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EDWARD J. NOLAN, M.D.,
Recording Secretary.

PUBLICATION COMMITTEE:

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PROCEEDINGS

OF THE

ACADEMY OF NATURAL SCIENCES

OF

PHILADELPHIA.

1907.

JANUARY 15.

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

Twenty-six persons present.

The death of Edward Coles, a member, August, 1906, was announced.

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

FINANCE.—John Cadwalader, Edwin S. Dixon, Effingham B. Morris, Horatio C. Wood, M.D., and the Treasurer.

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

LIBRARY.—Dr. C. Newlin Peirce, Thomas Biddle, M.D., Benjamin Sharp, M.D., George Vaux, Jr., and Henry Tucker, M.D.

INSTRUCTION AND LECTURES.—Benjamin Smith Lyman, Henry A. Pilsbry, Sc.D., Charles Morris, Philip P. Calvert and Dr. C. Newlin Peirce.

COMMITTEE OF COUNCIL ON BY-LAWS.—Arthur Erwin Brown, Thomas H. Fenton, M.D., John Cadwalader and Charles B. Penrose, M.D.

The President is, *ex-officio,* a member of all Standing Committees.

DR. HENRY LEFFMAN made a communication on diamonds and diamond mining in southern Africa. (No abstract.)

Edwin T. Simpson and Mary W. James were elected members.

The following was ordered to be printed:

CHERMES OF COLORADO CONIFERS.

BY C. P. GILLETTE.

Genus *Chermes* comprises a small number of species that have not received the attention which is their due in this country. As an economic group they are of little importance so far as their injuries to forest trees are concerned, but some of the species become decidedly injurious to pines and spruces when used as shade trees in parks or private grounds.

The apterous females belonging to the genus are characterized by having broad oval bodies, very short three-jointed antennæ, short stout legs, short stout beaks with very long setæ, and a large number of glandular patches upon head, thorax and abdomen for the secretion of long waxen threads for protection. The winged females have short stout five-jointed antennæ, very broad heads, suckers at the distal ends of the tibiæ and strong anterior wings with two unbranched discoidal veins. Cornicles in both forms wanting.

The males, at least in the United States, are unknown. Reproduction is always by means of eggs which are attached in clusters to leaves or bark by means of silken threads.

Chermes cooleyi n. sp. (Plates I, II, III, IV.)

Chermes abietis L., Cooley, 34th Report Massachusetts Agricultural College, 1897; Author's separata, p. 4.
Chermes abietes L., Fletcher, Report of Entomologist and Botanist, Canada Central Experimental Farm, p. 190.
Chermes abietis L., Fletcher, *ibid.*, 1903, p. 167.
Chermes sibericus Chldky., Fletcher, *ibid.*, 1903, p. 167.

While I cannot be certain that the records by Dr. Fletcher given above refer to *Chermes cooleyi*, it is strongly probable that such is the case, as I have examined immature but fully formed galls that were kindly sent me from the Northwest by Dr. Fletcher, and also by Dr. Hopkins of the U. S. Bureau of Entomology, and they were in both instances large strong galls, exactly like the typical galls of *Chermes cooleyi*.

My studies of this species have been wholly in the West, and I have not seen either winged or wingless examples of the closely allied species *abietis* and *sibericus*. Dr. C. H. Fernald kindly sent me galls of *abietis*, however, from Massachusetts which seem quite unlike the galls of *cooleyi.* The galls of *abietis* involve a comparatively small number of needles causing very large cells, in one of which thirty to fifty or more lice may develop, and the beginning of the gall formation is said to be caused by the punctures of the stem-mother at or close to a bud. The galls, it seems, seldom kill the terminal growth of the twig, and the number of eggs deposited by the winged female is given as "never much exceeding fifty," and the females are spoken of as though their eggs are freely deposited upon leaves of the same species of spruce that bears their galls. All these conditions are quite different in case of *Chermes cooleyi*, as may be seen by the account given below.

Chermes abietis is also described by Buckton and Cooley as having but one joint to the tarsus; but this is doubtless an error, as all the species I have studied have two joints, though the first is short and easily overlooked.

I sent specimens of both the galls and the lice of *Chermes cooleyi* to Dr. N. Cholodkowsky, of St. Petersburg, Russia, asking him if it were possible that this Western *Chermes* could be *abietis* or *sibericus*, and in his reply, written October 23, 1904, he said, "This is decidedly not *Chermes abietis*, nor is it *Chermes sibericus*, but a new species."

Life Habits.—The small hibernating form of this louse spends the fall and winter months upon the twigs of its host-plant, with its long setæ thrust into the crevices in the bark between the needles. The heavy winter skin is cast at Fort Collins about the middle of April, and in a day or two the white secretion again shows the location of the louse, which is always upon the under side of the twig.

The first eggs are deposited at Fort Collins about April 25, before the female has attained her maximum size. On May 3, 1906, three of the fifteen females examined were laying eggs, and the largest number found at one female was twelve. The white waxy threads completely hide both the eggs and the female at first, and serve doubtless as a protection to them (Plate I, figs, A, B. C). These white patches from a single female may measure four or five millimeters across and cover several hundred eggs. Counts of a few patches gave the following numbers: One female, 344 unhatched, 75 hatched; another, 561 unhatched, 0 hatched; two females together, 751 unhatched, 200 hatched, an average of 483. I have frequently counted four or five of these egg-masses within two inches of the end of a twig, and I have counted as many as fifteen females ovipositing on this length of stem. About May 20, before the hibernating females had finished laying their eggs, those that were first deposited began to hatch, and by May 25 the lice were hatching rapidly and locating at the bases of the tender new leaves that were just beginning to show at the terminal buds. I have been unable to see that the punctures of the stem-mothers have any effect to produce the galls, which seems to be caused entirely by the irritation produced by the young lice inserting their beaks and sucking the sap at the bases of the young growing needles. In fact, only those needles enter into the formation of the gall that actually have lice located at their bases. It sometimes happens that only a few needles are attacked and these needles become swollen at their bases, while all the others on the new growth of the twig are normal; and it is not infrequent that a few of the needles of the new growth fail to have any lice locate in their axils, and these needles remain normal in form on a gall where all others are greatly swollen. It seems possible, however, that the puncture of the stem-mother may have some influence upon the formation of the gall, as I transferred hatching egg-masses in several instances to twigs where there was no egg-mass and in no case did a gall form or any of the lice live. I also transferred the eggs to tender new growths of red fir (*Pseudotsuga mucronata*), but none of the young hatching from the eggs became established upon the changed food plant.

The galls (Pls. I and II) develop with surprising rapidity, and are due to the thickening and lateral enlargement of the bases of the needles together with the enlarging of the stem. In color, the growing galls vary from light green to a dark purple. They are always terminal in position and kill the end of the twig, except when the lice attack the bases of a few needles only on one side of the new growth, leaving the others, including those at the end, to develop normally, and such galls are quite uncommon.

The size of the gall depends upon the vigor of the tree and the number of lice that are at hand to attack the new leaves. A weak growing twig cannot develop a large gall. Vigorous growing young silver spruces (*Picea parryana*) on the campus of the Colorado Agricultural College often develop galls that are $1\frac{3}{4}$ to 2 inches in length and $\frac{1}{2}$ to $\frac{3}{4}$ of an inch in thickness inside of the needles. Average galls have from 75 to 150 chambers and consequently a like number of needles, with from 1 to 10 or 12 lice to a chamber. Mr. Charles Jones counted the needles upon three large galls for me which ran as follows: 125, 170 and 215, an average of 170 needles to a gall. At the base there was an average of about 12, at the middle about 8 and near the tip about 5 young lice to a chamber. The largest number found in one cavity was 32.

Mr. George Weldon reared and counted the lice from five large-sized galls for me and they ran as follows: 463, 602, 750, 894, and 996.

The lice within the galls are light red in color, and their bodies are more or less covered with the white waxy secretion which occurs both in the form of a powder and as threads. It might seem that there would be no need of this secretion as a protection in the galls, but it is of the greatest importance here as the lice give off a large amount of liquid excretion, which would drown them if it was not prevented from touching their bodies by their covering which is not wet by the excretion. The cast skins also come into service here. Prof. Cooley has called attention to the fact that the lice within the galls of *Chermes abietis* retain their cast skins for a time, fastened to the posterior end of the body. If one of the galls is broken open when nearly mature, the cast skins may be seen filled as full as they can hold with the liquid excretions. They may be shaken out in the hand and examined, but are easily broken. They appear like plump white models (ghosts) of the lice that shed them.

About the 1st of July at Fort Collins the lice begin to transform to pupæ, and a few days later the most advanced galls begin to open. The earliest gall found with lice escaping in 1906 was taken by Mr. L. C. Bragg, July 3, on a tree exposed to the open sun on the south side of a building. On July 16, trees most exposed to the sun and not very thrifty had matured nearly all their galls and most of the lice had escaped. Large, more thrifty trees, and especially those that were shaded much of the time, still had most of their galls closed, and particularly upon branches near the ground. Galls broken open at this time expose the pupæ, which seem to pack every chamber full, and all their heads point outward from the centre toward the place of exit, ready to escape once more into the light of day as soon as the opening is made large enough. The pupæ cling to nearby leaves, usually those of the gall, and shed their skins. During the few hours that the lice stay upon the leaves the little white patches of cottony secretion begin to show like masses of mycelial threads of a fungus.

After a few hours of resting upon the galls the winged lice all leave and go, so far as I have been able to trace them, to the red fir (*Pseudotsuga mucronata*), where they settle upon the leaves, insert their beaks, and begin almost immediately to lay eggs, which accumulate in large piles beneath their wings. Each egg is anchored by a short silken thread attached to one end. The threads vary in length from those that are shorter than an egg to those that are more than twice that length. The threads also cling to the eggs and to one another after they are loosened from the leaf, so it is very difficult to separate them out from the general cluster (see Pl. IV, figs. B and D). The white wax threads from the head, thorax and sides of the abdomen also grow very rapidly, so that, with the aid of the wings, both louse and eggs are almost completely hidden in two or three days. Egg laying proceeds very rapidly. From numerous counts made by the writer, and others made for me by Mr. G. P. Weldon, I extract the following: Seven large egg clusters, selected July 16 and 18, 1904, ran as follows in numbers of eggs: 96, 111, 127, 133, 136, 151, 155, an average of approximately 150. Seven medium egg clusters from leaves of red fir, where the lice had been located but 48 hours, gave counts as follows: 63, 66, 70, 74, 75, 88, and 104. Seven selected large egg clusters, where lice had been located only 48 hours, ran as follows: 90, 111, 126, 131, 133 and 150. When we consider the large size of these eggs as compared with the females that lay them, it seems to me this is a development of reproductive tissue that is simply marvelous. These winged lice seem never to change their location after they have once inserted their beaks and begun to lay eggs.

Occasionally one of these lice can be found feeding and laying eggs upon leaves of the blue (silver) spruce, but it is quite rare. By enclosing thousands of the lice in paper sacks upon twigs of this tree, I got enough to locate and lay eggs so as to get a few counts. The lice did not seem to be thrifty, however, and the number of eggs laid was smaller. Four lice located 48 hours on blue spruce deposited 16, 17, 19, and 36 eggs respectively. Seven of the largest patches where the lice had been settled 72 hours ran in numbers as follows: 33, 50, 53, 55, 74, 84, and 96; an average of about 64, or less than half the average number in large egg clusters upon red fir. On July 20, 1906, it required careful search to find one of these lice located upon blue spruce, while the red firs near them had one or more of the lice on nearly every leaf, and many leaves were loaded with five or six of them (Pl. II, fig. C_1 and D).

Lice continue to emerge from the galls till about July 25, and all apparently are females.

The eggs laid by these winged females hatch in from six to seven days. Eggs laid July 12 began hatching July 18, and were all hatched on the 19th. The lice from these eggs are yellow at first, but soon become nearly black in color fringed with short wax threads similar to variety *coweni* (Pl. VI, figs. A, A^1). Many of the lice hatching at this time remain beneath the dead bodies of the winged females, which die soon after the eggs are laid, but most of them scatter about over the leaves and come to rest chiefly upon the older leaves near the bases of the small twigs. Here they insert their setæ and remain till spring without growing perceptibly in size. These develop into stem-mothers upon the red fir the following spring and are probably the chief, but not the only, cause of the form described below as *coweni* occurring upon the red fir. It is also strongly probable that the stem-mothers for the two summer broods of *Chermes cooleyi* come in a similar manner from the winged females of variety *coweni* of the red fir that swarm upon the blue spruce in May, as described in my mention of the life history of that form below, though it is possible that the few females of *cooleyi* settling upon the blue spruce also give rise to stem-mothers the following spring, though in my attempts to follow these lice through the fall they have always perished. This brood of eggs laid by the winged females are practically all hatched by the end of July at Fort Collins.

Host Plants and Habitat.—I have found this species occurring in Colorado at Fort Collins, Greeley, Loveland, Boulder, Denver, Colorado Springs, Palmer Lake, Estes Park, and up Long's Peak and Pike's Peak to timber line. In the lower altitudes (from 4,000 to 8,000 feet) I have observed this gall chiefly upon blue spruce, but from 8,000 feet to timber line I have noticed it chiefly upon Engelmann spruce (*Picea engelmanni*). On August 15, 1903, I noted this gall as being very abundant on Engelmann spruce along the trail from Mill's Ranch to timber line on Long's Peak, and I have received the galls from the same locality sent by Mr. Enos Mills. The galls occur in small numbers to the limit of timber, but they become specially abundant three or four hundred feet lower down. The galls at timber line on August 15 were still closed, but a few hundred feet lower the lice were emerging. I have also received galls from the Sitcha spruce from the mountains of western Canada, sent me by Dr. James Fletcher, that seem undoubtedly to be of this species. This Chermes is surely a native of the Rocky Mountain region and, so far as I know, occurs only upon the trees mentioned. I find the galls most numerous in parks or lawns where the blue spruce and red fir are clustered together.

Stem-mother.—The stem-mother, in winter or early spring, is a grayish appearing object, about .6 mm. long by .3 mm. wide. The body of the louse is almost black, and the dark color shows through the white secretion which radiates in short stout threads about the margins of the body and rises in a crest down the median line of the back (Pl. III, fig. A). These hibernating lice are removed with some difficulty on account of the long setæ which are inserted deeply into the bark. After shedding the heavy winter coat the louse appears dark green in color, being lighter beneath and towards the posterior end of the abdomen, and becomes rusty brown later.

Adult Apterous Female (Pl. III, figs. B, C).—Fully grown examples measure 1 to 1.5 mm. in length by .8 to 1.2 mm. in width. The color is a dark rusty brown, and the entire dorsal surface is mottled with dark spots, representing the wax glands which occur upon all segments but the last. The arrangement of these glands is about as follows: On the head, nearly a continuous line of the gland pores on anterior margin, and two patches on a side near the hind margin; on the segments of the thorax and abdomen there are three glands on a side, but segments 5 to 8 of the abdomen have the patches more or less united, especially in the dorsal rows. The other glands of the dorsum have pores quite uniform in size and rather small (compare with var. *coweni*, Pl. VI, fig. B). On the ventral surface there is a pair of small patches upon the head caudad to the bases of the antennæ, and another pair of about the same size just in front of the middle coxæ. The antennæ (Pl. III, fig. F) are very small, about as long as the femora of the front pair of legs, or .14 mm., first and second joints short and stout and of about equal lengths, third nearly cylindrical and nearly twice as long as joints one and two combined, and with two tactile hairs at the tip. Legs (Pl. III, fig. G) short, rather weak, tarsi two-jointed, the basal one very short and appearing as a short piece on the under side.

Eggs.—The eggs are light amber yellow at first covered with a white powder. They are attached each by a silken thread and the whole mass clings together, so that it is difficult to separate a few from the general mass (Pl. I, fig. C). Before hatching, the eggs darken some and the eyes of the embryo show plainly through the shell as two dark spots. Length, .3 mm., width .17 mm.; good average size of egg-cluster, 2 mm.

Pupa.—The pupæ, when they first leave the galls, are of a uniform rusty brown color throughout, lightly dusted with a white powder. On leaving the gall, they walk out upon the leaves, come to rest, and in a short time the pupal skin splits over the head and thorax, and in a few minutes more the adult emerges. At first it is shining rufous in appearance with the wings deep green, which color is quite marked for some time after the wings are fully unfolded. This process takes about ten minutes. The costal nerve is light yellow from the first.

