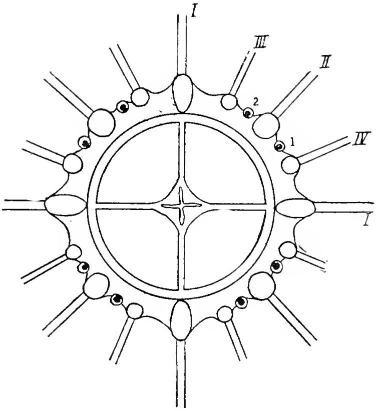


Fig. 21.

In Pl. XXXIII, fig. 19, one of the latest arisen quartette had not put in its appearance (see arrow in quadrant A). In the older specimens, the number of irregularities increases. It seems to me that the bell-margin increases in extent subsequent to and as a consequence of the increase in the number of tentacles, rather than that the tentacles arise, haphazard, wherever there is space enough on the margin to accommodate them (Hargitt, 1901). Certain it is that the most crowded part of the bell-margin at any particular moment is that from which new tentacles are in the process of arising.

Histogenesis of Marginal Organs.

A.—In the larva.—The similarity in the appearance of the tentacle-rudiment in polyp and in gonosome make it desirable to describe both in the same connection. The account of the origin of the tentacles in the polyp was therefore reserved for this section. At first the larval tentacle is merely a small round knob, externally, and internally it is made up of a core of two or three endodermal cells. When the tentacles make their appearance the body wall of the polyp is made up of the double layer of cells, the ectoderm and endoderm, separated by the thin supporting lamella of mesoglœa. These three layers are pushed out somewhat in the growth of the tentacle, the region of greatest activity being the endodermal layer, where the core of the tentacle is formed by a rapid outgrowth of the cells of the body wall, accompanied by multiplication of these same cells. After some weeks the cavity of the cœlenteron becomes drawn out in a diverticulum in the direction of the axis of the tentacle, so that the upper part of the gastric cavity becomes stellate in cross section. Pl. XXXII, fig. 15, shows this condition in a five-months'-old polyp. This cavity does not reach out into the tentacle itself in any of the specimens which I studied, but may do so before metamorphosis takes place. During the whole of larval life, the tentacle is made up of a core of endodermal cells in a single row, as is the case in hydra. Fig. 11 shows the first pair of tentacles only developed, and the cell-layers are seen as described. The endoderm cells are filled with a loose protoplasmic mass (Pl. XXXIV, fig. 24, *End.*) and the nucleus is conspicuous. The condition which is seen in an adult tentacle with several cells of endoderm surrounding the central cavity (fig. 23) is easily derivable from the larval condition by longitudinal fission of the endodermal cells, repeated until a cross-section of a tentacle cuts several cells (Pl. XXXIV, fig. 25).

B.—In the Adult.—The regularity with which the tentacles and sense-organs make their appearance in the adult, as previously described, makes it possible to locate with comparative certainty the beginning of one of these organs upon the bell-margin. Pl. XXXIV, fig. 24, is from a section of a medusa, cut horizontally at the point of origin of one of the tentacles. The figure shows the aspect at the level of the tentacle, somewhat above the velum.

Both cell-layers are seen to be concerned in the formation of the new tentacle. The endoderm (*End.*) is pushed out from the region of the circular canal, and has the shape of a solid plug of tissue composed of a few cells arranged radially about a central axis (*T. R.*). The nuclei are at the inner ends of the cells. Outside of this endodermal core is the ectoderm (*Ect.*) which is, in the region of the bell-margin, of the character of gelatinous tissue, containing large numbers of rudimentary nematocysts. These inclusions and the nuclei of the cells are more numerous at the point where the tentacle is to appear than elsewhere. In the medusa, as in the polyp, the greatest activity in the formation of a new tentacle is manifested by the endoderm. According to Allman,[16] in some hydroids (*Campanularia Johnstoni*, for example) the first indicaton of tentacle formation is the thickening of the ectoderm at the point where the tentacle is to appear. This is contrary to the condition which we have in *Gonionema*.

But to continue our description: along with the growth of the endodermal process, which is to be the core of the tentacle, the ectoderm also increases rapidly and constitutes an investment which contains within it numerous nematocysts and concretions which were scattered throughout the ectoderm at the margin of the umbrella. After the tentacle has grown out for a little distance beyond the bell-margin the cells on the upper or aboral surface become modified to form an adhesive organ (Pl. XXXIII, figs. 20 and 21). The cells over a disk-shaped area become elongated until they have the form of a thick pad (Pl. XXXIII, fig. 21). The tissue immediately around the pad grows out in a flange so that the organ becomes a vacuum-cup strongly muscular around the edge. After the tentacle has grown out to a length of six to eight millimeters and has increased in diameter considerably, the cavity of the circular canal is drawn out into it. The endodermal cells, arranged radially about the central axis, thicken until they are forced away from the centre, and a tubular cavity is left (Pl. XXXIII, fig. 21). As this process takes place first at the proximal end of the tentacle, within the tissue of the bell-margin, the cavity of the circular canal is carried out along the axis of the tentacle toward the tip. In this way the tentacle, which was originally imperforate as in the polyp, becomes hollow.

---

[16] Allman, *Monograph on the Tubularian Hydroids.*

C.—*Sense-organs.*—The origin of the sense-organs is very similar to that of the tentacles (Pl. XXXIV, figs: 24 and 25). In fact, it seems clear from a study of these processes in *Gonionema* that the sense-organs must necessarily be regarded as modified tentacles. In the case of these sensory clubs (Pl. XXXIV, fig. 25, *S. C.*), the endodermal tissue (*End.*) of the circular canal grows down in a plug into the ectodermal tissue (*Ect.*) of the bell-margin.

This latter becomes closely applied to the outside of the plug, as a thin investing epithelium, and it also spreads out in a thin lamella over the inner surface of the capsule which appears in the ectoderm in front of the developing club. Pl. XXXIV, fig. 25, is a drawing by Prof. Brooks from a section cut transversely across the bell-margin, showing the early stage in the formation of a sense-organ. I have not been able to demonstrate the presence of sensory hairs in the cavity of the capsule. The cells at the tip of the club soon begin to secrete the solid concretion which later attains a considerable size. The concretion is invested with a thin membranous ectodermal covering. In *Gonionema* the concretions correspond with the composition which has been given for similar structures in other medusæ—a calcium salt deposit in an organic matrix. Thus it is seen that both tentacle and sense-organ consist of an endodermal core which appears as a plug of tissue growing out from the lining of the circular canal. In each case this core becomes invested with a tunic of ectoderm which remains associated with it.

NEMATOCYSTS.

In the hydra-stage the earliest appearance of nematocysts was as interstitial cells arising from either tissue-layer. Their growth in *Gonionema* is much the same as in *Cordylophora lacustris* as described by Morgenstern (1901). They are carried out on the tentacles by migration along with the ectodermal layer in which they are set. The extreme attenuation of the tentacle as it is when fully extended (fig. 14) gives an admirable chance to study the cell-elements, especially the nematocysts. The tentacle appears as a delicate rod of translucent substance, partitioned off at intervals by the transverse walls of the endoderm cells, and studded along its length with numerous glistening beadlike bodies, the nematocysts. Above each of these thread cells a palpocil projects like a thorn (Pl. XXXIV, fig. 26). The capsule has an unusual form, long and bean-shaped (Pl. XXXIV, fig. 27). Examination with a high-power objective, focussing down into the water upon the extended tentacle, shows with considerable distinctness a ganglion cell of glistening highly refractive appearance, lying close to each nematocyst (Pl. XXXIV, fig. 27, *g.c.*). In every case this ganglion cell is situated distal to the thread-capsule, toward the free end of the tentacle (Pl. XXXIV, fig. 26). A thin strand of nervous tissue runs in each direction from the ganglion cell, toward the nematocyst proximally, toward the free tip of the tentacle distally. It is visible for only a short distance, however; soon vanishing into the ectodermal tissue, and none of its branches or terminations are to be traced. It evidently innervates the nettling capsule, near the base of which it can be seen.

In the gonosome the nematocysts are carried out onto the ectoderm of the growing tentacle *in situ*, as in the larva. Further growth in the extent of the ectoderm is brought about in two ways: By multiplication of the cells already incorporated in the epithelium of the tentacle, and by immigration of the cells from the thick ectodermal pad at the base. The tissue composing the pad is peculiar in character. The cell-walls are almost or quite obliterated, and the gelatinous substance contains the cell-products already mentioned. In this whole group of medusæ the older tentacles are left stranded, as it were, by the growth of the margin of the umbrella beyond their point of origin. As they are in this way carried up on to the exumbral surface of the medusa, the pad of ectodermal tissue grows so as to fill the space between the base of the tentacle and the bell-margin, forming a round cushion of hard tissue. In sections cut through this tentacle-pad (Pl. XXXIII, figs. 22 and 23) it is seen that the concretions which lie toward the bell-margin are more dense and homogeneous; that further inward they are somewhat less solid in appearance, spaces appearing within their outer walls; and that at the side nearest the circular canal there are great numbers of nettling cells in various stages of formation. All gradations are present between the solid concretion and the nettling cell (Pl. XXXIII, fig. 22). Fig. 22 was drawn by Prof. Brooks to show this condition in *Gonionema*. At the inner margin of the ectodermal pad the nematocysts lie closely packed together (fig. 22). From this breeding place they work their way out on to the tentacle along which they migrate until they reach a spot where they are needed. In young tentacles which are still elongating the nematocysts are carried out with the ectoderm as it becomes applied to the tentacle base. But after a certain time the tentacle increases only very slowly in length and additional nettling cells are needed to keep up with the increase in diameter. This migration of nematocysts has been seen and described by Murbach.[17] After the capsules have become established, the ectodermal covering becomes modified to form the cnidocil (Pl. XXXIV, fig. 27). The nerve connection in the cnidocil is developed at an early stage.

SEXUAL ORGANS.

In minute specimens of the adult gonosome the gonads are frequently found in their first stage of development. They appear as outgrowths of the ectodermal covering of the radial canals, at first in the form of a ridge projecting downward from the radial canal into the subumbrella at a point two-fifths of the distance from the top of the bell to the margin. The rudimentary ribbon of gonadial tissue elongates in both directions from the point at which it started. Text-figure 20 shows the condition in *Olindias*, in which it is similar at first to that in *Gonionema*. The gonad thus becomes an elongated ridge of tissue which finally reaches to the extremities of the radial chimiferous tubes, and increases in depth until it hangs down like a ribbon into the subumbrella. Early in its development the ribbon is somewhat sinuous, and as the medusa attains greater diameter the convolutions become more and more numerous, and farther extended on either side of the radial canal, until ultimately the folds are packed tightly together in a solid band of tissue, which at the time of maturity is extended with sexual elements. The process of formation of the sexual organs is identical in the two sexes; it is impossible to tell whether a given individual is male or female until the sexual products begin to mature.

SUMMARY.

1. Observations on the development of *Gonionema* indicate that Haeckel's sharp distinctions between jelly-fishes which he groups in

---

[17] L. MURBACH, 1894, Beitrage zur Kenntnis der Anatomie u. Entwick. der Nesselorgane der Hydroiden. *Archiv. f. Naturg.*, 60.

his orders "Trachomedusæ" and "Leptomedusæ" are not justified.

2. Dehiscence occurs in *Gonionema* with precise periodicity, and is definitely affected by changes in light.

3. Segmentation is total and equal; endoderm is formed by delamination of the blastomeres; a solid morula results.

4. A planula stage occurs, and later a hydra stage, in which the polyp develops first two tentacles, later a second pair.

5. Youngest medusæ and oldest polyps show marked homologies; direct metamorphosis is suggested.

6. Peculiar pathological phenomena occur, the larva living for weeks in the form of a plasmodium, with amœbiform activities.

7. Alternation of generations occurs. A non-sexual form of multiplication appears, during larval life; buds are produced which are detached as planulæ and go through the same changes as the parent.

8. The order and arrangement of tentacles in the gonosome follows a definite plan of cyclic sequence, producing a figure which is cyclically, not bilaterally, symmetrical. Tentacles and sense-organs appear at determinate points on the bell margin.

9. Histogenesis of tentacles and sense-organs shows their homology

10. The origin of nematocysts from the ectodermal pad at the base of the tentacle is described.

11. Gonads arise as enlargements by proliferation of the ectodermal subumbral epithelium of the radial canal.

DESCRIPTION OF PLATES XXXI–XXXIV.

The figures, except those otherwise noted, have been drawn by the author.

PLATE XXXI, Fig. 1.—Adult *Gonionema* in resting attitude; floating after a period of active swimming. 2/1.

Fig. 2.—Medusa in act of swimming; bell contracted, tentacles drawn up at the end of a forward impulse. Photographed from life. 1/1.

Fig. 3.—Photograph of medusa inverted and clinging to the bottom.

Fig. 4.—One radial canal from ripe male, showing gonad. *c*, circular canal; *r*, radial canal. 8/1.

Fig. 5.—Gonad of female, during dehiscence. 20/1.

Fig. 6.—Egg during first segmentation; cleavage furrow half completed. 570/1.

Fig. 7.—Egg during second segmentation, left hemisphere completely divided, right hemisphere in process of dividing.

Fig. 8.—Hollow blastula seven hours after fertilization. Optical section of live egg.
Fig. 9.—Two-layered blastula, endoderm having arisen by delamination.
Fig. 10.—Young planula larva. *P*, posterior end, *A*, anterior end. 675/1.
Fig. 11.—Planula larva; posterior end enlarged; endodermal cells at posterior end arranged along the axis of the larva, marking line of future cœlenteron, *C.*

Plate XXXII, Fig. 12.—Two-tentacled polyp, in section; four weeks old. *Ec.* thickened basal ectoderm.
Fig. 13.—Polyp, four months old, with five tentacles and five oral lobes, lying in the same vertical planes.
Fig. 14.—Polyp, five months old; in typical resting attitude, tentacles, expanded 2 mm.
Fig. 15.—Five-tentacled polyp, showing form of cœlenteron and formation of bud.
Fig. 16.—Polyp feeding upon a worm.
Fig. 17.—Larva twenty-three days old, exhibiting transverse fission of cœlenteron and elongated hydrocaulus.
Fig. 18.—Young medusa with twelve tentacles and four sense organs; showing spherical shape and constricted bell-margin.

Plate XXXIII, Fig. 19.—Thirty-two-tentacled medusa with fourteen sense organs. Seventh and eighth tentacles have appeared in each quadrant except quadrant A, where eighth is lacking. Four sense organs have appeared in quadrants B and D, five in quadrants A and C.
Fig. 20.—Tentacle-tip of medusa, showing rings of nematocysts, angle of tentacle, and adhesive organ on aboral side.
Fig. 21.—Cross section of adhesive organ. *G.C.*, gland cells composing cement gland; *M.F.*, muscular flange. 500/1, drawn by W. K. Brooks.
Fig. 22.—Ectodermal pad at base of tentacle. *E.P.*, ectodermal pad; *T.*, tentacle; *M.*, mesoglœa. Radial vertical section. Drawn by W. K Brooks.
Fig. 23.—Transverse section, at bell margin, of base of tentacle, showing tentacle pad, *C.P.*

Plate XXXIV, Fig. 24.—Horizontal section of bell margin at level of rudiment of tentacle, *T.R.*; *N*, rudimentary nematocysts; *N.R.*, nerve ring; *T*, tentacle; *C.C.*, circular canal.
Fig. 25.—Radial transverse section of bell, at point of origin of sense organ, *S.C.*, showing endodermal origin; *Caps.*, sensory capsule, surrounded by ectoderm; *V.*, velum. Drawn by W. K. Brooks.
Fig. 26.—Tentacle tip of larva from above. 500/1.
Fig. 27.—Nematocyst in detail, showing cnidocil, *Cn.*; ganglion cell. 2000/1.

FIVE NEW SPECIES OF TRACHELOMONAS.

BY T. CHALKLEY PALMER.

American forms of the genus *Trachelomonas* (Ehr.) Stein, though apparently not infrequent or wanting in variety, seem not to have been studied with any great degree of enthusiasm. The number of recognized species is small. Moreover, it is somewhat doubtful if known forms have been quite adequately distinguished and characterized. Since the days of Ehrenberg, also, the chemical constitution of the shells of *Trachelomonas* has been the theme of a continued, though desultory, discussion.

No attempt will be made, in this preliminary paper, to deal with the genus as a whole, or to discuss the values of characters relied upon for specific diagnosis. It will suffice for present purposes to take *Trachelomonas* as established by Ehrenberg, together with the same author's genera, *Lagenella*, *Chætotyphla* and *Chætoglena* as constituting one genus, the *Trachelomonas* of Stein and of most subsequent authorities. Neither is it necessary to enter here at length into the subject of the constitution of the lorica. This matter is, indeed, by no means simple; and certainly, it is not one capable of being decided, as to every species, by a few rough chemical tests upon the shells of one or two forms. The shells of *Chætotyphla* and *Chætoglena* were supposed by Ehrenberg to be silicious. On the other hand later investigators have found it possible to dissolve, wholly or in part, the shells of certain of these forms in acids. I have no notion of calling in question the correctness of any of these observations at present.

The lorica, however, in each of the five species now to be described is completely silicified. If this had not been the case, the following descriptions would not have been written now and in this form; for these five were selected from among about twenty, all appearing in a preparation of diatoms that had been strongly boiled for some time in a large volume of concentrated nitric acid, to which had been added, from time to time, small pieces of potassium chlorate. Moreover, subsequent experiments showed that the original material yielded the same shells, intact in every least feature, after long boiling in a mixture of equal parts of concentrated sulphuric acid and bichromate of potash. Other portions of the material were acted upon by both solutions in turn. Last of all the shells, after these processes, were mounted on a thin cover-glass, and this glass, supported on platinum, was brought to a low red heat, with incipient softening, and kept there for fifteen minutes. The loricæ emerged unaltered from this ordeal, in no way differing in this respect from the frustules of diatoms accompanying them. Whatever may be the case with other forms, therefore, the loricæ here described are neither chitinous nor calcareous but silicious. The material from which these forms were obtained came from Ancora, N. J. It was pointed out to the writer by Mr. C. S. Boyer, in the spring of 1897. It is in form of a grayish, paper-like film, and it completely covered many acres of boggy ground. It is made up mostly of the frustules of *Eunotia pectinalis* Kg., lined with the dead endoplasm and varnished over with coleoderm. This diatom, during the colder months, thrives enormously in the flooded cranberry bogs, and dies *in situ* when the water is drained off for the growing season. In addition to the *Eunotia*, the gathering contains the remains of various rhizopods, besides spicules of indeterminate origin, miscellaneous diatoms and *Trachelomonas.*

It is recognized that complete descriptions of the following species must include an account of the protoplasmic contents of the loricæ. This cannot be given here, for the reason that the organisms were long since dead and shrunken. Portions of the gathering were, however, macerated with water, and in some of the numerous forms enough was seen of the contents to indicate that the body of the living animal contained a quantity of deep-green chlorophyll, a part of which still survived. A final decision as to the allegiance of these forms must, undoubtedly, await a study of them in their living state. But the whole structure of the hard parts points to *Trachelomonas*, and the name is given with some confidence

Measurements are observed maxima in all cases. The total size will vary downward in different specimens of a given species, and with it, mostly to a corresponding degree, the dimensions of salient features.

Trachelomonas vestita n. sp. Pl. XXXV, figs. 1 and 2.

Lorica a sphere, opaque in air, with a prolonged, neck-like aperture. Walls of sphere complex, greatly thickened by a complete layer of radiating, closely compacted silicious rods or spicules. General surface of spicular coating showing numerous rounded and confluent terminations, with often a few more prolonged and somewhat spine-like. Neck transparent, finely striated longitudinally, flaring, with rounded, everted and somewhat reverted, finely fluted lip.

Diameter, including spicules, ...	25 μ.
Length of spicules, ...	2.5 μ.
Length of neck beyond spicules, ...	6.5 μ.
Diameter of lip, ...	7 μ.

Bogs, Ancora, N. J

Mounted in air the lorica shows yellowish-brown by transmitted light, bluish-green with a brown edge with spot-lens, and white on dark background with reflected light. In Canada balsam, colorless[1] and with a conspicuous spicular halo.

Trachelomonas spiculifera n. sp Pl. XXXV, fig. 4.

Lorica spherical. Wall thickened by a layer of radiating, compacted silicious spicules, less long than in *T. vestita*. Surface of spicular coating showing round, evenly sown, mostly isolated grains, the terminations of spiculæ. Aperture small, situated in a hyaline, nearly flat, crater-like area, with an upward-sloping, hyaline edge, which is circular or generally irregularly polygonal.

Diameter of sphere, ...	25 μ.
Diameter of crater, ...	7 μ.
Length of spicules, ...	1.25 μ.

Bogs, Ancora, N. J.

Mounted in air the lorica is slightly tinted with chocolate by transmitted light, light bluish-green with spot-lens, and nearly white on dark background with reflected light. In Canada balsam, colorless and with a spicular halo.

Trachelomonas vermiculosa n. sp. Pl. XXXV, fig. 3.

Lorica nearly spherical. Walls somewhat thin, general surface nearly smooth, at maturity adorned with high, rounded, isolated

---

[1] Color-effects with these silicious loricæ are no doubt due to refraction, interference, etc., and are serviceable or significant in specific diagnosis only to a very limited extent.

vermiform ridges. Aperture quite small, without crater-like area, the edge slightly raised, smooth and rounded.

Diameter of sphere,	23 μ.
Height of surface ridges,	2 μ.
Diameter of aperture at top,	2.5 μ.

Bogs, Ancora, N.J .

Mounted in air the lorica has a purplish tinge with transmitted light, is purple to yellow with spot-lens, and sometimes violet with top illumination. In Canada balsam, colorless.

Trachelomonas spinosa n sp. Pl. XXXV, fig. 6.

Lorica spherical, with long, slim neck. Walls transparent, somewhat granulate; spines about 10, hollow, nearly straight, slender, evenly tapering, distributed symmetrically. Neck with a strengthening ring of silica near the top. Aperture small.

Diameter of sphere,	13 μ.
Length of neck,	7 μ.
Greatest length of spines,	12 μ.