Winged Female (Pls. II, IV and XI).—The winged female is bright shining rufous at first, but by the time the wings are spread the eyes are black, and a few hours later the head and mesothorax are black also. The other portions gradually become darker, the abdomen retaining the rusty color longest. In about an hour after the pupal skin is shed the white secretion begins to show over the wax glands and the louse soon flies away. The size varies much, the usual range being between 1.5 and 2 mm. in length. The *wings* are a little smoky with a large stigma that is slightly green and the costal nerve is yellow. The fore wing in a medium large louse is about 2.5 mm. long, or about 1.6 times the length of the body, with two simple discoidal veins, and one stigmal. Hind wing with one discoidal vein, length of the hind wing about equalling the length of the body. *Antennæ* dusky, five-jointed, about three-fourths as long as the greatest transverse diameter of the head. Joints 1 and 2 short, stout, cylindrical and about equal in length; joint 1 rather smooth, but the remaining ones with impressed transverse lines or wrinkles. Joints 3 to 5 subequal in length, with joint 3 usually a little stouter and more conical; joints 4 and 5 rather slender, not especially enlarged at distal end, nor swollen for the transverse sensoria, of which there is one to each of the three terminal joints; fifth joint with two short hairs at distal end. The arrangement of glands is shown in Pl. IV, fig. A, and is about as follows: On the head two large transverse patches on anterior margin nearly coalescing, and a long narrow patch extending across the hind margin which may be divided at the median line; on the prothorax a long narrow patch occupying the entire lateral margin upon either side, and two long narrow patches along the hind margin nearly meeting at the middle line, and nearly or quite meeting the posterior ends of the lateral patches that are usually reflected mesad a short distance along the hind margin of the segment; mesothorax with two small patches mesally located near the hind margin, in line with the two middle rows of glands upon the metathorax and abdomen; metathorax with the middle pair of glands only; abdomen with three rows of glands on either side over the first seven segments, except that the middle row is lacking on segments one and two. The lateral rows have the larger patches, and these rows are continued upon the eighth segment; the glands of the middle rows are smallest, and all the four dorsal rows become smaller as they recede from the thorax. The number of gland patches is not constant and the weaker ones are often wanting, and the larger ones sometimes coalesce.

Chermes cooleyi var. **coweni n. v.**

This louse has been injuriously abundant on small trees of red fir in lawns and parks of northeastern Colorado for a number of years. I first observed it on trees standing upon the campus of the Colorado State Agricultural College, where it has been abundant for ten years past at least. A brief description of the winged female was given in Bulletin 31, p. 115, of the Colorado Experiment Station, by Mr. J. H.

Cowen. I have also mentioned this louse on p. 17 of the 1901 report of the same station. This form varies enough from *cooleyi* to be considered a distinct species; but as these two seem to owe their differences to an alternation of food plants, I have thought best to consider the form upon red fir a variety of *cooleyi*.

Life History.—The winter is spent as minute black lice, each being surrounded with a halo of white waxy threads and resting upon the upper surface of a leaf. They often occur in a line along the median groove. A few warm days about the last week in March or the first week in April cause the lice to grow, excrete drops of nectar, and burst the old larval skin. This first spring moult takes place at Fort Collins about April 1st. The hibernating form is shown on Pls. V and VI, figs. A and A[1]. As soon as the old skin has been cast, little patches of white secretion begin to appear along the dorsal surface, and in a few days more the entire body will be hidden by long curled threads of this material. About the 20th of April egg-laying begins, though not all of the lice develop together, and the time of the first egg-laying varies with the earliness of the season. From twenty-five to forty light yellow eggs are laid by each louse, and these hatch freely just as the new leaves begin to open at the ends of the twigs, and nearly all are hatched by the last of May. The lice migrate on to the new growths, insert their setæ into the tender leaves and begin to feed and grow, and apparently they never change their location afterwards. This first brood from eggs for the year is dimorphic, in that about one-half remain wingless like the preceding generation, while the other half develop wings. The adults of the alate form appear about June 10; the wingless ones lay eggs like their predecessors, and the young hatching from them, for the most part, insert their setæ in the leaves, take on a dark color, secrete a little of the white waxy material about themselves and upon their backs, and so remain until the following spring before growing perceptibly in size, and then become stem-mothers; but those that acquire wings all leave the red fir and, so far as I have been able to trace them, settle upon the leaves of the blue spruce (*Picea parryana*), though it is probable that they do settle on Engelmann spruce as well. Some of the apterous females continue to develop and lay eggs, especially in shady places and upon tender new leaves, until late in July or even longer; but for the most part development closes with the young hatching from the second brood of eggs for the year, making two full broods annually besides the partial broods.

The winged examples that migrate to the blue spruce settle upon the needles, secrete a large mass of cottony threads, deposit a patch of 30 to 40 eggs beneath their wings and die. The eggs hatch in about a week and the young remain on the leaves without developing until spring, as in case of most of the young from the second brood of eggs by the apterous individuals.

When abundant, early in the summer, the little snowy white patches concealing the apterous females and their young are so numerous as to attract attention to the foliage (Pl. V, figs. B, C and D). When the first brood from eggs for the year hatch and settle upon the new leaves, the latter often become crooked and disorted in shape and yellow in color (Pl. V, fig. C). I do not think I have ever seen a tree killed by this louse, but they are often made to look very unthrifty and sickly in color of foliage.

Hibernating Female.—The hibernating female, or stem-mother, grows very little if at all, after hatching from the egg the previous June or July, until the warm days of spring. The color, which seems black, is really a very dark green and the body is fringed all round with short white threads of waxy secretion, and down the middle of the back there is often a crest of the same threads, though these are not always present, and the entire dorsal surface is finely dusted with wax particles that glisten with a silvery white light. The setæ are considerably longer than the body and are inserted in the leaves, through the fall and winter (Pl. VI, figs. A and A^1). The length before spring development varies little from .4 of a millimeter. The antenna is three-jointed and little exceeds a front tibiæ in length, first and second joints short and stout and about equal in length, and the third joint fully one-half longer than joints 1 and 2 together, and quite scabrous in appearance due to transverse impressed lines, and with about four hairs at the tip. About the middle of April the liquid excretion is being given off freely, and the waxy secretions now begin to show plainly as transverse rows of white spots across the dorsal surface (Pl. V, figs. A. A.). When the winter skin is shed, the louse changes to a rusty brown color, darker towards the head. Adult specimens measure from .8 to 1.2 millimeters in length and from .6 to .9 mm. in greatest breadth. The antenna is still short, three-jointed, the third joint rather longer than joints 1 and 2 combined, and the whole length about .09 mm. (Pl. VI, fig. E).

The *wax glands* are arranged about as in *cooleyi*, but the pores are larger and fewer in number, at least for the glands anterior to the fourth abdominal segment (Pl. VI, figs. B and C). On the head there are three gland patches on either side, and then there are three rows on a side over the succeeding body segments to the sixth abdominal; on the seventh the median glands unite, reducing the number to five, and upon the eighth segment but three occur. A pair of rather large glands occur between the antennæ below, and there is a small one on either side in front of the middle coxæ. The rostrum is short and stout, with joints 1 and 2 subequal in length.

Pupa (Pl. VI, fig. F).—Length, .7 to 1 mm. Color light to a dull reddish brown, becoming darker as the time for moulting approaches. From the front of the head are two short, broad, outwardly curved pencils of white secretion, one on either side of the median line. The body is also more or less whitened by a covering of fine white powder, but there are no long waxy filaments; head, thorax and wing pads a little darker than the remainder of the body. Dark spots marking the presence of developing wax glands may be seen as follows: Upon the front of the head two large ones, and back of these two others of smaller size close to the hind margin; on the prothorax a very large lateral gland upon either side, and mesad of each of these four small ones; mesothorax with one lateral and one submedian spot on either side, both small; metathorax with three spots on each side in a line near the hind margin. On the abdomen there are six longitudinal rows extending over the first five segments, and the lateral rows over two or three segments more.

Winged Female (Pl. VII, fig. A).—Length, commonly .7 to 1.2 mm. Color reddish brown with head and thorax black or blackish, legs and antennæ a little dusky. Anterior wings 1.4 to 1.8 mm. in length, slightly smoky, venation normal; posterior wings without transverse nervure. After locating upon the blue spruces the body soon becomes nearly buried in a mass of white waxy threads, as in the case of *cooleyi*. Antenna nearly as long as the greatest width of the head (about .25 mm.), joints 1 and 2 short and subequal, joints 3 and 4 also subequal with the fourth a trifle the longer, fifth joint slightly longer than the fourth, joints 3, 4 and 5 deeply transversely marked with impressed lines and much enlarged toward the distal ends, and each with a transverse sensorium of moderate size, all the joints robust (Pl. VII, fig. B). Legs dusky brown and rather stout. Glands arranged about as follows: a large one on the front of the head on either side at the base of the antenna, and on the posterior margin of the head, close to the median line, another pair of smaller glands; on the prothorax, a large gland patch on the posterior lateral margin that extends a short distance along the hind margin, and a smaller patch on the hind margin near the median line upon either side. Upon the mesathorax, one pair of large submedian glands, and upon the abdomen there are three longitudinal rows upon either side, the middle row being quite small and occurring only upon segments 2 to 6. The inner rows occur upon segments 1 to 6, and the lateral rows upon segments 1 to 8. In a large series considerable variation will be found in the number of these glands, as some of the smaller patches often are wanting. I have found this form developing on the red fir only.

The distinguishing characters are the short stout beak, the small size and large pores of the dorsal glands, and the large size of the gland patches between the antennæ in the apterous form and the robust antenna and small sensoria of the winged form.

Chermes montanus n. sp.

On July 20, 1906, Mr. Harley F. Wilson collected galls of what seems undoubtedly to be a new species of *Chermes* at Victor, Colorado, at an altitude of about 9,000 feet. The inmates had already left some of the galls and from others they were just emerging. The writer visited the locality August 5 following, to determine what spruces these galls occur upon, and found them upon blue spruce only. On the same trees with them were old and new galls of *Chermes cooleyi.*

The galls (Pl. VII, fig. C) are cone-shaped, from three-fourths to more than one inch in length, and are a modified development of the new growth at the tip of a twig. Each needle, instead of thickening as in case of the galls of *cooleyi,* broadens in the middle and becomes concave on the inner or axillary surface. The broadened portion may include nearly the entire needle at the base of the gall, but towards the tip the broadened part extends a less distance from the base. The stem from which the needles arise is little if any swollen. The lice cause the death of the end of the twig, and as the tissue dies and begins to dry the modified leaves open so that the lice readily escape. Because of the loose structure of these galls *Syrphus* larvæ prey freely upon the lice.

Pupa.—The pupæ seem darker in color than those of *cooleyi,* but otherwise I cannot see that they are specially different.

Winged Adult.—When the pupal skin is first cast, the wing pads are yellow in color instead of green as in *cooleyi,* and the costal and subcostal nerves retain the same color after the wings unfold. The length of the body varies between 1.5 and 2.2 millimeters. The color is a reddish brown, abdomen rust brown, antennæ and legs dusky, wings normal, hind wings with one cross vein, and slightly smoky. Antennæ (Pl. XI, fig. A) five-jointed, joints rather stout and somewhat more enlarged at distal ends than in *cooleyi,* the striations upon joints 3 to 5 quite strongly curved, especially on joints 4 and 5, the convexity being towards the distal ends of the joints. Joints 1 and 2 short, stout, cylindrical; joint 3 a little longer than 4, and joint 5 a little longer than 3; joints 3 to 5 each with a very large sensorium; on joint 3 it extends fully one-third the length of the joint along the ventral side, in joints 4 and 5 the sensoria extend fully one-half the length of the joints; there are almost no hairs except for a cluster of four or five at the tip of the last segment. The antennal characters alone easily separate this species from all others mentioned in this paper. The legs are as distinctive as the antennæ, being much stouter than those of any other species I have studied (Pl. XI, fig. B).

The *wax glands* that are so conspicuous in cleared specimens of other species of *Chermes* are absent or faintly distinguished in the winged females of this species. The galls of this species are very distinct from those of any other *Chermes* known to me.

Eggs, young, and wingless females of this species have not been studied.

Chermes similis n. sp. (Plate VII, figs. D, D^1, E, E^1.)

On the visit to Victor, Colorado, August 5, I collected from trees bearing galls of *Chermes cooleyi* another gall very similar in appearance. Winged lice were issuing from them, as they were also from galls of *cooleyi*.

Galls.—The galls I collected were rather short and thick for those of *cooleyi*; they were in every case terminal upon the twigs, and they are produced by the broadening and thickening of the basal portion of the needles, but not at the extreme base as in *cooleyi*, see Pl. VII, figs. D and E. At the point of attachment the needle is about normal in size, but an abrupt thickening and broadening takes place about three or four millimeters from the twig. Each needle is separate from its neighbors, however, and may be removed without the tearing of any tissue except a small spot about one millimeter across at the point of attachment, so that in place of a number of separate chambers, as in the galls of *cooleyi*, the lice live in open spaces which pass into one another about the bases of the needles. The casual observer would not be likely to notice any difference between this gall and that of *Chermes cooleyi*.

The pupæ, as in *cooleyi*, are quite heavily covered with white powder when ready to emerge.

Apterous females and their egg-clusters were also found in some of the galls, but there was no way to make certain that they were of the same species.

The looseness of structure in the galls allowed the attacks of *Syrphus* larvæ which were very common.

Winged Female.—Color as in *cooleyi*; length from 1.3 to 2 millimeters; wings a little smoky, especially along the veins; venation normal, one transverse vein in hind wing very distinct. *Wax glands* of abdomen are arranged as follows: The lateral rows with well-developed glands on the first six segments; the two dorsal rows well developed on segments 1 to 6; the middle row on either side begins on segment 3 and ends upon segment 6. The antenna in this species is very similar to that of *montanus*. Segments 1 and 2 are short and cylindrical, segments 3, 4 and 5 are in the proportion of 22, 26, and 25 respectively, segments 3, 4 and 5 are provided each with a very large sensorium similar to those found upon the antenna of *montanus*. The transverse striations upon the segments run in nearly straight transverse lines instead of curved lines, as in the case of *montanus*. This species is easily separated from *montanus* by the presence of well-developed wax glands upon the abdomen, and the more slender legs.

I supplied the breeding cage where this louse was emerging with fresh twigs of red fir and blue spruce. The lice began at once to locate upon the needles of the blue spruce and to lay eggs rapidly, but none located upon the needles of the red fir.

The galls were all taken from blue spruce trees and were considerably less numerous than those of *Chermes cooleyi*. Altitude 9,000 feet.

Chermes coloradensis n. sp. (Plates VIII, IX and X.)

This species was first noticed by the writer upon the needles of Bull or yellow pine (*Pinus scopulorum*) growing upon the campus of the Colorado State Agricultural College in the spring of 1897. Its presence has been noticed in some numbers every year since. Some years the needles and the new growths have been fairly whitened with its cottony secretions during late spring and summer (see Pl. VIII), while in other years the lice have barely been able to survive in small numbers, as their insect enemies are many and active. The writer figured this louse upon pine needles in Plate I of *Fourteenth Annual Report of the Colo. Agr. Exp. Station*, 1901.

Habitat and Host Plants.—I have found this louse common upon Bull pines occurring upon the foothills of northeastern Colorado and in the city parks of Colorado Springs and Denver. In 1905 I found it common upon this pine in the vicinity of Palmer Lake. During the last week of June, 1906, Prof. T. D. A. Cockerell sent me infested pine needles from Florissant, Colorado, that were taken at an altitude of 8,000 feet, and I have on several occasions taken what seems to be the same species upon Lodge Pole pine (*Pinus murrayana*) growing upon the campus of the Colorado Agricultural College at Fort Collins. During June of 1905 and of 1906 I also took apterous females with their egg-masses from leaves and young cones of Piñon pine (*Pinus edulis*) at Salida, Colorado, at an elevation of 9,000 feet, which seem to be of this species.

In some instances the lice have been abundant enough to stunt and weaken small trees, but I can hardly consider this insect a serious pest upon the pines at the present time, except as it freqeuntly mars the appearance of the foliage of small trees in parks and about private residences.

Life History.—There seems to be no small hibernating form of this louse, as of the spruce-infesting species mentioned in this paper. Wingless lice in various stages of development pass the winter down among the flower buds, between the needles near their bases, or in other protected places. Examples taken February 27 ranged between .4 and .8 mm. in length. I have found the hibernating lice in considerable numbers spending the winter beneath the scales of *Chionaspis pinifoliæ*. This habit of spending the winter in varying stages of development and in more protected places probably accounts for this species getting the start of others in its development in the spring. At Fort Collins, the little white patches of secretion begin to show about the first week of April among the buds and between the needles (see Pl. VIII, fig. A), and by about the 10th of the month the first spring eggs are being laid. By the 5th of May it is common to find from 20 to 40 eggs to a female and the first young hatching. About one-half of the lice from this brood of eggs become winged, and the other half remain wingless and go on producing other generations of wingless lice and eggs until fall, a habit similar to var. *coweni* on red fir. The winged individuals all seem to be females and all leave the pines, but I have not been able to trace them to their alternate food plant, which I presume to be one of the spruces. The winged form begins leaving the trees about May 20, at which time the first brood of wingless females from eggs for the year are beginning to deposit eggs for another generation of apterous individuals, which begin to deposit their eggs about June 10. The winged form continues to appear for about ten days. I have seen the apterous females and their eggs in all stages of development from April 9 to October 22, but the number of generations that the lice pass through in a year I have not determined.