Bogs, Ancora, N. J.

Mounted in air, the lorica is nearly colorless by transmitted light, shining purple to violet with spot-lens and with top illumination on dark background. In Canada balsam, colorless and very faint.

Trachelomonas minor n. sp. Pl. XXXV, fig. 5.

Lorica spherical, with long, slim neck and one very long caudal spine. Walls transparent, surface showing a few isolated granules. Neck cylindrical, with capillary tube. Caudal spine nearly straight, or somewhat bent or spirally twisted, hollow.

Diameter of sphere,	9 μ.
Length of neck,	5 μ.
Length of spine,	17 μ.

Bogs, Ancora, N. J.

Mounted in air or in Canada balsam the lorica gives color-effects like those of *T. spinosa.*

Of the above, *T. spiculifera* and *T. spinosa* are fairly plentiful in the Ancora diatomaceous gathering, while *T. vestita* is not so abundant and *T. minor* may be called scarce. *T. vermiculosa* is about as plentiful as *T. vestita.* All five, however, are represented by numerous specimens, and a great many of each were studied with care. No wide variations from the types, as above given, were found in any of the five species, except in point of size as already mentioned, and to a minor degree in perfection of development, though not in character, of the surface markings. In particular, there seems to be no tendency toward intergradation in case of any of those here described, or among the other very numerous kinds, to be described in a future communication, which accompany them in this remarkable gathering.

In addition to the numerous forms from Ancora, N. J., others equally silicious, but quite distinct specifically, have been detected in small numbers among diatomaceous material from bogs and ponds over a wide range of country. All these are being made the subject of a careful study, the results of which are to be set forth in a future paper. Unmounted fresh material, preserved in formalin, which from its origin may be supposed to contain those organisms, is greatly desired by the writer.

EXPLANATION OF PLATE XXXV.

The figures are drawn to a uniform scale, an enlargement of 1200 diameters.

Fig. 1.—*Trachelomonas vestita* n. sp.
Fig. 2.—*Trachelomonas vestita* optical median section.
Fig. 3.—*Trachelomonas vermiculosa* n. sp.
Fig. 4.—*Trachelomonas spiculifera* n. sp.
Fig. 5.—*Trachelomonas minor* n. sp.
Fig. 6.—*Trachelomonas spinosa* n. sp.

The following reports were ordered to be printed:

REPORT OF THE RECORDING SECRETARY.

Forty-six meetings have been held during the year, with an average attendance of fourteen persons. Six weeks in midsummer were without a meeting because of the lack of a quorum. Verbal communications were made by Messrs. Lyman, Woolman, A. E. Brown, Harshberger, Pilsbry, Chapman, Murlin, Goldsmith, Crawley, Calvert, Montgomery, Shulz, Morris, Conklin, Mills, Stone, Moore, Keely, Bradner, Rhoads, Kraemer, H. Fox, Burnett Smith and Dr. Ida Keller.

Fifty-five papers have been presented for publication and acted on by the Publication Committee, as follows: Henry A. Pilsbry, 7; James A. G. Rehn, 7; Arthur E. Brown, 3; John W. Harshberger, 3; Thomas H. Montgomery, Jr., 3; S. N. Rhoads, 2; Howard Crawley, 2; J. Percy Moore, 2; Gerrit S. Miller, Jr., 2; Benjamin Smith Lyman, 1; G. K. Gude, 1; Ralph V. Chamberlain, 1; Thomas Meehan, 1; F. E. Blaisdell, 1; William J. Fox, 1; Albert M. Reese, 1; Edwin G. Conklin, 1; Clarence B. Moore, 1; Witmer Stone, 1; Witmer Stone and James A. G. Rehn, 1; Henry C. Chapman, 1; T. D. A. Cockerell, 1; John Raymond Murlin, 1; Henry Kraemer, 1; O. P. Hay, 1; Henry A. Pilsbry and Bryant Walker, 1; H. Carlton Bastian, 1; Ada Springer, 1; Henry F. Perkins, 1; Adele M. Fielde, 1; Malcolm P. Anderson and Joseph Grinnell, 1; William H. Dall, 1; H. Viereck, 1.

Forty-five of these have been published as papers in the *Proceedings*, two in the *Journal*, one has appeared as the report of a verbal communication, one was withdrawn, two were returned to the authors, two are in course of publication and two are held over until next year.

Since the last report there have been published of the *Proceedings* 907 pages and 41 plates; of the *Journal*, 358 pages and 6 plates; of the *Manual of Conchology*, 305 pages and 39 plates; of the *Transactions of the American Entomological Society* (the Entomological Section of the Academy), 367 pages and 9 plates, and of the *Entomological News*, 334 pages and 15 plates, making a total of 2271 pages and 110 plates issued by the Academy during the year.

We are indebted to Mr. Clarence B. Moore for the publication of the second part of the twelfth volume of the quarto *Journal*, the entire expense of printing and illustration having been defrayed by him.

The statistics of distribution remain the same as last year.

It is much to be regretted that the biographical memoir of our esteemed Vice-President, Thomas Meehan, the preparation of which had been provided for by the Academy as stated in the last annual report, has not yet been presented for publication.

Twenty members and one correspondent have been elected. The deaths of eighteen members and five correspondents have been announced. Seven members have been omitted from the roll because of non-payment of dues, and the following have resigned: Henry Leffman, Harry G. Parker, John H. Packard, Charles L. Phillips, Henry Erben, Miss E. W. Lowber, Theodore P. Matthews and Hampton L. Carson.

The Hayden Memorial Medal has been voted to Sir Archibald Geikie, D.Sc., LL.D., late Director-General of the Geological Survey of Great Britain and Ireland, and has been transmitted to him through H.B.M Consul in Philadelphia. This is the first time that the gold medal has been awarded, it having heretofore been struck annually in bronze and accompanied by a grant of the balance of interest arising from the fund. The modification has been made in the deed of gift by the founder of the award, Mrs. Ferdinand V. Hayden.

The cornerstone of the building formerly occupied by the Academy at the corner of Broad and Sansom streets, exposed during the demolition of the edifice, was received with its contents from the contractor, Mr. John Griffith, Jr., who received the thanks of the society. The contents of the interesting relic were found to correspond with the list recorded in the minutes of the meeting of May 25, 1839.

A resolution was adopted in January urging on the National Congress the propriety of erecting in Washington a memorial to the late Prof. Spencer F. Baird.

Mr. Stewardson Brown was appointed the Academy's representative to the proposed International Conference on Plant Breeding and Hybridization.

The Council Room and Lecture Hall continue to be used by several societies whose objects are in harmony with those of the Academy.

EDWARD J. NOLAN,
Recording Secretary.

REPORT OF THE CORRESPONDING SECRETARY.

During the year the roll of Correspondents has been revised. There have been stricken from the list of living the names of twenty-six persons whose decease has been ascertained. Direct responses to communications have been received from 132 Correspondents, and the addresses of sixty-nine more have been verified or corrected from other sources. There remain on the rolls the names of eighty-one persons whom the postal authorities have failed to find at the addresses indicated. A list of the last has been posted on the bulletin-board with the request that the Corresponding Secretary be advised by members having information which may assist in tracing any of those whose names appear.

There have been announced the deaths of the following: Carlos Berg, Henri Filhol, Alpheus Hyatt, John Wesley Powell and Rudolph Virchow.

Mr. George A. Boulenger, of the British Museum, has been elected a Correspondent.

It is desired to emphasize the importance of requiring a high standard of scientific productiveness as an invariable prerequisite to election as Correspondent of the Academy.

Responding to a circular letter of request seventy-six Correspondents have contributed and others have promised to contribute, to a collection of photographs and biographical sketches which is being formed. It is hoped that the representation of living correspondents will be completed during the ensuing year.

Copies of the Annual Reports were sent to all Correspondents whose addresses could be verified, and were acknowledged appreciatively by many.

Upon the invitation of the Senate of the University of Christiana to send a delegate to the meeting held to honor the memory of Niels Henrik Abel on the 100th anniversary of his birth, Prof. Robert Collett, a Correspondent, was appointed as the Academy's representative.

In lieu of sending delegates an address was forwarded to be read at the jubilee meeting of Prof. Albert Gaudry, held in Paris, and letters of sympathy to be read at the Boston meeting memorial to Prof. Alpheus Hyatt, and at the funeral services of Prof. Lacaze-Duthiers.

The statistics of the correspondence for the fiscal year are given in the following table:

COMMUNICATIONS RECEIVED.

Acknowledgments of the Academy's publications,	177
Notices transmitting publications,	66
Requests for exchanges and deficiencies,	10
Invitations to participate in meetings, etc.,	6
Circulars concerning the administration of scientific institutions, research funds, etc.,	4
Notices of the deaths of scientific men,	5
Photographs from correspondents,	76
Letters from correspondents,	43
Miscellaneous letters, requests for information, etc.,	12
Total communications received from 158 institutions and 104 individuals,	399

COMMUNICATIONS FORWARDED.

Acknowledgments of gifts to the Library,	667
Acknowledgments of gifts to the Museum,	84
Acknowledgments of photographs,	76
Copies of Circular letter,	132
Copies of Annual Reports,	173
Notices of election and correspondent's diplomas,	3
Address, resolutions, letters of congratulation and condolence,	4
Letters to correspondents,	14
Letters on miscellaneous topics,	21
Total forwarded,	1174

Respectfully submitted,

J. PERCY MOORE,
Corresponding Secretary.

REPORT OF THE LIBRARIAN.

The additions to the Library during the past year have amounted to 6,086. They were received from the following sources:

Societies,	2,259
I. V. Williamson Fund,	1,158
Editors,	765
General Fund,	683
Meigs Fund,	299
Authors,	211
U. S. Dep't of the Interior,	178
James L. Pennypacker,	164
U. S. Dep. of Agriculture,	86
Wilson Fund,	35
Geological Surv. of Sweden,	34
Ministry of Public Works, France,	15
East Indian Government,	15
Geolog'l Surv. of Russia,	13
U. S. Department of State,	11
Geological Survey of Belgium,	11
Observatory of Manila,	11
Pennsylvania State Library,	10
Geological Survey of India,	9
Mexican Government,	8
Henry A. Pilsbry,	8
Trustees of the British Museum,	8
Department of Agriculture, Cape of Good Hope,	7
Geological Survey of New South Wales,	6
Geological Survey of Finland,	6
Messrs. Pilsbry and Johnson,	5
Department of Mines, Victoria,	4
Conchological Section of the Academy,	4
U.S. Com. of Fish and Fisheries	3
U.S. Coast and Geodetic Surv.,	3
Geological Survey of Canada,	3
Bernice Panahi Museum,	3
Library of Congress,	2
Dr. W. W. Keen,	2
Special Exchange,	2
Bergen Museum,	2
Dr. H. C. Chapman,	2
Home Sec's Office, Queensl.,	2
Mrs. C. B. Aaron,	2
Illinois State Bureau of Labor,	2
Indian Museum,	2
Geological Survey of New Jersey,	2
Dr. S. G. Dixon,	2
Duc de Loubat,	2
U. S. Treasury Dep.,	1
U. S. Department of War,	1
United States Civil Service Commission,	1
Surgeon-General's Office,	1
Chicago Library Club,	1
Angelo Heilprin,	1
Dr. William Osler,	1

Commission of Inland Fisheries and Game, Massachusetts,	1
Norwegian Government,	1
Surveyor-General's Office, Natal,	1
Department of Mines, Nova Scotia,	1
Geological Survey of Portugal,	1
Edward J. Nolan,	1
Instituto Geologico de Mexico,	1
Bentham Trustees, Kew Gardens,	1
Morris Jastrow, Jr.,	1
Department of Marine and Fisheries, Canada,	1
Kommission zur wissenschaft. Untersuchungen der deutschen Meere in Kiel., Ab. Helgoland,	1
Geological Survey of Washington,	1
Council of the Fritjof Nansen Fund for the Advancement of Science,	1
Danish Government,	1
Bureau of American Ethnology,	1
Bryant Walker,	1
Geological Survey of Louisiana,	1
T. Guilford Smith,	1
Geological Survey of Iowa,	1
Witmer Stone,	1

They were distributed to the several departments of the Library as follows:

Journals,	4,672
Geology,	428
Botany,	178
General Natural History,	123
Conchology,	89
Entomology,	75
Voyages and Travels	64
Agriculture,	55
Anthropology,	50
Geography,	50
Anatomy and Physiology,	48
Mammalogy,	38
Ornithology,	37
Herpetology,	35
Physical Sciences,	32
Icthyology,	23
Encyclopedias,	19
Medicine,	17
Miscellaneous,	16
Mineralogy,	12
Bibliography,	11
Helminthology,	11
Philology,	2
Mathematics,	1

Of these 4,960 were pamphlets and parts of periodicals, 960 were volumes and 166 were maps and sheets.

We are also indebted to Dr. William P. Wilson for a collection of 617 Muybridge plates illustrating animal motion. They will fill six portfolios and go far toward the completion of the Academy's collection of these interesting plates, of which previously there were but 103 in the Library.

Four hundred and ninety-eight volumes have been bound.

A death-mask of Dr. Joseph Leidy, whose memory is held in deserved esteem, has been presented by his nephew, Dr. Joseph Leidy, Jr.

The decrease in the number of volumes bound and the slight falling off of receipts from those reported last year are consequent on the absence of the Librarian from May until October, four months' vacation having been kindly granted him by the Council for the improvement of his health, an end which was measurably secured by a prolonged stay in Italy. He has great pleasure in acknowledging his obligation to his assistant, Mr. William J. Fox, who during that period performed the routine work of the Library and also acted as Recording Secretary most acceptably.

All of which is respectfully submitted,

Edward J. Nolan,
Librarian.

REPORT OF THE CURATORS.

The year just past has been one of prosperity. While the society's income is small compared with that of many other institutions of like character, the increase in its scientific collections has been large, and the results obtained in original research have been the most extensive in its history.

The buildings and the collections in the care of the Curators have been kept in excellent condition during the year, while many improvements have been effected.

Additional space has been provided for the Entomological department by enclosing another section of the first floor of the old Museum. The taxidermist's quarters in the new wing have been partitioned off from the rest of the basement and heated.

An enlarged system of steam pipes, covered with magnesia, has been introduced in the old building.

Five new plate-glass and mahogany cases have been placed in the Museum during the year, one large case for birds and two for mammals, while Mr. Clarence B. Moore has added two for the accommodation of the archæological material obtained by him in northwestern Florida. A number of moth-proof storage cases of various kinds have been provided for the rapidly increasing study series of birds, mammals and insects.

The Museum staff was further increased at the beginning of the year by securing the services of Dr. J. Percy Moore and Mr. C. W. Johnson as assistants to the Curators. Dr. Moore has taken charge of the Helminthological collection and has identified and catalogued all of the material in the Museum. During the summer, when on leave of absence at Woods Hole, he made valuable collections in this department for the Academy.

Mr. Johnson, besides the care of the Isaac Lea Collection of Eocene Mollusca, which he has continued as heretofore, has been able to rearrange, identify and label the entire series of American Cretaceous invertebrates. The types identified number upward of 400. The additions to the Lea collection for the year number 730 trays.

In the care and arrangement of the various study collections important work has been accomplished, the details of which will be found in the reports of the several sections--that on the Conchological collections by Dr. Pilsbry; the Ornithological by Mr. Stone; the Botanical by Mr. Stewardson Brown, and the Entomological by Dr. Skinner.

In the rearrangement of the Museum the most notable work has been the installation of nearly one-half of the mounted birds in the cases provided for them in the new building. The specimens have been carefully examined by the taxidermist and labeled and arranged by Mr. Stone. Almost all the water-birds and the greater part of the Gallinaceæ have been transferred, and the floor will be ready for opening in the spring.

Rearrangement of the mounted mammals has been made necessary by the addition of new cases, and the moose and other exposed specimens have been placed under glass. Several attractive mounts have been prepared during the year, notably the groups of Siamangs collected and presented by Mr. Alfred C. Harrison, Jr., and Dr. H. M. Hiller.

The alcoholic material has been examined, and a large number of specimens have been catalogued and systematically arranged.

In the Department of Archæology, Mr. Clarence B. Moore has added many valuable specimens to his collection and has personally superintended their arrangement and labeling, while Miss H. N. Wardle has made important progress in cataloguing the Haldeman collection.

The additions to the collections during the year have been of importance, as may be seen from the appended list. Most noteworthy were the valuable series of vertebrates and insects collected in Sumatra by Mr. Alfred C. Harrison, Jr., and Dr. H. M. Hiller and generously presented by them to the Academy. Reports on these collections have already been published or prepared for publication, covering the mammals, birds, reptiles and fishes.

Another important gift was a collection of 2,000 plants from the western United States received from Mr. Benjamin H. Smith, while Alfred C. Harrison, Jr., Clarence B. Moore, Samuel F. Houston, John Carter, Charles H. Cramp, James D. Winsor and Beulah M. Rhoads, members of the Academy, have secured through purchase a valuable series of birds from the Galapagos Islands.

From its general fund the Academy has also been enabled to purchase the Rhoads Collection of North American Mammals, comprising some 4,000 skins and skulls which fill an important gap in the Museum, and places the mammal collection on an excellent basis.

Many valuable specimens of mammals, birds and reptiles have been received during the year from the Zoological Society of Philadelphia, and Dr. H. C. Chapman has presented a beautifully prepared set of marine invertebrates obtained from the Zoological Station at Naples.

During the spring Messrs. H. L. Viereck and J. A. G. Rehn visited southern New Mexico under direction of the Academy, and secured valuable collections of insects and plants and many vertebrates.

The Conservator of the William S. Vaux Collections, Mr. Theodore D. Rand, regrets that owing to illness he has not been able to give as much time to his duties as heretofore. With the assistance of Mr. George Vaux, Jr., such desirable specimens as came to his notice have been purchased. Among them may be specially mentioned a specimen of the water-enclosing chalcedony from Brazil, enclosed in a gangue of igneous rock, and two remarkably fine crystals of epidote from Prince of Wales Island, Alaska.

Besides the services rendered by the salaried Museum Staff, the Curators would express their indebtedness to Messrs. Theodore D. Rand, Lewis Woolman, Philip P. Calvert and Charles Liebeck for aid in various departments, and to the students of the Jessup Fund, Messrs. E. G. Vanatta, J. A. G. Rehn, H. L. Viereck and Miss H. N. Wardle.

A large number of specialists have visited the Academy during the year for the purpose of studying the collections and material has been loaned to the following: J. Dwight, Jr., G. S. Miller, Jr., William Brewster, W. B. Scott, H. F. Osborn, W. T. Hornaday, T. Wayland Vaughan, J. N. Rose, M. W. Lyon, J. W. Gidley, Robert Ridgway, W. H. Dall, C. D. Beadle, H. C. Oberholser, B. G. Wilder, W. B. Clarke, F. A. Lucas, C. W. Richmond.

REPORTS OF THE SECTIONS.

Biological and Microscopical Section.

The regular monthly meetings of the Section have been held with an attendance larger than that of last year. Several new members have been admitted.

Numerous communications were made as follows: By Mr. John W. Palmer upon malarial fever in the Philippines and upon collections of diatoms made in the same locality; by Dr. T. S. Stewart upon smallpox and bacteria; by Dr. J. Cheston Morris upon various pathological subjects, including Texas fever and vaccine virus; by Mr. John A. Shulze upon mounted specimens of diatoms; by Mr. T. C. Palmer on *Trachelomonas;* Mr. Silas L. Schumo on Mosses; Mr. Hugo Bilgram and Mr. Harold Wingate on Myxomycetes; Mr. Lewis Woolman on microscopic organisms in recent artesian well borings, and Mr. William B. Davis and Mr. C. S. Boyer on diatoms.

The Conservator reports as an addition to the collection a set of microscopic slides illustrating the structure of the placenta in Marsupials, presented by Dr. Chapman.

It has been proposed to hold extra meetings upon certain stated evenings during the year, for informal discussion and for the exhibition of microscopical slides.

The following officers have been elected:

Director, ...	J. Cheston Morris, M.D.
Vice-Director, . . .	T. Chalkley Palmer.
Recorder, ...	Charles S. Boyer.
Corresponding Secretary, .	Silas S. Schumo.
Conservator, ...	F. J. Keeley.
Treasurer, ...	Lewis Woolman.

CONCHOLOGICAL SECTION.

The growth of the collection of mollusks during the year has been satisfactory, although no single large accession has been received. A list of those giving specimens will be found in connection with the *Additions to the Museum.* The chief gifts in point of extent were the series of Japanese mollusks sent by Mr. Y. Hirase, Zanzibar species from Sir Charles Eliot, and Carolinian land snails from Mr. J. H. Ferriss. The greater portion of the material has been studied and the work on a large part of it is embodied in papers published in the *Proceedings* of the Academy.

The completion of the monograph on Bulimulidæ has rendered possible the arrangement of that group in the Museum, where two double table-cases now contain the exhibition series. The work of identifying and monographing the Urocoptidæ is in progress. The *Manual of Conchology* has been issued during the year, as hitherto.

The following officers were elected to serve for the ensuing year:

Director, ...	Charles W. Johnson.
Vice-Director, . . .	John Ford.
Corresponding Secretary, .	E. G. Vanatta.
Treasurer, ...	S. Raymond Roberts.
Librarian, ...	Edward J. Nolan.
Conservator, ...	Henry A. Pilsbry.

Entomological Section.

The Recorder reports that the meetings of the Section, at which interesting communications were made, have been well attended during the year. One member and one associate were elected. The *Entomological News,* the journal published by the Section, has been continued, 334 pages and 15 plates having been issued. The collections have been useful to our own students, and a number of investigators from other scientific institutions have visited the Academy to study them. Over 37,000 specimens have been added during the year, 25,000 having been collected by an expedition sent out by the Academy. Many species new to science have been described by the members of the Section and a few have been sent to specialists elsewhere for study and description. The collections are in a good state of preservation and improved boxes and cabinets have been added. Additional floor space has been granted and enclosed by the Academy to provide for the growth of the Section. At the annual meeting, held December 18, the following were elected to serve as officers during the year 1903:

Director,	Philip Laurent.
Vice-Director,	H. W. Wenzel.
Treasurer,	E. T. Cresson.
Recorder and Conservator,	Henry Skinner.
Secretary,	C. W. Johnson.
Publication Committee,	C. W. Johnson, J. H. Ridings.