The number of eggs laid by a single individual is not large, about 30 or 40, but the precise number is difficult to obtain as the first eggs laid hatch before the last from the same females are deposited. All are attached by threads to the surface upon which the female rests. I have had a female lay 9 eggs in 24 hours.

The individuals of the first brood that are to become winged secrete a conspicuous fringe of white wax threads about the borders of the head and prothorax in the pupa stage (Pl. IX, fig. D), which, with the longer antennæ, readily separate them from the apterous form.

Apterous Female (Pls. IX and X).—The length of laying individuals varies between .5 and 1.2 mm.; the color is a rusty brown, rather light over the abdomen and darker upon thorax and head where the color may be a slaty brown. The antennæ are minute, about .06 mm. long, three-jointed, joints 1 and 2 short and cylindrical and about equal in length, joint 3 distinctly longer than joints 1 or 2. Legs small and weak, femora about twice as long as thick, tibiæ equaling femora in length, tarsus two-jointed, the first joint appearing as a wedge-shaped piece with the broad end below; three clear spots upon either side of the head in the position for compound eyes which may function as ocelli. The *wax glands* (Pl. IX, figs. A. B, C) upon the dorsum of the adult seem quite constant and are arranged about as follows: Upon the head and prothorax, which are so united as to appear as one piece, there are, upon either side of the median line, a longitudinal row of four glands and outside of these another row of three, and still outside of these, and located near the posterior lateral angles of the prothorax, are three more small gland areas. The mesothorax has one transverse row of from eight to ten of these glands; the metathorax and first abdominal segment each have a transverse row of eight, but those upon the abdominal segments are small over the middle dorsal portion and may be largely missing; the second abdominal segment lacks two or four of the middle glands, leaving a row of four or six, and segments 3 and 4 usually have but four glands each, one upon the lateral margin and one near it a little mesad, and the glands upon the lateral margins are continued upon two or three succeeding segments. Upon the ventral surface there is a small gland near the base of each antenna and one (which may be separated into two parts) in front of each coxa. The marginal gland patches show upon the ventral as well as upon the dorsal surface, and in some specimens small glands may be detected upon the abdominal segments just inside the spiracles (Pl. IX, fig. B).

The *eggs* are light yellow in color and are entirely hidden from view by the long wax threads secreted chiefly from the head and thorax of the female; they vary little from .32 mm. long by .17 mm. in width, and each egg is anchored from one end by a short thread. As the eggs advance in age they become darker in color and exhibit two dark eyespots of the developing embryo.

Pupa (Pl. IX, fig. D).—Length varying but little from 1 mm. Color of abdomen a light rusty brown, head and thorax blackish, wing pads and legs dusky brown. As the time for moulting approaches a heavy fringe of short stout wax threads or scales develop about the margins of the head and prothorax and along the median dorsal line of the cephalothoracic plate, and about six small glands on either side of the cephalothoracic region push out long slender dividing threads of the same material. Near the time for moulting the body becomes covered with a white powder and the wax glands posterior to the prothorax are indicated by little white spots of secretion, but no threads are developed. The lateral rows of glands may be traced upon the abdomen to about the sixth segment, while the middle rows upon the dorsum usually end upon the second or third segment.

Winged Female (Pl. X, figs. A and B).—Color a rusty brown throughout just after shedding the pupal skin, but the head and thorax soon become nearly black in color. A measurement of thirteen examples gave lengths varying between .85 and 1.15 mm., the variation being due chiefly to the different lengths of the abdomen, as in some it was fully extended and in others the terminal segments were contracted. The wings are a little smoky in appearance, due to a great number of curved black dashes that are rather closely set over the entire surface. The wings vary little in length, the anterior pair measuring but little either side of 1.5 mm.; venation normal for this genus, the subcostal nerve strong and, with its large lanceolate stigma, smoky brown in color. There are two simple transverse nervures and the stigmal nerve is long and nearly straight, ending in the center of the apex of the wing.

The posterior wings are lanceolate in form, a little more than one-half the length of the front wings (ratio 1 to 1.7), and have two or three chitinous hooks on the costal margin. The transverse nerve is wanting (see Pl. X, fig. A).

Antenna dusky brown, five-jointed and .26 mm. in length; the terminal joint is slightly the longest (.067 mm.), joints 3 and 4 subequal (.06 mm.), the first and second joints short and cylindrical and of about the same diameter as the others; joints 3, 4 and 5 fusiform and imbricated; the distal ends of 3 and 4 truncated, but the fifth joint tapering gradually to the apex. Joints 3, 4 and 5 have each a large oval sensorium on the ventral side. There are about five hairs at the apex of the terminal segment and a very few scattering ones on the other joints. *Ocelli* three in number, one just above each compound eye, and one median in position upon the front above the insertion of the antennæ.

Legs dusky brown, tarsi two-jointed, the basal joint very short, tibiæ with prominent sucker at distal end, the use of which is readily seen by allowing one of the winged lice to walk over a glass slip under a microscope.

The *wax glands* are fewer in number over the head and thorax than in the apterous form; on the anterior margin are two that occupy nearly the whole distance from eye to eye, and there are two similar patches on the hind margin; there is also a long narrow patch upon either side along the hind margin, and in front of either of these is another very small patch. On the mesothorax occur the usual two patches near the median line next to the scutum, and upon the metathorax two large patches in line with the two inner rows upon the abdomen. Over the abdomen there are three longitudinal rows upon either side extending over about six segments. The patches are largest in the marginal and the middle rows, and the latter sometimes coalesce on the proximal segments. For arrangement of the glands see Plate X, fig. A.

Young Louse.—When first hatched the young are pale yellow in color and about one-third millimeter in length. The eyes are dark, the antenna three-jointed and about two-sevenths the length of the body, the third joint about one-third longer than joints 1 and 2 together, and the first two joints are subequal in length. Each tarsus has two glandular hairs. The young of this species can hardly be distinguished from the young of *cooleyi* shown at Plate III, fig. E.

Chermes pinicorticis Fitch.

I have found this species abundant upon a few trees of *Pinus sylvestris* in City Park, Denver, but have seen it nowhere else in Colorado. The cottony covered apterous females were numerous enough upon the smaller limbs of the trees to give them a distinctly whitened mouldy appearance. An excellent paper upon this species, containing a bibliography by Mr. E. L. Storment, was published in the Appendix to the *Twentieth Report of the State Entomologist of Illinois.*

Natural Enemies.—Most of the common plant louse enemies attack genus *Chermes*, but I have never found one of these lice attacked by internal parasites. *Chrysopa* species seem to attack them very little, but *Syrphus* and *Coccinellid* larvæ are great destroyers of these lice when exposed upon the surface of plants, the cottony secretion being apparently no hindrance. I have never found *Chermes cooleyi* disturbed within the gall chambers, but *Syrphus* larvæ at least attack *Chermes similis* and *Chermes montanus* before they escape from their galls. The most destructive enemies of the *Chermes* that infest red fir and pine in the neighborhood of Fort Collins is the yellow and black lady-beetle, *Harmonia picta*, shown in Plate XI, figs. D, E. F.

I wish especially to express my obligations to Miss Miriam A. Palmer for her accurate and painstaking work in the preparation of the pen drawings illustrating this paper.

If in any case the measurements as given in the plates do not fully correspond with measurements as given in the text, the latter is to be taken as correct.

EXPLANATION OF PLATES I–XI.

PLATE I.—*Chermes cooleyi*, new species.—A, twig of blue spruce showing three egg masses, natural size; B and C, egg masses with waxy secretion removed, × 8 times; D, two galls on a twig cut to show interior cavities, × $\frac{2}{3}$. (Photos by author.)

PLATE II.—*Chermes cooleyi*, new species.—A, two full-grown galls, natural size; B, needles from full-grown galls showing enlarged bases; C′, winged female, beneath and at right of D winged female, ovipositing upon leaves of red fir; D, an egg mass with female removed; E, gall cut to show that each gall chamber has a complete wall shutting it off from all other chambers. Figures of lice much enlarged. (Photos by author.)

PLATE III.—*Chermes cooleyi*, new species.—A, hibernating stem-mother in winter, × 85 times; B and C, adult stem-mothers, dorsal and ventral views showing wax glands, etc., × 65 diameters; D, eggs attached by threads, × 20 diameters; E, young from first brood of eggs, × 125 diameters; F, antenna of adult, × 240 diameters; G, leg of adult, × 120 diameters; H, normal leaf, and I, leaves from gall, all enlarged three times. (Miriam A. Palmer, artist.)

PLATE IV.—*Chermes cooleyi*, new species.—A, winged female, × 26 diameters, showing wax glands of dorsal surface; B, the same with wings closed laying eggs, × 20 diameters; C, antenna of same, × 200 diameters; D, egg mass of same, × 30 diameters. (Miriam A. Palmer, artist.)

PLATE V.—*Chermes cooleyi* var. *coweni*, new variety.—A and A, hibernating stem-mothers beginning to grow in spring, × 20 diameters; B, sprig of red fir showing white egg masses, slightly reduced; C, sprig of red fir showing curled leaves of new growth where young lice are locating, natural size; D, egg clusters of preceding, × 15 diameters. (Photos by author.)

PLATE VI.—*Chermes cooleyi* var. *coweni*, new variety.—A, apterous cottony covered female and her hibernating young, the last of June, × 8 diameters; A^1, hibernating young lacking dorsal wax threads, × 50 diameters; B and C, dorsal and ventral views of adult hibernating female showing wax glands, etc., × 45 diameters; D, leg × 60 diameters; E, antenna, × 240 diameters; F, pupa, × 40 diameters. (Miriam A. Palmer, artist.)

PLATE VII.—*Chermes cooleyi* var. *coweni*, new variety.—A, winged female, × 40 diameters; B, antenna of same, × 240 diameters; C, gall of *Chermes montanus*, n. sp., × 2 diameters.

Chermes similis, new species.—D and D^1, E and E^1, two views of two leaves from a gall of this species, the former from near the base and the latter from near the tip, showing the difference in their development; × 2 times. (Miriam A. Palmer, artist.)

PLATE VIII.—*Chermes coloradensis*, new species.—A, lice between the needles during winter and early spring; B, attacking the new growth a little later; C and D, cottony masses covering the wingless females and their eggs, taken during June. A, B and C enlarged 3/2, D 4 times. (Photos by author.)

PLATE IX.—*Chermes coloradensis*, new species.—A and B, apterous females taken during May, showing dorsal and ventral surfaces with arrangement of glands; C, dorsal surface of wingless female taken October 22; D, pupa taken June 22; e, anterior leg of A, × 120; f, antenna of the same, × 200. A and B are enlarged 50 times, C 90 times, and D 40 times. (Miriam A. Palmer, artist.)

PLATE X.—*Chermes coloradensis*, new species.—A, winged female showing wax glands, etc., enlarged 50 times; B, antenna of preceding, × 200 times; C, half-grown apterous female taken October 22, showing long curved pencils of secretion and drop of excretion, × 40 times. (Miriam A. Palmer, artist.)

PLATE XI.—A, antenna of *Chermes montanus*, new species, × 200 diameters; B, fore leg of *C. montanus*, × 50 diameters; C, leg of *C. cooleyi*, × 50 diameters; D, E, and F, larva, pupa and adult of *Harmonia picta*, much enlarged. (Miriam A. Palmer, artist.)

February 5.

Mr. George Vaux, Jr., in the Chair.

Thirty-two persons present.

The death of Alexander J. Cassatt, a member, December 28, 1906, was announced.

The Publication Committee reported that a paper entitled "Chermes of Colorado Conifers," by C. P. Gillette, had been presented for publication (January 28).

Mr. Howard W. DuBois made a communication on hydraulic mining in British Columbia. (No abstract.)

February 19.

The President, Samuel G. Dixon, M.D., in the Chair.

Twenty-two persons present.

The Publication Committee reported that papers under the following titles had been presented for publication:—

"Notes on Orthoptera from Southern Arizona, with Descriptions of New Species," by James A. G. Rehn (February 11).

"The Morphology of Dinophilus Conklini n. sp.," by James A. Nelson, Ph.D. (February 15).

Edwin G. Conklin, Ph.D., made a communication on the embryology of *Fulgur*, embodying a study of the influence of yolk on the development of the egg. The paper will be published later.

The following were ordered to be printed:

NOTES ON ORTHOPTERA FROM SOUTHERN ARIZONA, WITH DESCRIPTIONS OF NEW SPECIES.

BY JAMES A. G. REHN.

To better present the results of the study of a considerable amount of material from southern Arizona, it has appeared advisable to divide this paper into three parts, each of which treats of a different locality or set of localities.

These three are: first, Cochise County localities; second, Pima County localities; third, Phœnix, Maricopa County.

The total number of specimens treated in the three sections is 842, the species numbering 116, of which 11 are new, 7 are new records for the United States and 19 are here credited to Arizona for the first time.

I. Cochise County.

The specimens on which the following study is based are chiefly contained in four collections made during the year 1905 by as many field collectors. The two largest and in many respects the most important ones were made in Carr Canyon, Huachuca Mountains, one in August by Dr. Henry Skinner and now forming part of the Academy collection, the other made in September and October by Mr. C. R. Biederman and now being the property of Mr. Morgan Hebard, of Chestnut Hill, Philadelphia. The third collection was made in the same range of mountains as the two mentioned above, but at Palmerlee, and was due to the work of Mr. Charles Schaeffer, of the Brooklyn Institute of Arts and Sciences, to whose collection this series belongs. The fourth lot was in some respects the most interesting as far as range extension of species is concerned, and was made at San Bernardino Ranch, 3,750 feet elevation, by Prof. F. H. Snow, of the University of Kansas, to the collection of which institution the specimens belong.

A number of specimens from Douglas have been examined, and a few labelled simply "Huachuca Mts." are also mentioned herein.

The number of species here treated is 90, of which 8 are new, 5 previously known forms are here recorded from the United States for the first, and 16 are recorded the first time from Arizona. The number of specimens examined was 526, of which 407 belonged to the Acrididæ.

The author wishes to thank Mr. Hebard, Mr. Schaeffer and Prof.

Snow for the opportunity to examine the material from the collections mentioned above.

FORFICULIDÆ.

SPONGIPHORA Serville.

Spongiphora apicidentata Caudell.

Huachuca Mountains, August 22 (Schaeffer), 1 ♀.

This is the species recorded from Florence, Pinal Co., Arizona, as *Labia melancholica*,[1] and two ♂ and one ♀ from Riverside, Riverside Co., California, have also been seen. Of the ten specimens here examined but two, the Huachuca specimen and one from Florence, have the yellowish spot on the exposed portion of the wings strongly marked.

APTERYGIDA Westwood.

Apterygida linearis (Esch.).

Douglas, August (F. H. Snow), 1 ♀.

BLATTIDÆ.

ISCHNOPTERA Burmeister.

Ischnoptera uhleriana Saussure.

Palmerlee (Schaeffer), 1 ♀.

This specimen agrees very well with Saussure and Zehntner's description of the female of this species, but it is clearly separable from *Temnopteryx virginica* Brunner, which has been considered the female of this species. The tegmina are longer and rounded as in the female of *Ischnoptera pennsylvanica*, the latter being *Phyllodromia borealis* of authors, and not truncate as in "*Temnopteryx virginica.*" In general the specimen in hand resembles what I have considered the female of *couloniana*, but is smaller, with a comparatively greater space between the eyes, and with the supra-anal plate of a different shape, being more transverse and less produced. This specimen is clearly what Saussure and Zehntner called the female of *uhleriana*, and this seems to raise a question as to whether *Ischnoptera uhleriana* and *unicolor* might not be separable in the female sex, with very similar males. Male individuals of *uhleriana* have been recorded by Caudell from the Huachuca Mountains and the Patagonia and Santa Rita Mountains, southeastern Arizona.

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[1] *Proc. Acad. Nat. Sci. Phila.*, 1904, p. 562.

BLATTELLA Caudell.

Blattella dilatata Saussure.

Palmerlee (Schaeffer), 1 ♀. Huachuca Mountains (Schaeffer), July 8, 1 ♂.

The female specimen agrees very well with the description of this species, which has been recorded only from Orizaba, Mexico. The male, which has never been described, resembles *Blattella adspersicollis,* having the slight maculations of the pronotum very similar, but is slenderer with the pronotum more trigonal, the margins of the same more deflected and the tegmina shorter and broader. The measurements of the pair are as follows:

	♂	♀
Length of body, ...	12. mm.	13.5 mm.
Length of pronotum, ...	3.5 "	3.9 "
Greatest width of pronotum, ...	4.6 "	5.5 "
Length of tegmen, ...	14 "	8.5 "
Greatest width of tegmen, ...	4 "	3.8 "

In the female specimen the tegmina do not reach to the apex of the abdomen, which they exceeded in the type, but the form of supra-anal plate and other characters are very similar to those mentioned by Saussure.