Botanical Section.

Accessions to the herbarium fully up to those of former years are reported. About 6,000 specimens, principally North American, have been received, the greater number being donations.

The most important of these is a collection of Western American plants, consisting of 1,925 species and numbering considerably over 2,000 mounted sheets, representing most of the characteristic genera and a large number of the species of the Rocky Mountain region, presented by Mr. Benjamin H. Smith, the collection having been made by him some years ago while living in that district. It comprises, besides plants of his own collecting, those of Pringle, Suksdorf, Howell and others, many of the sheets being annotated by the late Dr. Porter, thus adding considerably to their interest and value. The collection includes a number of species and several genera not before represented in the herbarium.

A collection of 430 California and Oregon plants, made by Mr. H. E. Brown, was presented by the Conservator.

A collection of about 800 North American plants was presented early in the year by Mr. William M. Canby. They represent nearly all regions from the east coast to the west, including Georgia, Florida, the Gulf States and part of Mexico. The collection contains a number of recently named species, notably of *Cratægus,* not already contained in the herbarium.

A collection of about 100 specimens, of similar range of localities, was presented by Prof. Charles S. Williamson.

Smaller collections have been presented by Prof. E. A. Garratt, from British Columbia; by C. F. Saunders, from Vermont, and by E. G. Vanatta, from Maryland.

An interesting collection of about 130 specimens, made in the vicinity of Sandwich Bay, Labrador, during the past summer, was presented by Dr. Amos P. Brown.

A collection of West Indian plants, presented by Dr. John W. Harshberger, was collected by him in Jamaica, Haiti and Santo Domingo in 1901.

Messrs. James A. G. Rehn and H. L. Viereck, of the Academy's expedition to southwestern Texas and New Mexico, early in the year, brought back a good series of about 2,000 specimens of the plants of that region. The collection is particularly rich in the Cacti, of which most excellent examples were obtained. It adds a number of desirable forms to the collection, and when thoroughly studied will probably add several species to science.

The collections purchased by the Academy include about 900 specimens of California plants received from Mr. A. A. Heller, made by himself and Mr. H. E. Brown during the past season; 540 West Australian plants from Dr. Pritzel, and about 350 Canary Island plants from Dr. Bornmüller.

Most of these specimens have been mounted and consolidated with the general collection, and the others will be similarly arranged at as early a date as possible.

The work of arranging the C. W. Short Herbarium has progressed satisfactorily during the year, about 15,000 sheets having been mounted, completing the work through the Scrophulariaceæ. These specimens have been incorporated in the general collections, thus in many instances crowding the cases, so that additional room is required.

The local herbarium of the Philadelphia Botanical Club has been enriched by donations from its members aggregating about 500 specimens.

The meetings of the Section, at which a number of communications of scientific interest have been presented, have been held regularly during the year.

At the meeting held December 8, 1902, the following were elected to serve as officers for the ensuing year:

Director, ...	Benjamin H. Smith.
Vice-Director, ...	Joseph Crawford.
Recorder, ...	Dr. Ida A. Keller.
Corresponding Secretary, . .	John T. Pennypacker.
Treasurer and Conservator, .	Stewardson Brown.

MINERALOGICAL AND GEOLOGICAL SECTION.

The Director reports that nine meetings were held, with an average attendance of eight members. Six field meetings were held, at which the attendance was large. Some of the specimens collected were given to the Academy.

The officers elected for the ensuing year are as follows:

Director, ...	Theodore D. Rand.
Vice-Director, ...	Benjamin Smith Lyman.
Treasurer, ...	Emma Walter.
Conservator, ...	F. J. Keeley.
Recorder, ...	Charles Schäffer, M.D.

ORNITHOLOGICAL SECTION.

During the past year the Conservator has completed the arrangement of the mounted birds on the new ornithological floor, so far as the case-room will permit. The four large cases and three small ones now in place cover about 900 square feet of floor space and accommodate almost all of the water-birds and the majority of the Gallinaceæ, or approximately half of the mounted collection, so far as space occupied is concerned.

The specimens transferred during the year have all been labelled and have been carefully examined by the taxidermist, while the entire series has been rearranged to bring it into systematic sequence.

Several old horizontal cases have been renovated and placed on the ornithological floor for the accommodation of a special collection, prepared for exhibition by the Conservator, illustrating the structure and molt of birds.

The opening of this department to the public, unavoidably postponed, will take place early in the coming year.

Two additional large wooden storage cases and sixteen tin cases were provided for the accommodation of the rapidly increasing study collection of skins, and much important work has been accomplished in transferring the specimens to the new cases and in properly labelling the trays to aid in their examination. For this, as well as aid in cataloguing the collection, the Conservator is much indebted to Mr. J. A. G. Rehn.

Several valuable additions have been made to the collection of birds during the year, notably the beautiful series of specimens from Sumatra, collected and presented by Mr. Alfred C. Harrison, Jr., and Dr. H. M. Hiller, containing many forms new to the collection.

A collection of the birds of the Galapagos Islands was purchased through subscriptions by members of the Academy. This material fills an important gap in our collection, as the Academy previously possessed no specimens from this region. An interesting series of New Mexican birds was collected by Mr. Rehn while on the expedition sent out by the Academy in the spring, and many other specimens were received through gift or purchase.

The Delaware Valley Ornithological Club and the Pennsylvania Audubon Society have continued to hold their meetings in the Academy, and have done much to stimulate ornithological study. By invitation the American Ornithologists' Union has arranged to hold its twenty-first Congress at the Academy in November, 1903.

Many visiting ornithologists have made use of the collections during the year, and considerable aid has been given to workers in other institutions.

At the annual meeting of the Section, December 18, 1902, the following officers were chosen for the ensuing year:

Director,	Spencer Trotter, M.D.
Vice-Director,	George Spencer Morris.
Secretary,	William A. Shryock.
Recorder,	Stewardson Brown.
Treasurer and Conservator,	Witmer Stone.

The election of Officers, Councilors and Members of the Committee on Accounts to serve during 1903 was held with the following result:

PRESIDENT,	Samuel G. Dixon, M.D.
VICE-PRESIDENTS,	Arthur Erwin Brown, Edwin G. Conklin, Ph.D.
RECORDING SECRETARY,	Edward J. Nolan, M.D.
CORRESPONDING SECRETARY,	J. Percy Moore, Ph.D.
TREASURER,	George Vaux, Jr.
LIBRARIAN,	Edward J. Nolan, M.D.
CURATORS,	Henry C. Chapman, M.D., Arthur Erwin Brown, Samuel G. Dixon, M.D., Henry A. Pilsbry, D.Sc.
COUNCILORS TO SERVE THREE YEARS,	Thomas A. Robinson, Charles H. Cramp, Charles Morris, Isaac J. Wistar.
COMMITTEE ON ACCOUNTS,	Charles Morris, William L. Baily, Harold Wingate, Lewis Woolman, Philip P. Calvert, Ph.D.
COUNCILORS TO SERVE UNEXPIRED TERM OF TWO YEARS,	Edwin S. Dixon, Thomas H. Fenton, M.D.

COUNCIL FOR 1903.

Ex-officio.—Samuel G. Dixon, M.D., Arthur Erwin Brown, Edwin G. Conklin, Ph.D., Edward J. Nolan, M.D., J. Percy Moore, Ph.D., George Vaux, Jr., Henry A. Pilsbry, D.Sc., Henry C. Chapman, M.D.

To serve Three Years.—Thomas A. Robinson, Charles H. Cramp, Charles Morris, Isaac J. Wistar.

To serve Two Years.—John Cadwalader, William Sellers, Edwin S. Dixon, Thomas H. Fenton, M.D.

To serve One Year.—Charles Schäffer, M.D., Dr. C. Newlin Peirce, Theodore D. Rand, Philip P. Calvert, Ph.D.

CURATOR OF MOLLUSCA, . .	Henry A. Pilsbry, D.Sc.
ASSISTANT LIBRARIAN, . .	William J. Fox.
ASSISTANTS TO THE CURATORS, .	Witmer Stone, Henry Skinner, M.D., Stewardson Brown, J. Percy Moore, Ph.D., Edward G. Vanatta, Henry W. Fowler, J. A. G. Rehn.
TAXIDERMIST, ...	David McCadden.

Jessup Fund Students, . . .	J. A. G. Rehn, Raymond Winter, Harriet Newell Wardle.

Janitors, ...	Charles Clappier, John McIlhenny, Daniel Heckler.

ELECTIONS DURING 1902.

MEMBERS.

January 28.—J. Chester Bradley, Marian G. Nimlet, Alfred C. Harrison, Jr., H. M. Hiller, Judson Daland, M.D , Owen S. Paxson, Frederick Ehrenfeld, Burnett Smith.

February 25.—J. R. Murlin, Ph.D., A. F. K. Krout, James A. Nelson, A. B. Gordon-Davis.

March 25.—Madeline Dahlgren.

April 29.—Edwin C. Jellett, Frederick A. Packard, M.D., Robert Coleman Banes.

June 24.—Alexander MacElwee, John Vinton Dahlgren.

November 25.—Herman T. Wolf, Lilian V. Sampson.

CORRESPONDENT.

May 27.—G. A. Boulenger, of London.

ADDITIONS TO MUSEUM.

MAMMALS.

E. O. AUSTIN. Two Varying Hares, *Lepus americanus virginianus*, skins and skulls, Potter county, Pa.

C. M. BARBER. Skull of fœtal Puma, *Felis oregonus hippolestes;* skin and skull of *Perognathus* sp. and three alcoholic mammals.

ARTHUR ERWIN BROWN. Two skins of black Prairie Dog, *Cynomys*, and skull of Antelope, *Antilocapra*, Pecos, Texas.

HENRY C. CHAPMAN, M.D. *Galeopithecus volans*, dissected, in alcohol; two young Armadillos.

JONATHAN COPE. Fragment of Walrus jaw.

J. G. DILLEN. Star-nosed Mole, *Condylura cristata*, Pennsylvania, skin.

G. P. FRIANT. *Putorius cicognani*, skin, Scranton, Pa.

J. F. JONES. Eight-legged Puppy.

ALFRED C. HARRISON, JR., and DR. H. M. HILLER. Collection of sixty-three specimens of mammals from Sumatra.

GEORGE W. MELVILLE. Mounted head and skull of Pacific Walrus, *Odobenus obesus*.

J. PERCY MOORE. Five specimens of Bats from Jamaica, including *Glossophaga soricina antillarum.*

PURCHASED. Rhoads collection of North American mammals. Skins, skulls and skeletons numbering about 4300 specimens.

Four skins and skulls of Grizzly Bear and skin of *Conepatus* from Chihuahua, Mexico; series of mammal skins collected at Pt. Barrow, Alaska, by E. A. McIlhenny; twelve bats from Cuba.

J. A. G. REHN. Ten skins of Pennsylvania mammals.

J. A. G. REHN and H. L. VIERECK. (Collected on Academy Expedition to New Mexico.) Forty-six skins and skulls of small mammals.

S. N. RHOADS. Six Meadow Mice, *Microtus pennsylvanicus*, in alcohol, and skull of Muskrat, *Fiber zibethicus.*

WITMER STONE. Four skins and skulls of Barren Ground Caribou, two adults and two young, *Rangifer arcticus*, Pt. Barrow, Alaska.

U. S. NATIONAL MUSEUM. (In exchange.) Nineteen mammals (skins, skulls and alcoholic), mainly from the Malay region.

GEORGE VAUX, JR. Skull of Black Bear, *Ursus americanus*, British Columbia.

H. L. VIERECK. Incomplete skeleton of Cat.

OLIVER WHELER. Three skins of Pika, *Ochotona cuppis*, and a Chipmunk, *Tamias*, Glacier, B. C.

Lieut. H. L. Willoughby. Skin and skeleton of Manatee, *Trichechus latirostris* (for mounting), Florida.

Lewis Woolman. Two young moles, *Scalops aquaticus*, alcoholic, New Jersey.

Zoological Society of Philadelphia. Specimens prepared as indicated: Mounted: Nilghai, *Boselaphus tragocamelus*. To be mounted: Axis Deer, *Cervus axis;* European Otter (male), *Lutra lutra;* Mongoose Lemur, *Lemur mongoz;* Chimpanzee, *Anthropopithecus troglodytes.* Skin and skulls: Brush-tailed Wallaby, *Petrogale penicillata;* South American Opossum, *Didelphis cinerea* (no skull); Nine-banded Armadillo, *Tatu novemcinctum;* Burchell's Zebra, *Equus burchelli;* Stanley's Chevrotain, *Tragulus stanleyanus;* two Arizona Cottontails, *Lepus arizonæ minor;* two European Hares, *Lepus europæus;* Gopher, *Cratogeomys castanops;* Gray Wood Rat, *Neotoma micropus canescens;* Agouti, *Dasyprocta isthmica;* Price's Chipmunk, *Tamias pricei;* Algerian Hedgehog *Erinaceus algerus;* Two Black-footed Raccoons, *Procyon hernandezii;* European Otter (female), *Lutra lutra;* Great-eared Fox, *Otocyon megalotis;* Black-backed Jackall, *Canis mesomelas;* Japanese Macaque, *Macacus fuscatus;* Mona Monkey, *Cercopithecus mona;* White-crowned Mangaby, *Cercocebus æthiops;* Hocheur Monkey, *Cercopithecus nictitans;* Dwarf Lemur, *Microcebus coquereli;* Black Lemur, *Lemur macaco.* Skeletons: Rufous-necked Wallaby, *Halamaturus ruficollis;* Great Kangaroo, *Macropus giganteus.* Skulls. Hamadryas Baboon, *Papio hamadryas;* Japanese Deer, *Cervus sika;* Prehensile-tailed Porcupine, *Coëndu prehensilis;* Japanese Monkey, *Macacus fuscatus.* Alcoholic: five Bats from Pecos, Texas.

Birds.

Col. G. S. Anderson. Eight bird skins from the Philippines.

R. L. Blankenberg. Ostrich egg.

C. B. Clement. Pied-billed Grebe, *Podilymbus podiceps.*

Delaware Valley Ornithological Club. Two nests and eggs of Pennsylvania birds for the D. V. O. C. collection.

O. G. Diehl. Specimen of Australian Paraquet, *Callopsittacus novæhollandiæ* (mounted).

C. H. Guilbert. Mockingbird, *Mimus polyglottos.*

Alfred C. Harrison and Dr. H. M. Hiller. Collection of four hundred and forty bird skins from Sumatra.

Mr. and Mrs. T. R. Hill. Two skins of Canada Grouse, *Canachites canadensis*, Alaska

Purchased. Seven bird skins from Chihuahua, Mexico; forty bird skins from Colorado, Texas, etc.

Purchased by Subscription. Collection of bird skins from the Galapagos Islands.

J. A. G. Rehn. Skin of Meadow Lark, *Sturnella magna.*

J. A. G. Rehn and H. L. Viereck. (Collected on Academy Expedition to New Mexico) One hundred and twenty-one skins of birds and three nests.

S. N. Rhoads. Collection of Florida bird skins and several specimens of *Micropus* from Mexico.

Mrs. Charles Schaffer. Skins of Water Ousel, *Cinclus mexicanus*, and Jay, *Cyanocitta stelleri.*

L. I. Smith, Jr. Skin of Night Heron, *Nycticorax n. nævius*, Delaware county, Pa.

Rosealla Stuart. Skin of Robin, *Merula migratoria* (very old cage bird).

C. C. Taylor. Skin of Franklin's Grouse, *Dendrogapus franklini.*

H. L. Viereck. Nine skins of Pennsylvania and Virginia birds.

Zoological Society of Pennsylvania. Specimens prepared as follows: Skeletons: *Mycteria americana, Coscoroba coscoroba, Pelecanus crispus.* Skull and sternum: Cormorant, *Phalacrocorax* sp. Skins: Two *Heleodytes brunneicapillus, Dissemurus paradisæus, Cotinga cincta, Tanagra abbas, Conurus patagonus, Pauxi pauxi, Carpodacus purpureus* (abnormal). Nest and eggs: *Heleodytes brunneicapillus.*

Reptiles and Batrachians.

C. M. Barber. Two reptiles from Chihuahua, Mexico.

Arthur Erwin Brown. Three specimens of *Coluber subocularis*, and one *Ophibolus attenuatus* type. Collection of two hundred and twenty-one reptiles mainly from Western Texas.

Dr. H. C. Chapman. Soft-shelled Turtle from Cooper's Creek, N. J.

Dr. S. G. Dixon. Toad, *Bufo lentiginosus americanus*, British Columbia.

Alfred C. Harrison, Jr., and Dr. H. M. Hiller. Collection of reptiles from Sumatra.

Joseph L. Hicks. Gecko, Jamaica.

Dr. William E. Hughes. Small collection of reptiles from Chihuahua, Mexico.

Dr. W. H. Jones' Estate. Several reptiles from various localities.

Witmer Stone, and J. A. G. Rehn. Several reptiles from New Jersey. (Collected for the Academy.)

Witmer Stone. Muhlenberg's Turtle, *Chelopus muhlenbergi*, Pennsylvania, and Green Snake, *Cyclophis æstivis*, New Jersey.

I. A. Sweigart. Stuffed Alligator, skin of Rattlesnake.

L. H. T. Townsend, and C. M. Barber. Two Turtles, *Nicoria rubida*, Colina, Mexico.

Lieut. H. L. Willoughby. Young Crocodile, *C. americanus.*

Dr. H. C. Wood. Small series of reptiles from Egypt.

Zoological Society of Philadelphia. Crocodile, *C. americanus*; two snake-eating Cobras, *Naja bungara*; Madagascar Boa, *Boa madagascariensis*; *Varanus niloticus*; three *Emyda granosa.*

FISHES.

J. COPE. *Cottus ictalops*, Chester county, Pa.

ALFRED. C. HARRISON, JR., and DR. H. M. HILLER. Large collection of Sumatran fishes.

DR. W. H. JONES' ESTATE. Several small fishes from Pacific islands.

DAVID MCCADDEN. Several Atlantic coast fishes.

FRANK SMITH. *Cephalacanthus volans*, New Jersey.

I. A. SWEIGART. *Carcharius obscurus*, stuffed.

INSECTS.

ACADEMY EXPEDITION TO TEXAS AND NEW MEXICO. Twenty-five thousand insects.

O. W. BARRETT. Eight Orthoptera from Porto Rico.

DR. A. BORELLI. Sixty-one Orthoptera from Paraguay.

J. C. BRADLEY. Two hundred and thirty-eight insects, various orders.

DR. P. P. CALVERT. Eighteen Odonata from United States.

DR. D. M. CASTLE. Twenty-four Coleoptera from the United States.

T. D. A. COCKERELL. One hundred and eighty-seven insects from New Mexico.

LUCY V. CRAWLEY. One Orthopter.

E. T. CRESSON. Two hundred and fifty Hymenoptera from Brazil.

DR. S. G. DIXON. Four insects from British America.

S. N. DUNNING. Five thousand four hundred and forty Hymenoptera from United States.

DR. PHILIP FISCHELIS. Ten Solpugidæ from Russia.

W. J. FOX. Fourteen Hymenoptera from Brazil.

GEORGE FRANCK. Three Lepidoptera from United States.

A. C. HARRISON, JR., and DR. H. M. HILLER. One thousand five hundred insects from Sumatra.

S. H. HAMILTON. Forty-three insects from Cuba. Purchased.

MORGAN HEBARD. One Lepidopter from Colorado.

Y. HIRASE. Five hundred Orthoptera from Japan. Purchased.

DR. W. E. HUGHES. Forty-two Coleoptera and Orthoptera from Mexico.

C. W. JOHNSON. Seventy Diptera from United States.

DR. W. H. JONES. One hundred and eighty insects from Corea.

WARREN KNAUS. Eighteen Coleoptera from Kansas.

L. W. MENGEL. Sixteen Lepidoptera (exotic).

H. H. NEWCOMB. Four Lepidoptera from Mt. Katahdin, Maine.

E. J. NOLAN, M.D. Two insects from Italy.

O. E. POLING. Forty-two Heterocera from Western United States.

J. A. G. REHN One hundred and eighty-four Orthoptera from United States.

S. N. RHOADS. One thousand two hundred and seventy-four insects from Florida, Cuba and Mexico.

Wirt Robinson. Twenty-five Coleoptera and Lepidoptera from Jamaica, W. I.

Henry Skinner. One hundred and ninety insects, including one hundred and twelve Lepidoptera from Thibet.

C. S. Smallwood. Seventy Lepidoptera and Orthoptera from Florida.

J. B. Smith. Eight Heterocera from United States.

K. Stoddard. One Lepidopter from Pennsylvania.

W. Stone. Five Hymenoptera from Philadelphia.

Mrs. Charles Schaeffer. Three Lepidoptera from British Columbia.

H. E. Summers. Thirty-one Hemiptera from United States.

Lancaster Thomas. Four insects from North Carolina.

C. H. T. Townsend. Twenty Orthoptera from Colima, Mexico.

E. G. Vanatta. Thirteen insects from Pennsylvania.

H. L. Viereck. Two hundred and thirty-five insects from United States.

H. W. Wenzel. Eleven Hymenoptera from North Carolina.

Joseph Willcox. Sixty Coleoptera from North Carolina.

Dr. H. C. Wood. Sixty-six Coleoptera from Africa.

Zoological Society of Philadelphia. Four Scolopendra and insects.

F. S. Schaupp. One hundred and fifty-nine Orthoptera from Texas.

Witmer Stone and J. A. G. Rehn. Five hundred insects from New Jersey Pine Barrens.

Purchased from E. J. Oslar. Two hundred and two insects from Arizona and New Mexico.

Recent Mollusca.

Lucien Alexander. Two species of bivalves from Daytona, Fla.

John. A. Allen. Four species of shells from Delaware and Pennsylvania.

Rev. E. A. Ashmun. Ninety trays of land shells from Arizona and New Mexico.

C. F. Baker. Seven species of North American land and marine shells.

Dr. Fred Baker. Two species of *Truncatella* from California.