MANTIDÆ.

YERSINIA Saussure.

Yersinia solitaria Scudder.

Carr Canyon, Huachuca Mountains, August (Skinner), 2 ♂. September and October (Beiderman), 3 ♀.

All of these specimens are larger than a female from Gallinas Canyon, New Mexico, and no traces of organs of flight are present. A very curious feature about this species is the distinct proximal inflation of the caudal femora, probably a sign of considerable saltatorial ability.

LITANEUTRIA Saussure.

Litaneutria skinneri n. sp.

Types: ♂ and ♀; Carr Canyon, Huachuca Mountains, Cochise Co., Arizona. August, 1905 (H. Skinner). [A. N. S. Phila.]

Differing from the known members of the genus in having the tegmina and wings of the male short as in the known females of the genus.

Size about the average for the genus. Head distinctly trigonal when viewed cephalad, dorsal outline straight in the male, slightly arcuate in the female; facial scutellum transverse, slightly arched in the male, oblong in the female; eyes moderately prominent, slightly elevated above the dorsal outline of the head in the male, in a general way continuing the dorsal arcuation in the female; antennæ short, hardly exceeding the head and pronotum in the female. Pronotum with the greatest width contained about two and a fourth times in the length, the dilation considerable, the cephalic section of the pronotum hardly constricted and evenly rounded, the caudal section considerably but not greatly constricted, caudal margin arcuate; median carina distinct on the shaft of the pronotum, represented by a slight longitudinal sulcus on the cephalic section; lateral margins practically unarmed in the male, crenulato-dentate in the female. Tegmina very slightly longer than the pronotum in both sexes, elongate-ovate in shape, stigma present at about a third the distance from the apical margin, the apex rotundato-truncate, veins distinct. Wings slightly projecting beyond the apices of the tegmina. Abdomen with a distinct longitudinal carina extending the whole length and more distinct in the female than in the male; supra-anal plate of the male with the apex subtruncate and the width of the same about equal to the length, subgenital plate with two very short apical styles, cerci exceeding the supra-anal plate and reaching the tip of the subgenital; supra-anal plate of the female similar to that of the male in shape but more pro-

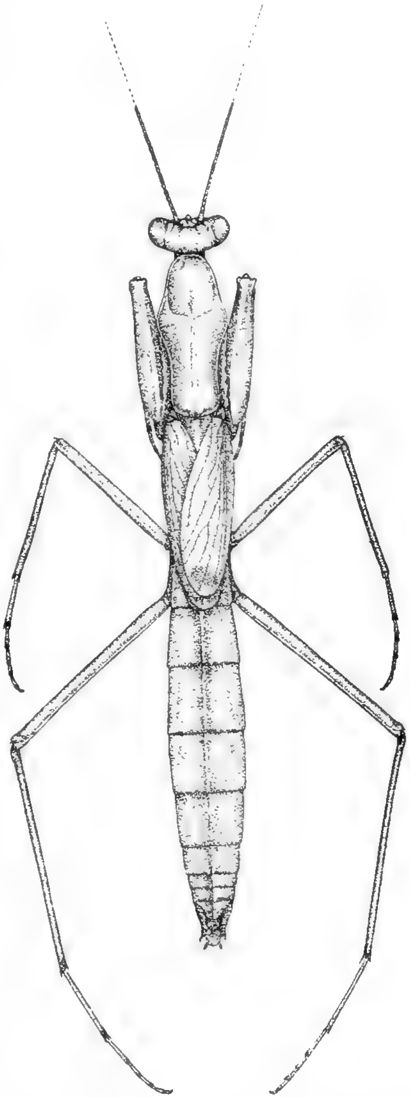

Fig. 1.—*Litaneutria skinneri* n. sp. Dorsal view of male type. (× 4.)

duced, the subgenital plate with the apical cleft not quite reaching to the middle of the plate, cerci as long as the supra-anal plate. Cephalic coxæ slightly shorter than the pronotum in both sexes; femora about equal to the pronotum in length, particularly robust in the female, caudal margin with five, cephalic with ten to eleven spines in both sexes, largest discoidal spine rather heavy; cephalic tibiæ not quite two-thirds the length of the femora, margins with nine to ten spines; tarsi with the proximal joint about equal to the tibia in length. Median and caudal limbs rather slender.

General color of the male buff with a wash of clay color on the abdomen and the head with russet; of the female clove brown, the median carina of the pronotum and maculations and imperfect annulations on the limbs pale ecru drab. Tegmina in both sexes with their ventral surface near the distal margin with a transverse blackish maculation. Face with an obscure transverse blackish median bar in the female.

Measurements.

	♂	♀
Length of body,	22 mm.	26.2 mm.
Length of pronotum,	5 "	6.5 "
Greatest width of pronotum,	2.2 "	3.2 "
Length of tegmen,	5.5 "	7 "
Length of cephalic femur,	4.5 "	6 "

In addition to the types a paratypic series of one male, three females and one immature individual have also been examined. The second male agrees fully with the type in the shape and structure of the tegmina, and the females differ only in the depth of the general coloration.

I take pleasure in dedicating this species to its collector, whose kindly advice and sympathetic interest has been of the greatest assistance to the author.

STAGMOMANTIS Saussure.

Stagmomantis limbata (Hahn).

San Bernardino Ranch, 3,750 feet, August (F. H. Snow), 2 ♂, 1 ♀. Carr Canyon, Huachuca Mountains, August, 1905 (Skinner), 2 ♂, 9 ♀, 3 immature individuals. September and October, 1905 (Biederman), 5 ♂, 1 ♀.

These specimens are typical with the exception of the female from San Bernardino Ranch, which has the general appearance, size and form of pronotum of *limbata*, but has the costal area of the tegmen very narrow, comparatively narrower even than in *carolina*. This individual is so clearly typical of *limbata* in every respect, except the width and form of the costal area, the only thing to consider it is an abnormality of this species. The width of the costal area is less than a fifth that of the tegmen. Four of the male specimens are in the green phase and five in the brown, one, however, not as completely brown as the others; seven of the females are green and four brown, one of the latter being rather pinkish.

BACTROMANTIS Scudder.

Bactromantis virga Scudder.

Carr Canyon, Huachuca Mountains, August, 1905 (Skinner), 1 ♀. Huachuca Mountains (Schaeffer), 1 ♂.

These two specimens measure as follows:

	♂	♀
Length of body,	39.2 mm.	49 mm.
Length of pronotum,	10 “	14 “
Length of tegmen,	24 “	
Length of cephalic femur,	8.5 “	11 “

Whether these specimens are identical with the typical Florida *virga* can only be determined by comparison with authentic or topotypic material, as the original description is very brief and unsatisfactory.

Caudell has recorded this species from the Huachucas, Nogales and Phœnix, Arizona, as well as Brownsville, Texas.

PHASMIDÆ.

PSEUDOSERMYLE Caudell.

Pseudosermyle truncata Caudell.

Carr Canyon, Huachuca Mountains, August, 1905 (Skinner), 1 ♂. Huachuca Mountains, July (Schaeffer), 1 ♂, 1 ♀. San Bernardino Ranch, 3,750 feet, August (F. H. Snow), 1 ♀.

The Huachuca female agrees very well in size with the measurements of the type, and has the basal abdominal segments with prominent tubercles as in the Bright Angel female mentioned by the describer. The San Bernardino Ranch female is slightly smaller than the other, smoother, and has the carinæ and lobes similar in disposition but lower and weaker. The male specimens are larger than those mentioned in the original description, being approximately 47 and more millimeters in the length of the body.

When compared with the Mexican *P. tridens* (Burmeister), the apex of the male abdomen is seen to be distinctly less inflated with a trigonal disposition of the cercal teeth instead of a digitiform arrangement as in *tridens*, in addition to which the size is slightly less. The females of the two species are very similar, but *truncata* has the limbs longer and the carinæ of the abdomen more distinct.

This species has previously been recorded from Dos Cabezos, Cochise Co. (type locality), and Bright Angel, Coconino Co., Arizona, as well as Los Angeles Co., California.

DIAPHEROMERA Gray.

Diapheromera arizonensis Caudell.

San Bernardino Ranch, 3,750 feet, August (F. H. Snow), 1 ♂.

This specimen has fully retained its natural coloration, which appears worthy of description.

General color cadmium yellow, a broad dorsal line covering practically all of the metanotum and all of the mesonotum except the caudal seventh parrot green, the abdomen with the proximal half of all segments except the distal one green, ranging from parrot green on the proximal four to oil green on the others; terminal segment and cerci tawny ochraceous. Pronotum with a slight median touch of greenish. Head with a slight clay-colored bar caudad of the eyes; antennæ vinaceous-rufous. Venter of the mesothorax and metathorax marked with green as on the dorsum, and bearing a fine median longitudinal line of blackish coextensive longitudinally with the green. Limbs with each joint greenish (apple green) proximad, chrome yellow distad, tarsi raw sienna, femoral spines blackish-brown.

The Mexican *D. calcarata* is closely related to this form, but differs in the much more swollen median and caudal femora of the male.

This species has previously been recorded only from the type locality, Hot Springs, Yavapai Co., Arizona.

PARABACILLUS Caudell.

Parabacillus coloradus (Scudder).

Carr Canyon, Huachuca Mountains, August, 1905 (Skinner), 1 ♀. September and October, 1905 (Biederman), 1 ♂, 1 ♀. Huachuca Mountains (Schaeffer), 1 ♂.

The male has a distinct dorsal longitudinal stripe of brownish on a light yellow ground.

The Mexican *P. palmeri* (Caudell) is extremely close to this species.

ACRIDIDÆ.

PARATETTIX Bolivar.

Paratettix toltecus (Saussure).

Carr Canyon, Huachuca Mountains, August, 1905 (Skinner), 2 ♀. Huachuca Mountains (Schaeffer), 2 ♂, 2 .

These specimens fully agree with New Mexican and Mexican individuals of this species. One female belongs to the long-winged form *P. toltecus extensus* Morse.

Paratettix mexicanus (Saussure).

Huachuca Mountains (Schaeffer), 1 ♂.

ACHURUM Saussure.

Achurum acridodes (Stål).

Carr Canyon, Huachuca Mountains, August, 1905 (Skinner), 1 ♂. Palmerlee, August (Schaeffer), 1 ♀.

After comparison of these specimens with two females of true *A. sumichrasti* from Guadalajara, Jalisco, Mexico, the conclusion is reached that two species are represented. The Arizona specimens differ from the Jalisco individuals in the head being somewhat less elongate, with the eye somewhat shorter and the antennæ distinctly shorter and slenderer. The pronotum also is not so elongate and the lateral lobes are distinctly shorter than in *sumichrasti,* while the lobes of the genicular region of the caudal femora are distinctly less elongate and stouter, the length of the principal genicular lobes in *sumichrasti* being equal to that of the genicular arch, while in the Arizona specimens it is distinctly less. The dorsum of the pronotum is obscurely punctate on the cephalic portion of the prozona and all of the metazona in *acridodes* and lineato-rugose on the same areas in *sumichrasti.* On the basis of this character of the pronotum the name *acridodes* has been applied to this form, as Stål states in his description in the *Recensio Orthopterorum,*[2] in comparing with *sumichrasti,* "pronotoque dorso haud alutaceo-rugoso, sed antice et in lobo postico obsolete punctulato."

Burr in his key to the species of the genus[3] appears to have misinterpreted Stål's remarks on the length of the tegmina, as the former says: "Elytra abdomen haud superantia," while Stål's words are: "Elytra corpore paullo breviora, femoribus posticis plus duplo longiora." It seems evident that Stål intended to mean the entire length of the body rather than the apex of the abdomen, as in the latter case the tegmina would have been very little longer than the caudal femora, considering of course the slender femora present in this genus.

MERMIRIA Stål.

Mermiria bivittata (Serville).

Douglas, August (F. H. Snow), 1 ♂, 1 ♀.

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[2] I, p. 101.

[3] *Trans. Ent. Soc. London,* 1902, p. 178.

Rather larger than Nebraska, Colorado, Utah and New Mexico individuals, but otherwise inseparable. The male has the base color greenish, the female reddish ash.

Mermiria texana Bruner.

Carr Canyon, Huachuca Mountains, August, 1905 (Skinner), 3 ♀.

These specimens are quite typical of this richly colored species which has previously been recorded from Fort Grant, Arizona.

SYRBULA Stål.

Syrbula admirabilis (Uhler).

San Bernardino Ranch, 3,750 feet, August (F. H. Snow), 1 ♂, 1 ♀.

The female specimen has the pronotum slenderer than is the case in seventeen female specimens from east of the Rocky Mountains. It is possible that the specimens from Arizona represent Stål's *S. leucocerca*, which is clearly either *admirabilis* or a closely allied form, but this matter involves the examination of Stål's type.

Syrbula fuscovittata Thomas.

Carr Canyon, Huachuca Mountains, August, 1905 (Skinner), 10 ♂, 10 ♀, 1 immature individual. September and October, 1905 (Biederman), 5 ♂, 1 ♀. Huachuca Mountains, July 13 (Schaeffer), 1 ♂. Palmerlee, August (Schaeffer), 1 ♀. Douglas, August (F. H. Snow), 1 ♂, 1 ♀. San Bernardino Ranch, 3,750 feet, August (F. H. Snow), 1 ♀.

This very interesting series shows that both sexes exhibit considerable color variation, in the male being chiefly due to either the greenish or grayish tone of the lighter areas, the general clove brown or blackish color remaining much the same, while in the female variation is due to the presence of two phases with different base colors. The greenish phase has light green by far the predominating color, while the brown phase ranges from warm browns to a decided umber, the dorsum of the tegmina being ashy gray in several individuals. One female specimen has the tegmina and limbs colored as in the green phase, while the pronotum and head show practically no greenish, being nearly as in the brown phase. The single male labelled Huachuca Mountains is extremely interesting as it appears to represent the freshly emerged condition, as the date (July) would also testify. This specimen is somewhat shrivelled, as would be expected in the drying of soft chitin, and in color is quite striking, the insect being generally pea green, the dorsum of the pronotum buff, the eyes and distal portion of the antennæ walnut brown the tegmina whitish hyaline and the wings distinctly infuscate.

This species has been recorded from several localities in southern Arizona.

ACROCARA Scudder.

Acrocara maculipenne Scudder.

San Bernardino Ranch, 3,750 feet, August (F. H. Snow), 1 ♂.

This specimen is perfectly typical of this scarce species except that the pale colors are bone white, the darker colors more sombre brown and the proximal portion of the wings, the metanotum and dorsal section of the proximal abdominal segments sevres blue instead of bronze green. Such differences as exist are merely in color shades, the maculation and pattern of lines and bars being the same as described by Scudder. This species has only been recorded from Montelovez, Coahuila, and Villa Lerdo, Durango, Mexico, the above record constituting the first from within the limits of the United States.

ERITETTIX Brunner.

Eritettix variabilis Bruner.

Douglas, August (F. H. Snow), 1 ♀.

This specimen has little or no trace of the supplementary carinæ on the dorsum of the pronotum, but the antennæ are typical of the species. There appears to be no doubt that *Eupedetes carinatus* Scudder is no other than this species, as a study of the description will show. The character of the antennæ does not appear sufficient to form the basis of a new genus, especially in view of the appreciable reduction of the clavation in species like *tricarinatus* and *navicula.* Another point apparently overlooked by Scudder in describing *Eupedetes* is that *Eritettix*[4] was based on but two definitely stated species, *variabilis* and *abortivus,* although *carinatus, tricarinatus* and *virgatus* were mentioned through the generic description in explanation of variable characters. Of these two definitely placed species *variabilis* stands first, and is the type also by elimination as *abortivus* was removed by Scudder to *Mesochloa* in 1898. It is thus evident that the type of *Eritettix* is a species with non-clavate antennæ.

This species has previously been recorded only from Silver City, Grant Co., New Mexico, and, as *Eupedetes carinatus,* from La Trementina, San Miguel Co., New Mexico.

AMPHITORNUS McNeill.

Amphitornus ornatus McNeill.

Carr Canyon, Huachuca Mountains, 5,500 feet, September, 1905 (Biederman), 2 ♀.

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[4] *Proc. U. S. Nat. Mus.,* XII, p. 56.

One of the specimens examined has the brown shades much darker than the other, and the femoral maculations more distinct in consequence.

The greater angle of the face appears to be the most satisfactory structural character to separate this species from the allied *A. coloradus.*

OPEIA McNeill.

Opeia testacea Scudder.

San Bernardino Ranch, 3,750 feet, August (F. H. Snow), 1 ♂, 1 ♀.

This species has previously been recorded from a number of localities in southern California, but not from Arizona.

ORPHULELLA Giglio-Tos.

Orphulella compta Scudder.

San Bernardino Ranch, 3,750 feet, August (F. H. Snow), 2 ♂, 3 ♀.