F. C. Baker. Two species of *Planorbis* from Maine and Wisconsin.

Mrs. Beaman. One species of *Sistrum*.

A. C. Billups. Twenty-three species of shells from Indiana.

Dwight Blaney. Three species of *Vertigo* from Maine.

H. C. Borden. Three species of *Unio* from Canada.

Botanical Section. One shell from Surinam.

F. W. Bryant. Co-types of *Glyptostoma newberryanum depressum* Bryant.

Miss Mabel Buck. Twelve species of marine shells from Barbadoes.

J. L. Buck. *Borus oblongus* Müll., from Barbadoes.

Jacob B. Butler. One species of Mollusca taken from Rockfish.

Fred L. Button. Fifteen species of North American land and marine shells.

Dr. H. C. Chapman. Twenty-nine jars of Cephalopoda, etc., from Naples.

George H. Clapp. Twenty-eight species of shells from America and Japan.

T. D. A. Cockerell. Ten species of land shells from New Mexico.

T. D. A. Cockerell and Miss Mary Cooper. Two species of shells from New Mexico.

O. Collett. *Amphidromus albizonatus simoni* Jouss., from Ceylon.

Prof. E. D. Cope Estate. Twenty-three species of Mollusca.

Mrs. Annie P. Cope. Thirty-nine species of Indo-Pacific shells.

O. A. Crandall. One species of *Physa* from Tennessee.

Prof. W. H. Dall. Nine species of North American *Venericardia.*

L. E. Daniels. Two species of *Polygyra* from Indiana.

James M. Delaney. Three species of Japanese marine shells.

Binney W. Earl. Two species of land and fresh-water shells from Burlington, N. J.

J. H. Ferriss. Ninety species of land shells, North Carolina, Arkansas, etc.

John Ford. *Nanina complanata* Mt., from Borneo.

R. C. McGregor. Two species of land shells from Washington.

George W. Griffith. *Vitrea cellaria* Müll., from Wilmington, Del.

G. K. Gude. Six species of land shells from India and Japan.

A. Gulick. *Eulota cavicollis* Pils., from Teje, Omi, Japan.

Mrs. W. H. Harned. Two species of bivalves from Holland.

Alfred C. Harrison and Dr. H. M. Hiller. One species of *Ampullaria* from Sumatra.

Dr. J. W. Harshberger. *Mytilus* from New Jersey.

Prof. Angelo Heilprin. Thirty-six species of mollusks from Martinique and St. Kitts.

J. B. Henderson, Jr. Three species of *Urocoptidæ* from Haiti.

Y. Hirase. Three hundred and thirty-one species of Japanese land shells.

O. P. Jenkins. Three jars of slugs in alcohol from California.

C. W. Johnson. Three species of marine shells from Florida.

F. W. Kelsey. Three species of marine Gastropoda from California.

Dr. R. J. Kirkland. *Acanthinula harpa* in alcohol from Michigan.

William A. Marsh. One species of *Quadrula* from Tennessee.

D. N. McCadden. One *Loligo* in alcohol from Stone Harbor, N. J.

Clarence B. Moore. Two hundred and twenty-one trays of marine shells from western Florida.

P. W. Moore. *Vitrinizonites latissimus* in alcohol from Blowing Rock, N. C.

Dr. E. J. Nolan. Ten trays and two jars of land shells from Italy.

Ida S. Oldroyd. Two species of marine shells from California.

C. R. Orcutt. Eight trays of *Pupidæ* from California.

Dr. Charles Penrose. Nine species of land shells from Idaho.

H. A. Pilsbry. Eighteen trays of shells from New Ireland and Tennessee.

Sadie F. Price. Three species of *Polygyra* from Kentucky.

Purchased. Two hundred and forty-six trays and eight jars of alcoholic mollusks from Cuba, Mexico, East Indies, etc.

John Ramie. *Veronicella gilsoni* Coll., from Fiji Islands.

J. A. G. Rehn and H. L. Viereck. Twenty-four trays and one jar of land shells from New Mexico and Texas.

S. N. Rhoads. Eight species of land and fresh-water shells from Massachusetts and Pennsylvania.

John Ritchie, Jr. *Chelidonura hirundo* Mart., from Upper Congo.

S. Raymond Roberts. Six species of marine shells.

E. W. Roper. *Vertigo gouldi* Binn., from Massachusetts.

Rev. J. Rowell. Sixteen species of shells from California and Africa.

Mrs. T. E. Ruggles. Seven species of marine shells.

F. A. Sampson. *Polygyra mooreana* W. G. B., from Texas.

H. E. Sargent. *Pomatiopsis lapidaria* Say, from North Carolina.

Silas L. Schumo and U. C. Smith. Eleven species of Jamaican land shells.

Dr. B. Sharp. *Chiton apiculatus* Say, from Nantucket, Mass.

Charles Simpson. *Auricula pellucens* Mke., from S. Florida.

Burnett Smith. Eighteen species of American shells.

G. W. H. Soelner. Seven jars and two trays of Mollusca from Washington, D. C.

B. Strubell. Twenty species of land shells from the Molucca Islands.

E. R. Sykes. Two species of *Eulima* from England.

D. Thaanum. Fifty species of marine shells from Pacific Islands.

U. S. National Museum in Exchange. One specimen of *Gaza superba* Dall, from the Gulf of Mexico.

E. G. Vanatta. Four species of bivalves from Chestertown, Md.

T. Van Hyning. *Polygyra multilineata* Say, from Iowa.

Henry Viereck. Eight jars of land shells in alcohol from Pennsylvania and New Jersey.

H. von Ihering. Three species of South American land shells.

Bryant Walker. Forty-five species of American land and fresh-water shells.

H. W. Wenzel. Seven species of shells from New Jersey.

Joseph Willcox. Fourteen species of land and fresh-water shells from North Carolina. Suite of thirty-one specimens of *Cypræa exanthema* (No. 72152–4).

Dr. Harold Bacon Wood. Four species of land and marine shells from Mexico.

L. WOOLMAN. Three species of North American shells.

S. YOSHIWARA. Thirteen trays and eight jars of alcoholic land shells from Ogasawara-jima.

WORMS.

REV. E. H. ASHMUN. Larval trematodes.

T. D. A. COCKERELL. *Nephelopsis* and *Eysobdella;* five bottles of *Polychæta.*

SIR CHARLES ELLIOT. Larval trematodes.

S. H. HAMILTON. *Pheretima.*

ALFRED HARRISON, JR., and DR. H. M. HILLER. Six bottles of Planarians.

DR. H. P. JOHNSON. Three species of Californian *Polychæta.*

ESTATE OF DR. W. H. JONES. Eighteen bottles of *Polychæta.*

PROF. W. G. LIBBEY AND A. ORTMANN. Thirty-nine bottles of Greenland *Polychæta.*

J. PERCY MOORE. Twenty-nine bottles of Planarians and leeches from Patagonia; three hundred and nineteen bottles of *Polychæta,* Massachusetts. (Collected for the Academy.)

DR. CHARLES B. PENROSE. Cysticerci of *Tænia marginata.*

J. A. G. REHN and H. L. VIERECK. (Academy Expedition to New Mexico.) Three bottles of *Cucullarius* from *Phrynosoma.*

S. N. RHOADS. *Filaria* from Skunk.

DR. BENJAMIN SHARP. Thirty-three bottles of worms chiefly European.

DR. H. SKINNER. *Erpobdella punctata.*

GEORGE W. N. SOELNER. *Rhynchodesmus terrestris.*

BURNETT SMITH. *Lepidonotus squamatus.*

L. I SMITH, JR. *Filaria* from Night Heron.

WITMER STONE. Six bottles of Planarians and leeches.

E. G. VANATTA. *Helodrilus.*

PROF. A. E. VERRILL. Seven bottles of *Oligochæta,* Bermuda.

ZOOLOGICAL SOCIETY OF PHILADELPHIA. Nine bottles of round and tape worms.

OTHER INVERTEBRATES.

DR. H. C. CHAPMAN. Twenty jars of alcoholic invertebrates from Naples, and Bar Harbor, Maine.

DR. S. G. DIXON. Fan coral *Acropora muricata,* Jamaica.

ALFRED C. HARRISON, JR., and DR. H. M. HILLER. Several crabs from Sumatra.

DR. W. H. JONES ESTATE. Several bottles of invertebrates from various localities.

DAVID MCCADDEN. Jelly fish, Stone Harbor, N. J.

IDA S. OLDROYD. *Laqueus californicus,* San Pedro Bay

H. A. PILSBRY. One milliped from Cades Cove.

PURCHASED. One Crab, Cuba.

S. N. RHOADS. Several alcoholic invertebrates, various localities.

JOSEPH WILLCOX. *Cambarus* from Blowing Rock, N. C.

VERTEBRATE FOSSILS.

PURCHASED. Eleven specimens of fossil fishes.

INVERTEBRATE FOSSILS.

JOHN A. ALLEN. *Polygyra,* Wounded Knee, South Dakota.

REV. LEANDER T. CHAMBERLAIN, D.D. Additions to the Isaac Lea Collection of Eocene mollusks. Seven hundred and thirty trays.

DR. S. G. DIXON. Brachiopods from Islesboro, Maine, and series of Trilobites from British Columbia.

GEORGE C. GILLESPIE. *Baculites ovatus.*

C. J. HATHAWAY. Specimens of fossils from Moosehead Lake, Me.

JOHN TORPEY. Five specimens of fossils.

FOSSIL PLANTS.

GEOLOGICAL SECTION. Slab of Fern impressions.

MINERALS.

E. GOLDSMITH. Several minerals and rocks from Pennsylvania and Colorado.

MOHAWK MINING CO. Mohawkite, Michigan.

ARCHÆOLOGY AND ETHNOLOGY.

CLARENCE B. MOORE. Cast of skull of "*Pithecanthropus,*" Java. Many additions to the Moore Collection.

PURCHASED. Several Indian utensils, Western Texas; Mexican neck lace with onyx pendant.

CHARLES and THEODORE TOWN. Whip made from vegetable fibre, Jamaica.

PLANTS.

AMOS P. BROWN, PH.D. One hundred and thirty specimens from Labrador.

STEWARDSON BROWN. Four hundred and thirty specimens from California and Oregon, three hundred and fifty specimens from Pennsylvania and New Jersey.

J. L. BUCK. Fruit of *Aristolochia ringens* Vahl.

William M. Canby. Eight hundred specimens principally from the south and west, and eight specimens of *Cratægus*.

Samuel G. Dixon, M.D. Specimen of *Pinus edulis* Engelm, from the Yellowstone.

T. W. Edmondson. Fifty-three specimens from Ontario, Canada.

William J. Fox. Fourteen specimens from the old world, and twenty-one specimens from North America.

E. A. Garratt. Fifty specimens from British Columbia.

John W. Harshberger, Ph.D. One hundred and twenty specimens from Jamaica, Haiti and Santo Domingo.

Purchased. Nine hundred Californian plants collected by Heller and Brown, five hundred and forty W. Australian plants collected by Dr. Pritzel and three hundred and fifty plants from Canary Islands collected by Dr. Bornmüller.