The two males are dull brown in color, one female ochraceous, another very dark brown and the third in the green phase. In measurements they agree closely with the types.

BOÖPEDON Thomas.

Boöpedon fuscum Bruner.

San Bernardino Ranch, 3,750 feet, August (F. H. Snow), 1 ♂.

This specimen is typical of this form, which appears to be doubtfully separable from *nubilum* (Say). The only differential character which appears constant when compared with three males of *nubilum* from Nebraska and Colorado is the absence of a pale pregenicular annulus on the caudal femora, as the color of the caudal tibiæ is uniform blackish in a Pueblo, Colorado male, and the number of spines on the outer tibial margin is twelve in the San Bernardino specimen and ranges from eleven to thirteen in the males of *nubilum.* This species was described from Nogales and Phœnix, Arizona, and specimens from Casas Grandes, Chihuahua, Mexico, recorded by the author as *B. nubilum,*[5] should be referred to this form, although one possesses very faint traces of pregenicular annuli.

SCYLLINA Stål.

Scyllina calida (Bruner).

San Bernardino Ranch, 3,750 feet, August (F. H. Snow), 1 ♀.

This specimen clearly represents the form of the genus found in Morelos, Guerrero, Michoacan and Jalisco, Mexico. It is not closely related to *S. patriæ* (Scudder), supposed to be from California, which

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[5] *Proc. Acad. Nat. Sci. Phila.,* 1904, p. 519.

has among other differential characters luteous caudal tibiæ instead of the parti-colored type found in most of the Mexican and Central American members of the genus. This is the first record of the species from north of Guadalajara, and in consequence the first record from within the United States.

PSOLOESSA Scudder.

Psoloessa maculipennis Scudder.

Palmerlee, August 7 (Schaeffer), 2 ♀.

These specimens are inseparable from New Mexican individuals.

Psoloessa buddiana Bruner.

Carr Canyon, Huachuca Mountains, August, 1905 (Skinner), 1 ♂, 1 ♀.

This species has been recorded from southern Arizona, Dimmit Co., Texas, and Montelovez, Coahuila, Mexico.

AGENEOTETTIX McNeill.

Ageneotettix australis Bruner.

Carr Canyon, Huachuca Mountains, August, 1905 (Skinner), 2 ♀. September, 1905 (Biederman), 1 ♀. Palmerlee, August (Schaeffer), 1 ♀.

The only previous record of this species is that of the types—Phœnix, Arizona.

AULOCARA Scudder.

Aulocara femoratum Scudder.

Carr Canyon, Huachuca Mountains, August, 1905 (Skinner), 1 ♂, 4 ♀. September, 1905 (Biederman), 4 ♂.

The lateral lobes of the pronotum are usually less strongly marked in these individuals than in Colorado, Nebraska and Wyoming specimens.

This species has been recorded from Phœnix, Arizona, by Bruner.

Aulocara rufum Scudder.

San Bernardino Ranch, 3,750 feet, August (F. H. Snow), 1 ♂, 1 ♀.

These individuals are inseparable from Colorado and Nebraska specimens. The caudal margin of the pronotum is strongly marked with dark maroon and the general color is vinaceous pink.

This species has been recorded by Scudder and Cockerell from La Cueva, Organ Mountains, southern New Mexico.

ARPHIA Stål.

Arphia crassa Bruner.

Carr Canyon, Huachuca Mountains, August (Skinner), 1 ♂, 4 nymphs. September 23 and 27, October 16 and 20, 1905 (Biederman), 7 ♂, 12 ♀.

San Bernardino Ranch, 3,750 feet, August (F. H. Snow), 1 ♂.

Aside from the larger general size and broader fuscous arc of the wing this species is very closely allied to *A. pseudonietana.* A number of specimens have the dorsum of the pronotum clay color, while others are strongly marked with a "pepper and salt" color pattern.

Arphia aberrans Bruner.

Carr Canyon, Huachuca Mountains, August (Skinner), 1 ♂, 2 ♀. Palmerlee, July 27, 1905 (Schaeffer), 2 ♀.

These specimens agree very well with the description and measurements of this species, the dorsal (caudal) edge of the tegmen, however, being decidedly pale and unicolorous in all but one specimen. The individuals possessing the pale edging show such variation in the shade of the same that it is, no doubt, subject to considerable variation. The contrast between the bluish distal two-thirds of the tibiæ and the pale ferruginous tarsi is quite striking.

ENCOPTOLOPHUS Scudder.

Encoptolophus texensis Bruner.

San Bernardino Ranch, 3,750 feet, August (F. H. Snow), 1 ♂.

Individuals from Florence, Arizona, previously recorded by the author as *E. subgracilis* Caudell,[6] are referable to this species.

HIPPISCUS Saussure.

Hippiscus corallipes (Haldeman).

Douglas, August (F. H. Snow), 1 ♀. San Bernardino Ranch, 3,750 feet, August (F. H. Snow), 1 ♂. Palmerlee, July 23 (Schaeffer), 1 ♀. Carr Canyon, Huachuca Mountains, August, 1905 (Skinner), 1 ♀.

Several of these specimens are what is usually called *zapotecus,* as they possess red internal faces to the caudal femora. However, there appears no reason why this type is not true *corallipes* as Haldeman's original description says: "Inside of the posterior femora, tibiæ and tarsi bright vermilion, a paler tint extending to the outside of the tarsi and half of the tibiæ." This is exactly what we find in specimens now referred to *zapotecus,* and such a description cannot well be considered that of a form with the proximal two-thirds of the internal faces of the caudal femora dark blue. Caudell[7] has called attention to this fact and the author wishes to add that representatives of the two forms have been taken at the same locality on the same day, as demonstrated by material in the collection of the Academy.

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[6] *Proc. Acad. Nat. Sci. Phila.*, 1904, p. 566.

[7] *Proc. U. S. Nat. Mus.*, XXVIII, p. 468.

The female representative from Douglas has the pronotum rather slenderer than the other specimens, and in this respect superficially resembles *H. pardalinus*, from which, however, it is quite distinct.

LEPRUS Saussure.

Leprus elephas Saussure.

Carr Canyon, Huachuca Mountains, September 26 and October 20, 1905 (Biederman), 2 ♂, 1 ♀.

These specimens are unquestionably *elephas*, but in none are the wings clear yellow on the disk as usual in this species. All have that area bluish or green, in one decidedly blue proximad, in another with all except the proximal section strongly inclined toward yellow. The subequal lateral lobes of the pronotum will readily separate this form from the species with pronounced blue wings, all of the latter type having the ventral width of the lobes greater than the dorsal, owing to the rounded extension of the ventro-caudal margin.

Leprus glaucipennis Scudder.

Carr Canyon, Huachuca Mountains, August, 1905 (Skinner), 2 ♂, 2 ♀. September 27 and October 16, 1905 (Biederman), 2 ♀.

This series is inseparable from Californian specimens of this species and also exhibits some variation in the definition of the tegminal bars. The color of the disk of the wings varies slightly, the blue being quite rich and deep in some (two) specimens. This species has been recorded from Hermosillo, Sonora, and is here noted from Arizona for the first time.

SPHARAGEMON Scudder.

Spharagemon collare (Scudder).

San Bernardino Ranch, 3,750 feet, August (F. H. Snow), 1 ♀.

This specimen appears to be perfectly typical of race *angustipenne* Morse when compared with Salt Lake (topotypic) material.

TOMONOTUS Saussure.

Tomonotus ferruginosus Bruner.

Carr Canyon, Huachuca Mountains, August (Skinner), 6 ♀. Palmerlee, July (Schaeffer), 1 ♀.

These specimens show that glaucous caudal tibiæ are also present in the female, the majority of the specimens examined approaching the above color closer than "pale greenish yellow," given for the female in the original description. Several of the individuals examined also exceed the measurements given by Bruner, the maximum in the series being: length of body 38 mm.; length of pronotum 11; antennæ 12; tegmina 31; caudal femora 20.

Tomonotus azteous (Saussure).

Douglas, August (F. H. Snow), 1 ♂.

This specimen is typical of *aztecus*, as ascertained by comparison with Mexican material, except for the parallel margins of the frontal costa, which is not constricted ventrad of the ocellus as in the majority of the other individuals examined. As several undoubted *aztecus* have the constriction very slight, I would consider the absence of it as an individual peculiarity.

MESTOBREGMA Scudder.

Mestobregma rubripenne (Bruner).

Palmerlee, August 7, 1905 (Schaeffer), 1 ♀. Carr Canyon, Huachuca Mountains, August, 1905 (Skinner), 7 ♀, 4 ♂. September 22 and 27, 1905 (Biederman), 2 ♀.

The coloration of the disk of the wing in this species is yellow as well as red, but three of the above series being colored with the latter.

CONOZOA Saussure.

Conozoa carinata n. sp.

Types: ♂ and ♀; Carr Canyon, Huachuca Mountains, Cochise Co., Arizona. August (♂) and October 20 (♀), 1905. Male collected by Skinner in Coll. Acad. Nat. Sci. Phila., female collected by Biederman in Hebard collection.

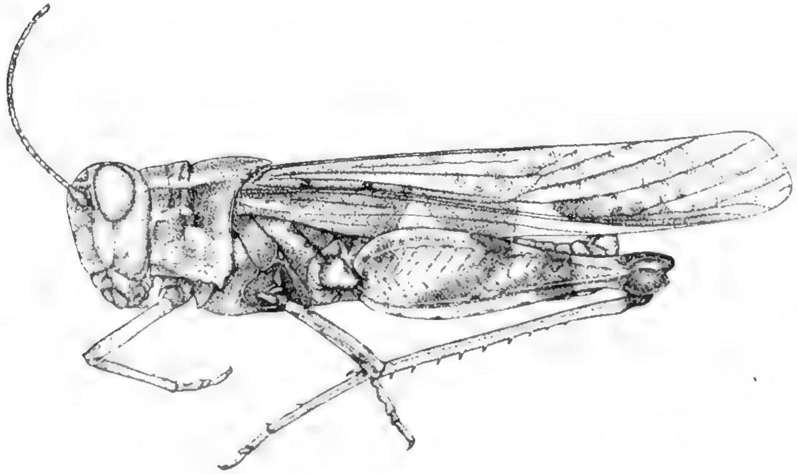

Fig. 2.—*Conozoa carinata* n. sp. Lateral view of male type. (× 4.)

Allied to *C. behrensi*, *sulcifrons* and *acuminata*, differing from the first two in the more elevated median carina of the pronotum, the more compressed pronotum and the color of the caudal tibiæ. Of these two forms it is closely related to *sulcifrons* on account of the slender build of that species. From *acuminata* it differs in the more elevated pronotal carina and the color of the caudal tibiæ.

Size small (♂) or medium (♀); distinctly compressed, moderately slender. Head deep, greatest width ventrad; occiput well rounded and distinctly elevated above the general level of the disk of the pronotum, interocular space in the male narrower than the width of the eye, in the female very slightly exceeding the width of the eye; fastigium deeply excavate in the male, considerably excavate in the female, median carina subobsolete in both sexes, lateral carinæ well elevated, the narrowed cephalic section of the fastigium deeply depressed; lateral foveolæ trigonal, moderately impressed; frontal costa slightly constricted dorsad and immediately ventrad of the ocellus, regularly expanding toward the clypeus, deeply sulcate throughout the length except for a small dorsal section which is shallowly so; eyes ovoid, flattened cephalad, moderately prominent in the male, little so in the female, in length slightly exceeding (female) or about equalling (male) the infraocular sulcus; antennæ distinctly exceeding the head and pronotum in length in both sexes. Pronotum distinctly flattened, disk with the median carina distinct, moderately high, well divided by the principal transverse sulcus, the division of the prozonal section being merely an indention and not a complete deep incision as is the prometazonal separation;[8] prozona contained about one and one-half times in the length of the metazona, cephalic margin obtuse-angulate, concave laterad, caudal margin slightly acute-angulate in the male, rectangulate in the female; lateral angles distinctly marked, not continuous, carinate in the immediate vicinity of the principal sulcus; lateral lobes distinctly deeper than long, ventral margin oblique, the ventro-caudal angle produced into an acute process; surface of the dorsum with a number of low but distinct asperities in the male and with weak longitudinal strigæ in the female. Interspace between the mesosternal lobes very strongly transverse in both sexes. Tegmina very considerably exceeding the tips of the abdomen and caudal

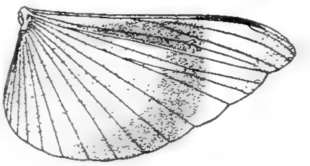

Fig. 3.—*Conozoa carinata* n. sp. Wing of male type. (× 2.)

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[8] In the male type the carina of the prozona is without the cephalic (prozonal) indention, a condition found to be approached in three of the series examined and which appears to be without taxonomic value.

femora; costal margin with a distinct arcuation in the distal third, apex narrowly and very obliquely truncate, sutural margin nearly straight; intercalary vein strong, median in position for the greater part of its length but approaching the median vein distad. Wings ample but rather narrow, the greatest width contained nearly twice in the length; apex rather narrowly rounded. Caudal femora very slightly exceeding the apex of the abdomen in the male, in the female falling very little short of the same,[9] in form moderately robust; caudal tibiæ with nine spines on the external margins.

General color wood brown in the male, mars brown in the female, in both sexes blotched and marked with clove brown or blackish. Head dull in the female, the markings obscure and chiefly consisting of postocular and arcuate occipital bars, the facial carinæ being regularly beaded and the plain surfaces punctate with the darker colors, eyes russet, antennæ wood brown with alternating segments generally marked with bistre; head of the male nearly completely washed with ecru drab, the dorsum more sprinkled with darker than the other surfaces, three occipital bars as well as the postocular bars being developed, while the pattern of the facial carinæ approaches that of the female, eyes as in the female and with a distinct dark continuation of the postocular bar passing through them, antennæ similar to those parts in the female but the paler parts are inclined toward ecru drab. Pronotum with the dorsum of the general color, the median carina, asperities and beading of the caudal margin of the darker color; lateral lobes dark dorsad, pale ventrad, the two shades marbled mesad and the margins beaded. Tegmina with a solid median and proximal blotch on the costal area, while a third distal spot is faintly indicated, intervals between the spots very light, sutural margin with the venation infuscate, distal third of the discoidal field hyaline except for the finely lined veins. Wings with the fuscous band placed very slightly distad of the middle and considerably narrowed cephalad, of greatest width at the point where it touches the periphery of the wing, here about one-fifth the length of the wing, and continued very little toward the internal margin of the wing, spur distinct, thick, extending slightly more than half way to the base of the wing; color of the disk pale sulphur yellow in the male, very weak primrose yellow in the female, apical portion hyaline except for the infuscation of a few veins near the immediate apex. Abdomen and ventral surface sulphur

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[9] In this sex the abdomen is slightly distended from the normal and deduction has been made for this extension.

yellow. Cephalic and median limbs of the general colors, imperfectly annulate and sprinkled the darker on the lighter, the cephalic limbs in the male clouded with ecru drab. Caudal femora with the genicular region blackish, a distinct pregenicular annulus of pale wood brown present, the lateral face with three oblique fasciæ of the darker color, the distal of which is the only one which clouds the ventral face to any great extent, in the male the lighter areas are almost bluish white; caudal tibiæ naples yellow with the proximal portion clouded and the genicular section and the tips of the spines blackish.

Measurements.

	♂	♀
Length of body,	17.8 mm.	30.5 mm.
Length of pronotum,	4.2 "	6.4 "
Length of tegmen,	18.5 "	25.7 "
Greatest width of tegmen,	3.5 "	4.5 "
Length of caudal femur,	10.2 "	14.5 "

A series of four males and three females have been examined in addition to the types, one from Palmerlee (Schaeffer; September 5), the others from Carr Canyon (Biederman; September 22, 24, October 8 and 28, 1905). The Palmerlee male is lighter in color than the four Carr Canyon male specimens available; this not only being true of the brown shades but of the disk of the wings as well, those parts being of the same shade as in the female. One of the female paratypes is very similar to the type, another is slightly paler and the third decidedly paler with the color contrasts much reduced and in some cases absent. The size appears to vary little, and in structure the chief variation worthy of note is the degree of "blocking" of the dorsal portion of the frontal costa. The fuscous band of the wing is carried nearer to the internal margin of the wing in some specimens than in others.

Trimerotropis fascicula McNeill.

Carr Canyon, Huachuca Mountains, August, 1905 (Skinner), 4 ♂. Palmerlee (Schaeffer), August 7, 1905, 1 ♂.

These specimens agree very well with McNeill's description, except that they are slightly larger with distinctly longer tegmina, a feature of variation well exhibited by series of the closely related *T. bruneri*. This form is extremely close to *bruneri*, appearing somewhat slenderer and with a narrower fastigium and wider tegminal bars.

Trimerotropis alliciens Scudder.

Carr Canyon, Huachuca Mountains, August, 1905 (Skinner), 1 ♂, 1 ♀. September 24 and 28, October 8, 1905 (Biederman), 1 ♂, 3 ♀. Palmerlee, August 7, 1905 (Schaeffer), 1 ♀.

In several of these specimens the elytral bands are more distinct than in others. This species is clearly a member of the *citrina* group.

Trimerotropis laticincta Saussure.

Carr Canyon, Huachuca Mountains, August, 1905 (Skinner), 1 ♂; October 8 and 20, 1905 (Biederman), 3 ♂, 2 ♀. Palmerlee, September (Schaeffer), 1 ♂. Douglas, August (F. H. Snow), 1 ♂.

These specimens are true *laticincta*, although the validity of this as distinct from *latifasciata* appears rather doubtful.

Trimerotropis magnifica n. sp.

Type: ♂; Carr Canyon, Huachuca Mountains, Cochise Co., Arizona. August, 1905 (Henry Skinner). [A. N. S. Phila.]

This very large and striking new species is allied to *T. tolteca* and *pistrinaria* Saussure, but differs from both in the very much greater size, and from *tolteca* in the presence of a hyaline distal section on the wings, as well as from *pistrinaria* in the practical absence of the usual ulnar spur on the wing.

Size very large (for the genus); form moderately robust. Head with the occiput rounded and slightly elevated above the level of the disk of the pronotum, interspace between the eyes as broad as the greatest width of the disk of the fastigium; fastigium considerably declivent, the slope of the same being a regular continuation of the arch of the occiput, lateral carinæ of the fastigium parallel caudad, regularly approaching one another cephalad, median carina faintly indicated caudad; lateral foveolæ undefined, no ventral bounding ridge in the usual position; frontal costa considerably constricted dorsad, broader and subequal for a distance dorsad and ventrad of the ocellus, on the

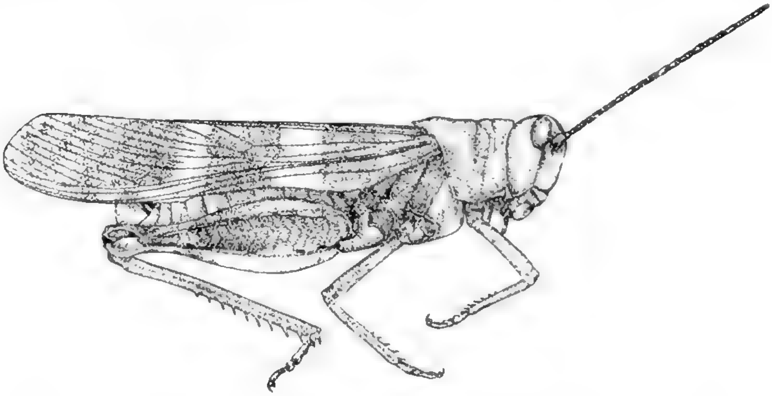

Fig. 4.—*Trimerotropis magnifica* n. sp. Lateral view of type. (× 1½.)

ventral portion of the face the costal carinæ expand in an undulating fashion, sulcation distinct but not very deep, in fact shallow in the constricted dorsal portion; eyes not prominent, somewhat shorter than the infraocular sulcus; antennæ heavy, in length exceeding that of the head and pronotum combined by that of the head alone. Pronotum with the disk but very slightly tectate, prozona contained about one and three-fourths times in the metazona; cephalic margin very slightly arcuate, caudal margin rectangulate with the margins slightly undulate; median carina very faintly indicated on the prozona, distinct but very fine on the metazona; lateral angles faintly tuberculate on the prozona, rounded shoulders on the metazona; lateral lobes of the pronotum with the depth slightly exceeding the dorsal length, caudal margin descending with a slight cephalad trend, ventral margin irregularly rounded. Interspace between the mesosternal lobes distinctly but not strongly transverse; interspace between the metasternal lobes slightly transverse. Tegmina four and a half times the length of the pronotum, exceeding the apices of the caudal femora and the abdomen by the pronotal length, the greatest width contained about four and a half times in the length; costal margin with the distal third regularly arcuate, apex obliquely truncate; intercalary vein closer to the median than to the ulnar vein throughout its length. Wings ample, rather broad, the greatest width contained about one and three-fourths times in the length; apex obliquely truncate, axillary field with the margin distinct arcuate. Abdomen with the subgenital plate rather broad; cerci simple, straight, substyliform, blunt. Cephalic and median limbs rather slender; caudal femora robust, not strongly but regularly inflated, the ventral carina distinctly elevated, length about two and one-half times that of the pronotum; caudal tibiæ with nine spines on the lateral margins.

General color pale ochraceous-buff overlaid with bistre. Head pale ventrad and on the face, dark dorsad, genæ lightly mottled; eyes burnt umber; antennæ, except for the paler two proximal joints, clove brown. Pronotum nearly uniform bistre. Tegmina with solid median and proximal dark transverse bars,[10] the latter confluent with the base of the tegmen and both extending solidly across the same,[11] a premedian bar is present but not as regular as the others, the pale interspaces between the three bands being sharply defined and distinctly but not greatly narrower than the average of the darker bars; apical fourth

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[10] These bars are darker and nearly blackish on the costal field.

[11] The median is a little broken on the anal field.

changing from subhyaline to hyaline with about a half dozen subquadrate blotches of the darker color. Wings with the band clove brown in color, crossing the wing immediately distad of the middle, extending in a complete arc from the costal to very near to the internal margin, regularly narrowing in width from the axillary field caudad, the width on the axillary field being about two-sevenths the length of the tegmen, spurs hardly indicated; disk pale sulphur yellow; apical area hyaline except for several blotches of dark color, no suffusion however being present. Abdomen dull naples yellow. Caudal femora of the lighter general color inclined to vinaceous-pink on the ventral portion of the lateral face, dorsal and bounding carinæ of the paginæ sparsely beaded, face of the paginæ suffused with the dark color, broad pregenicular annulus of the pale color laterad; genicular regions mingled drab and bistre, internal and ventral face of the femora blackish except for the pregenicular annulus and a proximal portion, both of which are Chinese orange; caudal tibiæ orange vermilion the genicular section and tips of the spines black; caudal tarsi buffy ventrad washed with orange vermilion dorsad.

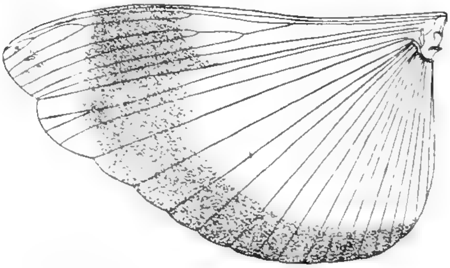

Fig. 5.—*Trimerotropis magnifica* n. sp. Wing of type. (× 1½.)

Measurements.

Length of body.	38.5	mm.
Length of antenna.	19	“
Length of pronotum.	9	“
Length of tegmen.	39.5	“
Length of caudal femur.	21.5	“

The type is the only specimen of this handsome species seen by the author.

Trimerotropis melanoptera McNeill.

Carr Canyon, Huachuca Mountains, August (Skinner), 1 ♀.

This specimen is quite peculiar in that the proximal light area of the wings is not yellow but creamy white. The width of the fuscous wing band is about half the total length of the wing, and the internal faces of the caudal femora have a single pregenicular orange red band.

Trimerotropis vinculata Scudder.

San Bernardino Ranch, 3,750 feet, August (F. H. Snow), 1 ♂, 1 ♀. Benson, July (Schaeffer), 1 ♀. Douglas, August (F. H. Snow), 1 ♂, 2 ♀. Carr Canyon, Huachuca Mountains, August (Skinner), 1 ♂. September 23 and 27, October 8 and 20 (Biederman), 15♂, 21 ♀.

Several specimens of this common and widely distributed species from Grand Canyon of the Colorado (Skinner, July 11) are also in hand.

Trimerotropis cyaneipennis Bruner.

Carr Canyon, Huachuca Mountains, August, 1905 (Skinner), 6 ♂, 6 ♀. September 24, 1905 (Biederman), 6 ♂, 4 ♀. Palmerlee, September (Schaeffer), 1 ♀.

Scudder's *T. cyanea*[12] appears to be a synonym of this species.

HADROTETTIX Scudder.

Hadrotettix trifasciatus (Say).

Carr Canyon, Huachuca Mountains, August (Skinner), 2 ♂, 3 ♀. September 23 (Biederman), 1 ♂, 2 ♀. Palmerlee, July 31 (Schaeffer), 1 ♂.

TREPIDULUS McNeill.

Trepidulus melleolus (Scudder).

1902. *Conozoa melleola* Scudder, Proc. Davenp. Acad. Sci., IX, p. 34, pl. II, fig. 2. [La Cueva, Organ Mountains, New Mexico.]
1905. *Mestobregma gracilipes* Caudell, Proc. U. S. Nat. Mus., XXVIII, p. 471, fig. 5. [Nogales and Huachuca Mountains, Arizona.]
1906. *Trepidulus gracilipes* Bruner, Biol. Cent.-Amer., Orth., II, p. 185.

San Bernardino Ranch, 3,750 feet, August (F. H. Snow), 1 ♂.

There is no doubt in the author's mind that *Conozoa melleola* is the species later described by Caudell as *Mestobregma gracilipes*. A comparison of the descriptions shows the identity of the two species.

HELIASTUS Saussure.

Heliastus benjamini Caudell.

Carr Canyon, Huachuca Mountains, August (Skinner), 4 ♂, 2 ♀. September 22 and 23, October 20 and 24 (Biederman), 3 ♂, 8 ♀. Palmerlee, August 7 (Schaeffer), 1 ♀.

This series shows that in general color some specimens are decidedly grayish, while others are warm brown, the tegminal bars varying little in intensity. In some female individuals the metanotum is slightly more tumid than in others.

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[12] *Proc. Davenp. Acad. Sci.*, IX, p. 36.

Heliastus aridus (Bruner).

Carr Canyon, Huachuca Mountains, August (Skinner), 1 ♀. Palmerlee, August (Schaeffer), 1 ♂, 1 ♀. San Bernardino Ranch, 3,750 feet, August (F. H. Snow), 1 ♂.

The Carr Canyon specimen is grayish, the Palmerlee individuals reddish.

BRACHYSTOLA Scudder.

Brachystola intermedia Bruner.

Carr Canyon, Huachuca Mountains, August, 1905 (Skinner), 3 nymphs. September 23 and 24, 1905 (Biederman), 5 ♂, 3 ♀. San Bernardino Ranch, 3,750 feet, August, 1905 (F. H. Snow), 1 nymph.

This species, recently described from Sonora(?) and Mazatlan, Mexico, was considered by the describer to possibly reach "south-western Arizona in the vicinity of the Huachuca Mountains," an opinion which the present material well sustains. In size the adults in this series are fairly uniform, only one male being slightly smaller than the others, while the coloration is distinctly more uniform than usual in series of this genus. As the male sex was not in the possession of the describer, the measurements of an average male may be of interest:

Length of body,	41	mm.
Length of pronotum,	11.5	"
Caudal width of dorsum of pronotum,	7.7	"
Length of tegmen,	7.8	"
Length of caudal femur,	25.5	"

PHRYNOTETTIX Glover.

Phrynotettix magnus (Thomas).[13]

Carr Canyon, Huachuca Mountains, August (Skinner), 7 ♂, 5 ♀. September 24 and 27 and October 8 (Biederman), 9 ♂, 2 ♀. Palmerlee, August (Schaeffer), 1 ♂, 1 ♀. San Bernardino Ranch, 3,750 feet (F. H. Snow), 1 ♂, 1 ♀.

This series exhibits considerable variation in size in both sexes, and also some difference in the length of the metanotum and the character of the caudal angle of the same. In color numerous variations are observed, hardly two specimens appearing exactly the same; variation in base color, washes, pronotal margining and maculations, as well as

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[13] By the acquisition of new material and the re-examination of old the author has been compelled to modify his opinion expressed in 1902 (*Proc. Acad. Nat. Sci. Phila.*, 1902, pp. 595-597) regarding the synonymy of species of this genus. Thomas's *magnus* is distinct from *tshivavensis*, as is also Bruner's *robustus*. The specimens recorded from El Paso, Texas, Alamogordo, Otero Co., and Lake Valley, Sierra Co., New Mexico, are of the latter species.

femoral bars and fine, abdominal maculations, all combining to give numerous color schemes of browns and grays. A few specimens are reddish and others rather blackish.

Schistocerca vaga (Scudder).

Carr Canyon, Huachuca Mountains, August (Skinner), 1 ♂, 4 ♀, 1 nymph. October (Biederman), 4 ♂, 7 ♀. Palmerlee, August (Schaeffer), 1 ♂.

As is usual in this species a great amount of individual color variation is present in the above series. In some specimens the pale dorsal line is almost obsolete, in one completely lacking, in others, particularly males, strongly marked. The tegminal maculations are of variable intensity, in two specimens being extremely weak, while the dark femoral bars and pale ventral section of the lateral lobes of the pronotum are subject to equal variations, but as a rule the femoral bars are distinct in the individuals with a well contrasted color pattern.

Schistocerca venusta Scudder.

Carr Canyon, Huachuca Mountains, August (Skinner), 6 ♀, 1 nymph. September and October (Biederman), 4 ♂, 7 ♀. Huachuca Mountains, July (Schaeffer), 1 ♂.

The above series contains specimens extremely close to *S. shoshone*, and the author inclines strongly toward the belief expressed by Mr. Caudell that *venusta* is probably a form of *shoshone*.[14] Both sexes of this form vary considerably in size, and in some individuals the metazona is distinctly bullate dorsad instead of nearly plane as in the majority. The color of the caudal tibiæ varies from glaucous and purplish pink to very dull purple.

CONALCÆA Scudder.

1897. *Conalcæa* Scudder, Proc. U. S. Nat. Mus., XX, pp. 9, 23.

Type.—*C. miguelitana* Scudder.

Conalcæa neomexicana Scudder.

Carr Canyon, Huachuca Mountains, September 22–24 (Biederman), 2 ♂, 8 ♀.

This series is fairly uniform in coloration, such variation as is present being in the shade of browns and yellows which make up the base colors. The postocular bar is more distinctly marked in some specimens than in others, while in some individuals the black lateral bars of the prozona are slightly broken caudad of the yellowish oblique bar. The caudal tibiæ vary from pinkish red to deep chrome yellow.

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[14] *Proc. U. S. Nat. Mus.*, XXVIII, p. 476.

Conaloæa huachucana n. sp.

Types: ♂ and ♀; Carr Canyon, Huachuca Mountains, Cochise Co., Arizona. September 24, 1905. (Biederman.) [Hebard Collection.]

Allied to *C. miguelitana* and *C. neomexicana*, differing from the former in the form of the cerci and some features of the coloration, and from *C. neomexicana* in the characters which separate *miguelitana* from the same, the form of the cerci, however, being very similar to *neomexicana*.