J. A. G. Rehn and H. L. Viereck. Two thousand specimens from New Mexico (collected for the Academy).

Charles F. Saunders. Seventy-five specimens principally from Vermont and North Carolina.

Benjamin H. Smith. Two thousand specimens from the Rocky Mountain region, and specimen of *Heterotoma lobelioides* Zucc.

E. S. Steele. Specimen of *Lacinaria pilosa* Ait.

Curwen Stoddart, Jr. Specimen of *Kœlreuteria paniculata* Laxm.

E. G. Vanatta. One hundred specimens from Pennsylvania and Maryland.

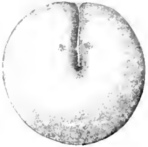
Charles S. Williamson. One hundred specimens from various parts of the Eastern United States.

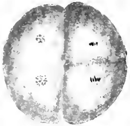
INDEX TO SPECIES, ETC., DESCRIBED AND REFERRED TO IN THE PROCEEDINGS FOR 1902.

Species described as new are indicated by heavy-faced, synonyms by italic numerals.

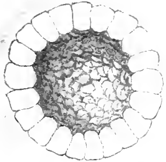
GENERAL INDEX,

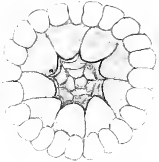
1902.


6

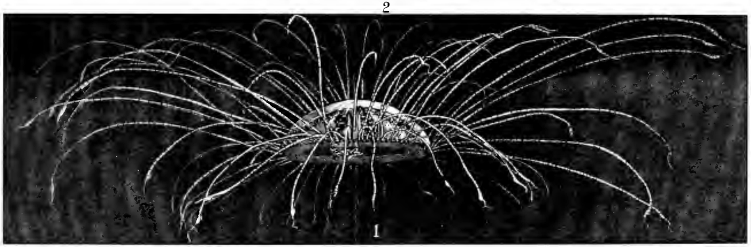

7

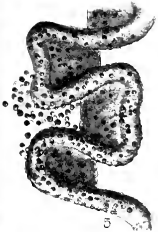

2


8

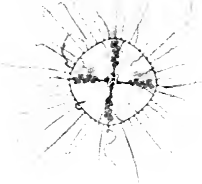

9

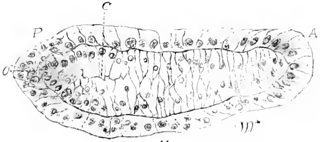

4


1


5

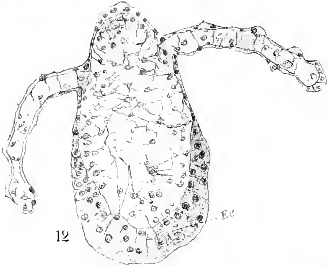
10


3

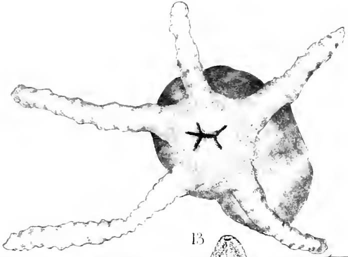


11

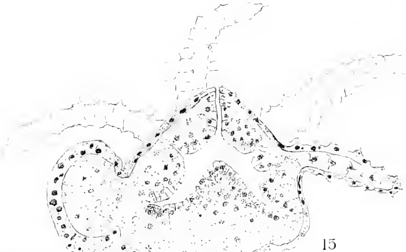
PERKINS. GONIONEMA MURBACHII.



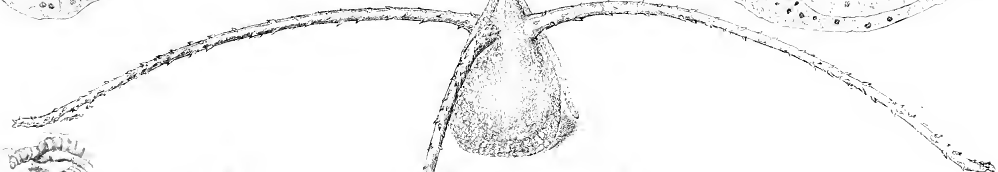
12



13



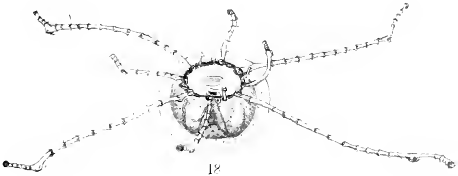
15



14

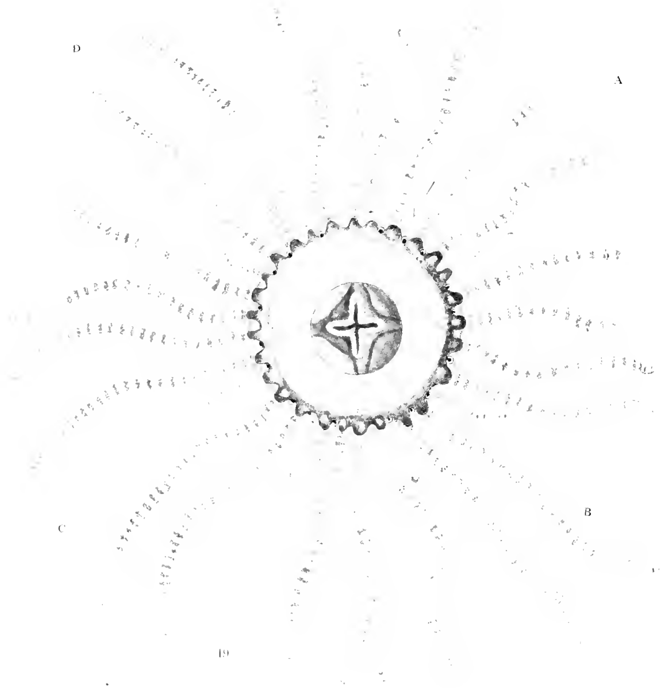
16

17

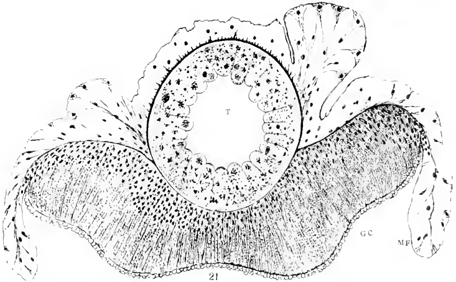


18

PERKINS. GONIONEMA MURBACHII.

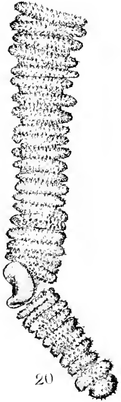


19

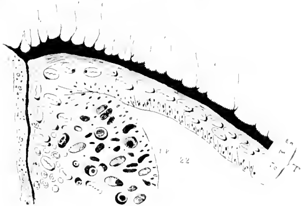


21

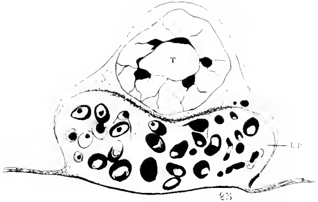
Wr. B. ad.



20



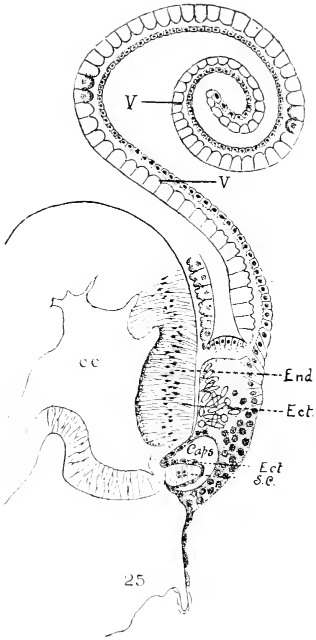
22



23

PERKINS: GONIONEMA MURBACHII.

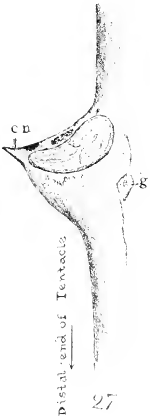
24



25

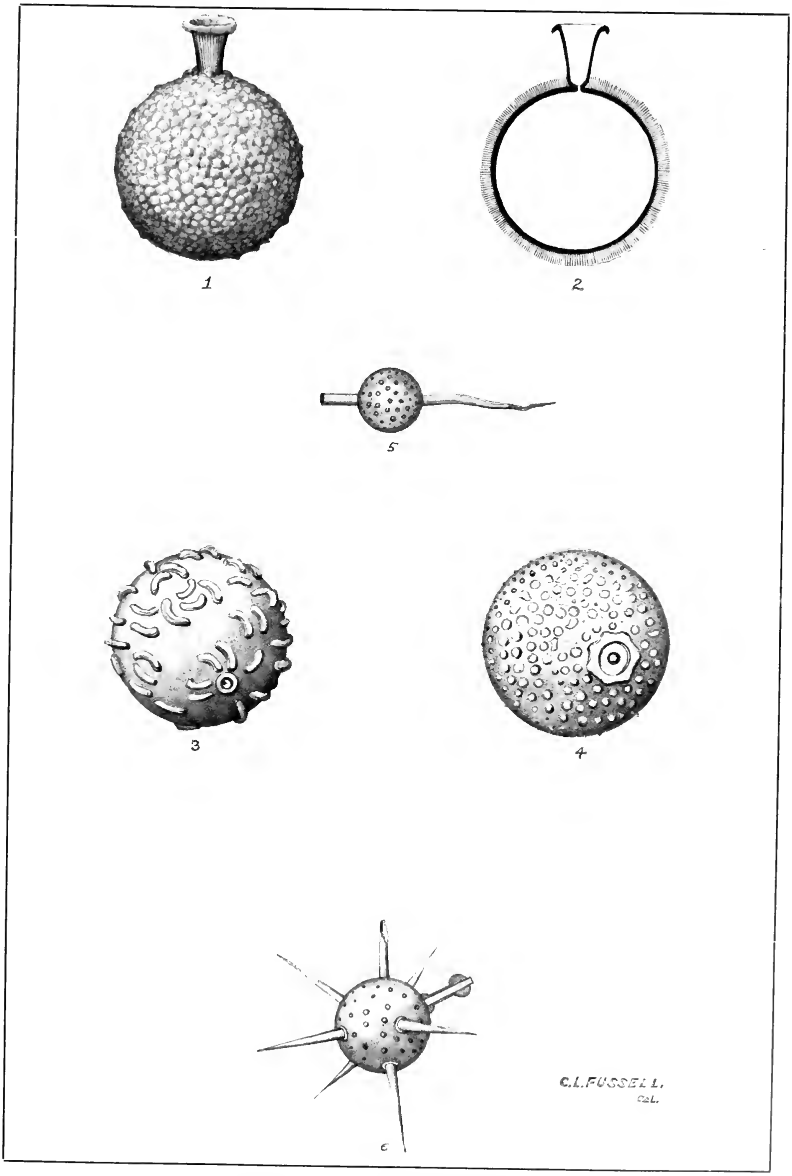
Tentacle of polyp 5 mos old $\frac{500}{1}$

26



27

PERKINS. GONIONEMA MURBACHII.



PALMER ON TRACHELOMONAS.