Size slightly smaller than *C. neomexicana*; form subfusiform, robust; surface rather more glabrous in the male than in the female. Head with the occiput very slightly arched, not elevated above the level of the disk of the pronotum; interspace between the eyes rather narrow, in the male no wider, and in the female but little wider than the proximal antennal joint; fastigium roundly deflected, the greatest width very considerably greater than that of the interspace between the eyes, width of the scutellum of the fastigium very slightly broader than the same, moderately but not greatly excavated; frontal costa rather broad, slightly constricted dorsad, parallel ventrad and fading before reaching the clypeus, dorsal section not sulcate (slightly impressed in the male) but deeply punctate, area around the ocellus and for a short distance ventrad broadly and shallowly sulcate; eyes oval with the cephalic border flattened, in length half again as long as the infraocular sulcus in the male, about a quarter again as long in the female; antennæ moderately depressed proximad, in the male very slightly shorter than the head, pronotum, mesonotum and metanotum together, in the female equal to the head, pronotum and mesonotum. Pronotum with the disk moderately tectate; cephalic margin subtruncate, and the caudal margin with a broad triangular emargination

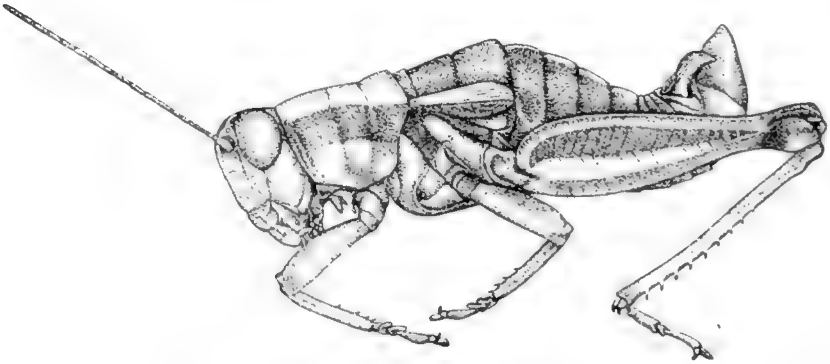

Fig. 6.—*Conalcæa huachucana* n. sp. Lateral view of male type. (× 3.)

in both sexes; median carina distinct but hardly elevated, lateral angles distinct, obtuse, slightly more rounded on the metazona than on the prozona, the angles regularly expanding caudad throughout their length, the expansion being much more marked in the female than in the male; metazona about half the length of the prozona, the metazona also more closely punctate than the prozona; lateral lobes with the length distinctly one and one-half times the depth in the male, less than one and one-half times the depth in the female, cephalic margin very slightly arcuate, caudal margin with a concave-arcuate cephalic trend, the ventro-caudal angle thick and very slightly recurved, ventral margin arcuate with the cephalic half sinuate, sulci well marked on the lateral lobes. Mesonotum and metanotum together slightly shorter than the pronotum in the male, distinctly shorter than the pronotum in the female, both tectate and carinate as is the pronotum. Prosternal spines erect, thick, apex slightly blunted; interspace between the mesosternal lobes slightly longer than broad in the male, subquadrate in the female; interspace between the metasternal lobes very narrow in the female, lobes contiguous in the male. Tegmina reaching to the caudal margin of the metanotum, lanceolate, about two and a half times as long as broad in each sex, slightly narrower in the male than in the female; apex rather broadly rounded. Abdomen slightly compressed and with a low median carina; furcula developed as very broad, short, trigonal plates, no longer than the segment from which they arise; supra-anal plate produced trigonal, apex bluntly rounded, median sulcus narrow and deep in the proximal half; cerci moderately compressed with the proximal half thick and subequal, the distal half falciform, the cephalic margin slightly elevated and arcuate around to the acute apex, the sublamellate portion of the distal half curved in toward the median line of the body; subgenital plate subpyramidical, the apex well elevated above the margin, the two being connected by a blunt ridge. Cephalic and median limbs robust in the male, rather weak (for a Melanoplid) in the female; caudal femora regularly tapering, not greatly inflated, the greatest width in the male contained about three and a half times in the length; caudal tibiæ with nine spines on the external margin.

Fig. 7.—*Conalcæa huachucana* n.sp. Dorsal view of apex of male abdomen. (× 3.)

General colors russet and seal brown. Head with the postocular bar not strongly marked; eyes varying from burnt umber to raw umber;

antennæ pale proximad, dark distad. Pronotum with the continuation of the postocular bar solid, deep seal brown in the male, slightly weaker in the female, extending across the whole of the lateral lobes and in depth being nearly half that of the same, the ventral line being more definite mesad than cephalad and caudad; ventral portion of the lateral lobes pale russet. Dorsum of the mesonotum and metanotum similar to the dorsum of the pronotum, metathoracic epimera dorsad to the line of the dorsal margin of the tegmina and the mesothoracic epimera shining seal brown, episterna russet. Tegmina with a dorsal section russet (paler in the male); ventral section shining seal brown. Abdomen of the lighter general color with longitudinal series of contiguous seal brown blotches on the dorsal section laterad of the median line, which is a very striking pale bar, these blotches varying in intensity in the sexes (stronger in the male) and in individuals; apex of the male abdomen and the ventral surface of the same touched with orange rufous. Cephalic and median limbs brownish touched with olive green; caudal femora vandyke brown dorsad, the dorsal half of the paginal area blackish brown, ventral half and ventral sulcus cream color washed slightly with greenish, genicular lobes pinkish buff touched with scarlet vermilion; caudal tibiæ and tarsi scarlet vermilion, the spines tipped with black.

Measurements.

	♂	♀
Length of body,	21 mm.	28 mm.
Length of pronotum,	5 "	6 "
Cephalic width of disk of pronotum,	2.7 "	3.5 "
Caudal width of disk of pronotum,	4.2 "	6 "
Length of tegmen,	4.3 "	5 "
Length of caudal femur,	13 "	14.7 "

In addition to the types a series of six males and seven females of this species have been examined, all of which except one pair from Palmerlee (in coitu; August 7, 1905; Schaeffer) are paratypic (September 23 and 24). In size but little variation is presented, and in color such as exists is chiefly in the depth of the coloration, the two extremes, both females, one with russet predominating and the other with seal brown the prevailing color, can readily be given their proper association, as the distinctive color pattern is essentially the same. In some specimens there is a tendency to breaking in the pronotal continuation of the postocular bar, but in no case is this as complete and strongly defined as in *C. neomexicana*.

MELANOPLUS Stål.

Melanoplus lakinus Scudder.

Carr Canyon, Huachuca Mountains, September 22–27, October 8–20 (Biederman), 15 ♂, 13 ♀.

These individuals would probably be Scudder's *M. sonorae,* as the pronotum is less expanded caudad than in average Colorado specimens of *lakinus,* and the lateral faces of the caudal femora are either not at all or but slightly marked with the usual bars of *lakinus.* In the author's opinion *sonorae* is no more than a geographic race of *lakinus,* and may hardly be of such rank, as Colorado specimens of *lakinus* vary greatly in size, somewhat in the expansion of the pronotum and occasionally have the lateral face of the caudal femora without distinct markings. The reddish color of the caudal tibiæ of *sonorae,* as mentioned in the original description, is possibly due to the type specimens having been immersed in a liquid preservative, as the individuals in hand all have the tibiæ glaucous.

Melanoplus aridus (Scudder).

Carr Canyon, Huachuca Mountains, September 23 and 24, October 8 (Biederman), 2 ♂, 1 ♀. Palmerlee, August 7 (Schaeffer), 1 ♀. Douglas, August (F. H. Snow), 1 ♀.

From these specimens it is evident that this species varies considerably in size, in parts of its range at least, the Cochise County individuals being much larger than representatives from Florence, Arizona. These latter are distinctly smaller than the measurements given by Scudder, while a pair from Carr Canyon measure as follows:

	♂	♀
Length of body,	21.5 mm.	29.5[15] mm.
Length of pronotum,	5 “	7 “
Length of tegmen,	4.8 “	5.5 “
Length of caudal femur,	12.5 “	16 “

Melanoplus desultorius n. sp.

Types: ♂ and ♀; Carr Canyon, Huachuca Mountains, Cochise Co., Arizona. September 24, 1905 (Biederman). [Hebard Collection.]

Allied to *M. aridus* and closely resembling it superficially, but differing in the more sulcate frontal costa, the flattened and moderately expanded cerci and in the interspace between the mesosternal lobes, which is strongly longitudinal in the male, slightly longitudinal in the female. In the shape of the cerci this species approaches *M. humphreysii,* but the caudal margin of the pronotum is as in *M. aridus.*

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[15] Abdomen distended beyond normal size.

Size medium; form of medium build. Head with the occiput rounded but hardly elevated above the dorsum of the pronotum, interspace between the eyes slightly narrower (♂) or slightly broader (♀) than the proximal antennal joint, fastigium distinctly broader than the interocular space, rather deeply (♂) or shallowly (♀) sulcate, the sulcation extending caudad between the eyes; frontal costa distinctly (♂) or slightly (♀) wider than the interspace between the eyes, impresso-punctate dorsad of the ocellus in the male, punctate in the female, in the male strongly sulcate around and ventrad of the ocellus, in the female moderately sulcate at and for half the distance ventrad of the ocellus, the costal margins slightly constricted dorsad and very slightly approximate ventrad; eye subovate in the male, ovate with the cephalic margin flattened in the female, when viewed from the dorsum the eyes are moderately prominent in the male, very slightly prominent in the female; in length considerably (♂) or not greatly (♀) longer than the infraocular portion of the genæ; antennæ in the male slightly shorter than the head, pronotum and tegmina together, in the female very slightly longer than the head and pronotum together. Pronotum with the disk very gently arched transversely, the lateral angles rounded, the median carina distinct on the cephalic half of the prozona and on the metazona, more elevated on the metazona and obsolete on the caudal half of the prozona; cephalic margin very slightly arcuate, the caudal margin very obtusely angulate; metazona closely punctate, in the female also with very fine transverse strigæ, prozona about one and three-eighths times the length of the metazona, principal transverse sulcus well marked in both sexes, the prozonal sulci breaking the median carina in the male, not dividing the same in the female; lateral lobes half again as long as deep in the male, slightly

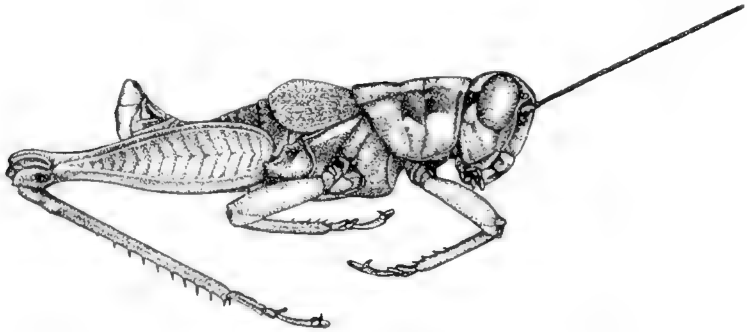

Fig. 8.—*Melanoplus desultorius* n. sp. Lateral view of male type. (× 3.)

shorter in the female, the lobes moderately tumid in their cephalic portion, particularly of the prozona, the caudal margin descending obliquely cephalad, the ventral margin slightly emarginate cephalad. Prosternal spine thick, somewhat compressed in the male, directed caudad; interspace between the mesosternal lobes half again as long as broad in the male, slightly longer than broad in the female; metasternal lobes contiguous in the male, subcontiguous in the female. Tegmina in the male subovate, reaching nearly to the distal margin of the proximal abdominal segment and slightly shorter than the pronotum; in the female suborbicular, reaching to about the middle of the same segment and distinctly shorter than the pronotum, the apical margin slightly subangulate in the male, broadly subtruncate in the female, the greatest breadth of the tegmina in the male about two-thirds the length, in the female slightly less than the length. Abdomen moderately compressed, the apex in the male slightly expanded and erected but not recurved; furcula developed as short, well separated spines, not longer than the segment from which they arise and slightly diverging distad; supra-anal plate trigonal, the median sulcus narrow and extending about two-thirds the length of the plate; cerci with the length not more than twice that of the broad base, from which the remainder of the cercus is sharply and regularly contracted to about half the basal width, the narrow portion being slightly curved dorsad, the apex acute and the ventral margin slightly proximad of the apex with a blunt angle, in transverse plane the cerci are curved mesad and then bent sharply dorsad; subgenital plate slightly produced, moderately compressed, the apex slightly rounded ventro-dorsad. Cephalic and median limbs robust in the male. Caudal femora well developed but not strongly inflated, in the male very slightly exceeding the head, pronotum and tegmina in length, in the female distinctly exceeding these; caudal tibiæ with ten to eleven spines on the lateral margins.

Fig. 9.—*Melanoplus desultorius* n. sp. Dorsal view of apex of male abdomen. (× 4.)

General color clay color. Head with the vertex and occiput marked with a median longitudinal bar of seal brown, more or less broken into spots; postocular bar blackish-brown; face and genæ clouded and washed with drab, rather greenish-olive in the male; eyes russet; antennæ flame-scarlet, a little obscured distad and less brilliant in general color in the male (nearly vermilion) than in the female. Pronotum olive dorsad in the male, of the general color with a median wash of prout's brown on the prozona in the female; lateral lobes with the dorsal half of the prozona shining blackish, a narrow continuation of this bar on the angle of the metazona being dull blackish, ventral portion of the prozonal lobes creamy buff against the blackish changing to the general color along the ventral margin and on the metazona. Tegmina broccoli brown with a strong steel-bluish tinge in the male; the ventral margin in both sexes narrowly marked with blackish and the minute interspaces between the veins showing up darker than the veins themselves; apical margin faintly (♂) or distinctly (♀) margined with buffy. Abdomen with the proximal segments marked with black dorsad, the remaining segments and the ventral surface chiefly maize yellow. Caudal femora with the ventral aspect and the ventral portion of the faces yellow, the dorsal section of the lateral face washed with pale olive-green, the dorsal face and the dorsal section of the internal face with a median and premedian bar of raw umber, genicular arches seal brown, a moderately well defined pregenicular annulus yellow, genicular lobes with a black basal spot, the remainder yellowish dorsad, greenish blue ventrad; caudal femora bottle green, the spines black, pale at their bases.

Measurements.

	♂	♀
Length of body, ...	17.3 mm.	26.5 mm.
Length of pronotum, ...	5 "	6.3 "
Length of tegmen, ...	4.5 "	5 "
Length of caudal femur, ...	11.7 "	14.2 "

In addition to the types a series of eleven topotypic specimens have been examined, two males and nine females (date identical with types). From these specimens it is evident that the species varies considerably in size, and apparently in both sexes, although the male material is necessarily not as conclusive as the female. In coloration the variation is chiefly in the brilliancy of the yellow areas and of the yellow values, the base color varying in the same ratio as the pure yellows. In several specimens the color of the dorsal section of the lateral faces of the caudal femora strongly encroaches on or suffuses the ventral section, and this is apparently irrespective of the strength of the yellow colors. In one female the whole of the lateral lobes except the blackish area is uniform cream-buff.

Melanoplus flavidus Scudder.

Carr Canyon, Huachuca Mountains, August, 1905 (Skinner), 1 ♀. October 8, 16–17, 20, 1905 (Biederman), 4 ♀. Palmerlee, August 7, 1905 (Schaeffer), 1 .

These specimens have the coloration much subdued and with gray-browns the predominating color value. The Palmerlee specimen is of a warmer brown than the others, and in the Carr Canyon series the yellows usually have a greenish cast.

Melanoplus regalis (Dodge).

Carr Canyon, Huachuca Mountains, August, 1905 (Skinner), 2 ♀. September 23 and 24, October 8, 16–17, 1905 (Biederman), 4 ♂, 14 ♀. Palmerlee, June 13, 1905 (Schaeffer), 1 ♀.

A pair of this form was submitted to Prof. Bruner, who was responsible for the transference of Dodge's species from *Æoloplus* to this genus,[16] and his opinion confirmed the author's suspicion that they represented Dodge's very poorly described species. It belongs to the *femur-rubrum* series and must have a very great superficial resemblance to *M. sanguineus* Bruner,[17] judging from the description of the latter, and in a number of ways also suggests *M. corpulentus*, which, however, is very different structurally.

The coloration of the series examined is very interesting and shows considerable variation in the intensity of purplish-reds and greens, which on a yellowish ground and varied with umber markings constitute the main color features. In by far the majority of the specimens the green is conspicuous. In all the specimens the crimson ventral sulcus of the caudal femora and the glaucous tibiæ are marked, and very little variation in the color of the same is noticed.

Melanoplus corpulentus Scudder.

Carr Canyon, Huachuca Mountains, September 21, 23 and 24, October 8, 16–17, 1905 (Biederman), 9 ♂, 7 ♀. Palmerlee, August 7, 1905 (Schaeffer), 1 ♂, 1 ♀.

This series varies considerably in size and somewhat in the intensity of pattern and general shade of the coloration; a few individuals have their general color more grayish than the average, others more yellowish. The caudal tibiæ are glaucous in five of the series. The length of the tegmina and wings varies considerably and is more pronounced in the male than in the female.

Melanoplus thomasi Scudder.

Douglas, August, 1905 (F. H. Snow), 1 ♂.

This striking species is here recorded from Arizona for the first, this

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[16] In Gillette, Bull. 94, Colo. Agr. Exp. Sta., p. 55.

[17] Two specimens from the Garden of the Gods, Colorado, recently recorded by the author (*Proc. Acad. Nat. Sci. Phila.*, 1906, p. 406) as *sanguineus* prove on second examination to be *regalis*. The superficial resemblance between these two is so great that without authentic material the two are liable to be confused.

being only the fourth record for the species—Scudder having described it from Lerdo, Durango; Scudder and Cockerell recording it from Tularosa, New Mexico, and the present author examined and recorded seven specimens from the Sacramento Mountains, New Mexico.

Phœtaliotes nebrascensis (Thomas).

Carr Canyon, Huachuca Mountains, September 24, October 16–17, 1905 (Biederman), 1 ♂, 1 ♀. San Bernardino Ranch, 3,750 feet, August, 1905 (F. H. Snow), 1 ♂.

The individual from San Bernardino Ranch belongs to the form *volucris*, the others being the short-winged type.

When compared with Nebraska, Colorado and Indiana specimens the males appear to have the dorsal constriction of the frontal costa stronger than the average from those localities; but one Colorado specimen (Greeley, Colorado) differs in that portion being narrower than in the Arizona males. This species has been recorded from Tucson, Pima Co., Arizona.

Dactylotum variegatum (Scudder).

Carr Canyon, Huachuca Mountains, August, 1905 (Skinner), 2 ♀. September 23 and 24, 1905 (Biederman), 5 ♂, 6 ♀. Palmerlee, June 23, 1905 (Schaeffer), 1 ♂.

The females of this series present considerable variation in size, one particularly being no larger than male individuals, while this one specimen is but little surpassed in size by another of the same sex. There is a very perceptible amount of variation in both sexes in the depth of the bluish pronotal markings.

TETTIGONIDÆ.

Dichopetala brevihastata Scudder.

Carr Canyon, Huachuca Mountains, August, 1905 (Skinner), 1 ♂.

This species is the *D. brevicauda* Scudder of 1902, but not of 1900.[18] The former records are from southern New Mexico (several localities in the Mesilla Valley) and Mexico.

Dichopetala lævis n. sp.

Types: – ; Carr Canyon, Huachuca Mountains, Cochise Co., Arizona. August, 1905 (H. Skinner). [Acad. Nat. Sci. Phila.]

Allied to *D. brevihastata* Scudder, but differing in the shorter ovipositor which is also slightly thicker distad than mesad and proximad, and has the margins unarmed, and also in the smaller general size and shorter, more robust limbs.

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[18] *Vide* Morse, *Psyche*, IX, p. 381.

Size small; form very distinctly compressed. Head with the vertex regularly declivent to the narrow but low fastigium; eyes ovate, small but rather prominent; antennæ slightly more than twice the length of the body proper, rather thick in the proximal portion. Pronotum with a moderate mesad constriction; in length slightly more than twice that of the head; cephalic margin truncate, caudal margin very faintly obtuse-angulate, lateral lobes shallow, the greatest depth contained slightly more than twice in the length. Tegmina very short, the extreme apex alone visible beyond the caudal margin of the pronotum. Styles very short, thick, conic; ovipositor about equal to the cephalic femur in length, the proximal third nearly subequal in width, from which, however, it gradually enlarges to the distal section, which is distinctly but not greatly broader than the proximal portion; the caudal margin is strongly curved dorsad in the distal portion, the extreme apex, being rounded and nearly dorsad in position, all the margins unarmed; subgenital plate with a small but deeply and strongly rounded apical emargination. Cephalic limbs slender, the bullæ quite small; median limbs slightly longer than the cephalic. Caudal femora nearly two and one-half times the length of the cephalic femora, well inflated in the proximal half; caudal tibiæ exceeding the length of the femora by nearly the dorsal length of the head.

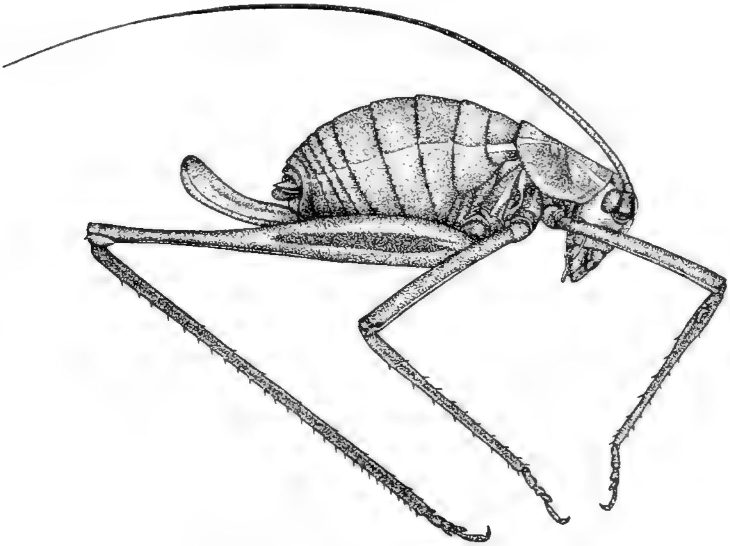

Fig. 10.—*Dichopetala lævis* n. sp. Lateral view of type. (× 3.)

General color ochraceous-buff. Head with the face overlaid with very pale greenish; palpi oil green; eyes russet; dorsum of the head with a narrow median whitish line extending from the fastigium caudad, enclosed laterad by line borders of pansy purple, a broad bar of which borders dorsad the narrow whitish postocular streak; antennæ proximad very pale greenish overlaid with purplish, distad clear oil green. Pronotum with the usual situation of the lateral carinæ marked with whitish, as is also the entire cephalic margin and also the other margins of the lateral lobes, caudal margin beaded with small purplish spots. The median fine white line with its purplish borders is also continued on the pronotum and mesonotum, while the mesonotum and metanotum are beaded caudad as on the pronotum, the lateral whitish bars of the pronotum being also continued on these sections. Abdominal segments beaded caudad as with the thoracic segments, the whitish lateral lines also extending to the apex of the abdomen, the dorsal area between which is darker than laterad. Ovipositor russet, the immediate apex darker. Femora wood brown mottled with broccoli brown and on the caudal femora touched with a wash of greenish; caudal femora marked mesad and laterad in the proximal half with a pattern of short oblique brownish lines; tibiæ green, the cephalic and median pair brownish green proximad, clear dark green distad, the caudal pair dark clear green, spines narrowly tipped with black.

Measurements.

Length of body,	13.5 mm.
Length of pronotum,	4.5 "
Length of caudal femur,	17.5 "
Length of ovipositor,	7 "

The type is unique.

Hormilia elegans Scudder.

Benson, July, 1905 (Schaeffer), 1 ♀. San Bernardino Ranch, 3,750 feet, August, 1905 (F. H. Snow), 1 ♀.

These specimens belong to the typical color form.[19] Caudell[20] has recorded this species from this region and the records now extend from Florence, Arizona, to the Mesilla Valley, New Mexico.

Hormilia apache n. sp.

Types: ♂ and ♀; Carr Canyon, Huachuca Mountains, Cochise Co., Arizona, August, 1905 (H. Skinner). [Acad. Nat. Sci. Phila.]

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[19] *Vide* Rehn, *Proc. Acad. Nat. Sci. Phila.*, 1904, pp. 572, 573.
[20] *Proc. U. S. Nat. Mus.*, XXVIII, p. 477.

Allied to *H. abbreviata* Bruner from Cuernavaca, Morelos,[21] but differing in the much longer tegmina and wings, the latter extending beyond the former, the well-defined humeral sinus of the lateral lobes of the pronotum and the more arcuate ventral margin of the same parts, the more recurved tips of the male cerci and the truncate subgenital plate of the same sex (this has distinct lateral angles and a very well-developed median protuberance in *abbreviata*). The form of the pronotum is very similar to that of *abbreviata*, and in this respect these species stand apart in the genus from the others which possess sharp lateral angles.

Size medium; form moderately compressed and elongate. Head with the occiput moderately globose, not elevated above the pronotum and regularly declivent to the narrow, compressed fastigium, which is truncate distad, subequal in the distal half and with distinct lateral carinæ, contiguous to the trigonal facial fastigium; eyes rather small, elliptical and prominent for their size; antennæ with the proximal joint subtrigonal in section, in length slightly more than twice that of the tegmina. Pronotum with the dorsum deplanate, lateral angles sharp

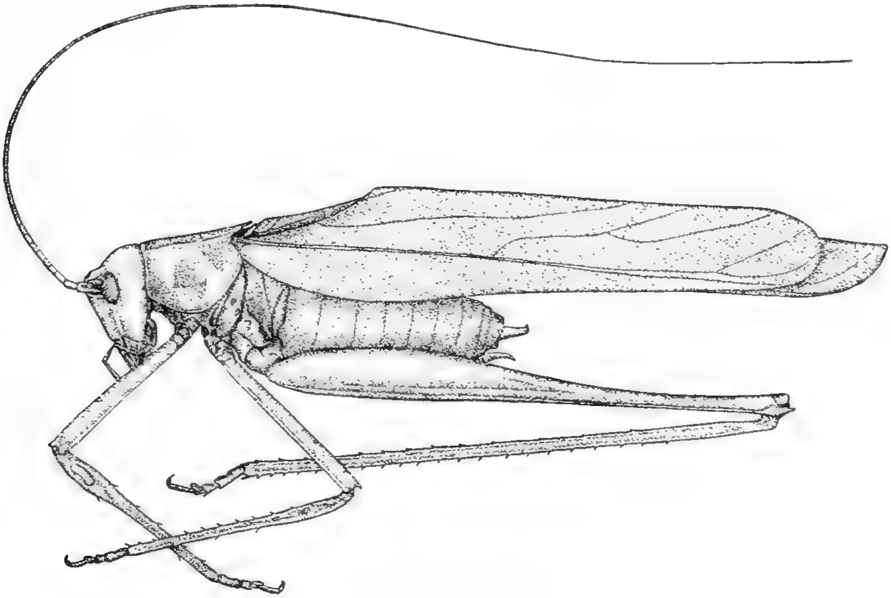

Fig. 11.—*Hormilia apache* n. sp. Lateral view of male type. (× 3.)

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[21] Topotypic specimen examined.

and subrectangulate, the width of the disk regularly expanding caudad, with, however, a very slight expansion at the cephalic margin; cephalic margin gently emarginate, caudal margin moderately arcuate with a very slight median emargination; lateral lobes slightly longer than deep, the humeral sinus distinct and angulate, but not wide or deep, the margin from the ventro-cephalad angle to the humeral sinus being rather regularly arcuate. Tegmina about four and a half times as long as the pronotum, in greatest width about equal to the length of the latter; costal margin very gently arcuate proximad, tapering distad; apex rounded, sutural margin straight; tympanum of male hardly wider than the disk of the pronotum caudad, veins not strong; radial vein furcate, the ramus reaching the sutural margin immediately proximad of the apex. Cephalic and median limbs slender, the cephalic femora more robust than the median, the genicular margin of the four cephalic femora provided dorsad with a trigonal dentiform process; cephalic tibiæ with the auditory foramina cochate, median tibiæ slightly expanded proximad. Caudal femora slightly longer (♀) or slightly shorter (♂) than the tegmina, the proximal half moderately bullate, this condition being almost entirely dorsad, genicular lobes with peg-like processes; caudal tibiæ slightly longer than the femora. Distal dorsal segment of male with the median section with a rounded slightly depressed area; supra-anal plate small, trigonal; cerci rather short, slightly curved, distal section somewhat flattened, the apex acute and sharply bent dorsad; subgenital plate short, the apical margin truncate and laterad with two short style-like processes. Ovipositor longer than the pronotum, broad, very sharply bent at the base, very slightly tapering distad, the bent portion of the dorsal margin and the distal third of the ventral margin finely serrate. Subgenital plate acute trigonal.

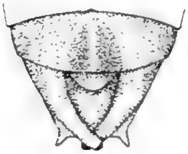

Fig. 12.—*Hormilia apache* n. sp. Dorsal view of apex of male abdomen. (× 8).

General color chromium green, paler ventrad and on the limbs; antennæ with about seven irregularly disposed dark brown annuli on the distal third; pronotum faintly lined with yellowish on the angles; eyes mottled drab and ecru drab.

Measurements.

	♂	♀
Length of body.	17 mm.	16.5 mm.
Length of pronotum.	4.8 "	5 "
Caudal width of disk of pronotum.	3 "	3 "
Length of tegmen.	25 "	23.5 "
Length of caudal femur.	22 "	23.5 "
Length of ovipositor.		5.8 "

In addition to the types a male from Palmerlee (Schaeffer) has also been examined.

Arethæa sellata n. sp.

Type: ♂; Palmerlee, Cochise Co., Arizona, July 30, 1905 (C. Schaeffer). [Brooklyn Inst. Arts and Sci.]

Allied to *A. constricta* Bruner, but differing in the strongly sellate pronotum, the shorter and comparatively broader head, the broader tympanal field with its strongly bisinuate margin, the slightly longer cephalic femora and slightly shorter median femora, and also in the form of the cerci which have a very slightly dorsal curve at the tips.

Size medium; form very elongate. Head with the mouth cephalad; occiput gently descending to the compressed, slightly elevated and distinctly sulcate fastigium, which, however, is low ventro-cephalad; facial fastigium trigonal, slightly higher than wide, the borders distinctly marginate; eyes elliptical, quite prominent when viewed dorsad; antennæ elongate, rather heavy in structure for this type of Orthopteron. Pronotum distinctly sellate, the caudal portion (metazona) forming a considerable angle with the prozona, the cephalic margin of which is also slightly elevated when viewed laterad; when viewed dorsad the cephalic margin is very broadly triangular emarginate, caudal margin semi-oval in outline; prozona much more constricted than the metazona, the principal sulcus distinct on the lateral lobes; humeral sinus moderately deep, placed well dorsad on the caudo-lateral margins, which are oblique ventrad, the true ventral margin being somewhat sinuate, a moderately distinct arcuate transverse depression extends from one humeral sinus to the other, wholly independent of the depression of the principal sulcus. Tegmina about four-fifths the length of the caudal femora, narrow, costal field roundly expanded proximad, the costal margin evenly arcuate distad, the sutural margin straight, the apex closer to the sutural margin than to the costal and narrowly rounded; tympanum of medium size, the sutural margin strongly bisinuate, the proximal lobe slightly acute-angulate with the apex rounded; lateral margins of the tympanum slightly arcuate; radial vein with three rami all of which reach the sutural margin. Wings exceeding the tegmina, when in repose, by

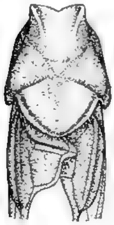

Fig. 13.—*Arethæa sellata* n. sp. Dorsal view of pronotum and tympanal area of male. (× 4.)

Fig. 14.—*Arethæa sellata* n. sp. Single male cercus. (× 15.)

nearly the length of the median femora. Limbs very slender. Cephalic femora slightly more than twice the length of the pronotum, the tibiæ distinctly but not greatly exceeding the femora. Median femora about two-thirds the length of the tegmina, the tibiæ exceeding the femora by about the same distance as in the cephalic limbs. Caudal femora about three times as long as the head and pronotum together, the inflation about limited to the proximal two-fifths; tibiæ distinctly exceeding the femora in length, all margins spined, the dorsal more strongly so than the ventral. Abdomen subtectate; terminal dorsal segment truncate; cerci tapering, comparatively stout in the proximal half, the apex sharp and rather strongly curved; subgenital plate produced, the apex narrowed and arcuate-emarginate, supplied laterad with distinct, rather sharp styliform processes of moderate length.

General color pale apple green, rather whitish ventrad. Head with the eyes prout's brown; antennæ beyond the proximal joint yellowish; narrow postocular stripe indian purple, flanked ventrad with a greenish-white line of equal width. Pronotum with the prozona bearing two converging greenish-white lines, between which the disk is punctate with purplish, the metazona margined with greenish-white and bordered internally with a purplish line, the white margin very broad on the lateral lobes. Tympanum of the tegmina purplish-brown, the veins yellowish as well as the sinuate margin; sutural margin washed with purplish-brown. Abdomen with an arcuate lateral greenish-white line distinctly margined with purple ventrad, the dorsum of the abdomen uniform punctate with the same color; extreme apex of the cerci blackish. Limbs faintly washed with purplish-red.

Measurements.

Length of body,	16	mm.
Length of pronotum,	4	"
Greatest width of pronotum,	3.5	"
Length of tegmen,	20.5	"
Greatest width of tegmen,	2.8	"
Greatest width of tympanum,	2.7	"
Length of wing beyond closed tegmen,	11.8	"
Length of cephalic femur,	9.5	"
Length of median femur,	12.5	"
Length of caudal femur,	25	"
Length of caudal tibia,	27	"

The type is the only specimen of this interesting species examined by the author.

The five species of the genus *Arethæa* which have been examined by the author may be separated by the following key,[22] which is based in part on that given by Brunner.

1.—Tegmina and wings distinctly shorter than the body, *carita* Scudder.
1.1.—Tegmina and wings very much longer than the body.
  2.—Tympanal field of the male tegmen roundly produced. Cephalic and median femora with the dorsal apex dentate.
    3.—Radial vein with three or four rami. Size small, *gracilipes* (Thomas).
    3.3.—Radial vein with five or six rami. Size large, *phalangium* (Scudder).
  2.2.—Tympanal field of the male tegmen angularly produced at the transverse vein. Cephalic and median femora with the dorsal apex obtuse.
    3.—Tympanal field of the male tegmen but little expanded, the margin being moderately bisinuate. Pronotum moderately sellate. Cerci with the tips strongly recurved dorsad, ... *constricta* Brunner.
    3.3.—Tympanal field of the male tegmen moderately expanded, the margin being strongly bisinuate. Pronotum strongly sellate. Cerci with a very slight dorsal inclination at the tips, . . . *sellata* Rehn.

Scudderia mexicana (Saussure).

Carr Canyon, Huachuca Mountains, September 27, October 8, 16–17, 1905 (Biederman), 2 ♂, 4 ♀.

The species has previously been recorded from this region by Caudell.

Scudderia furcifera Scudder.

Carr Canyon, Huachuca Mountains, August (Skinner), 1 ♂, 2 ♀. September 24, October 3, 8 and 20, 1905 (Biederman), 3 ♂, 6 ♀. Palmerlee, July 26, 1905 (Schaeffer), 1 ♀.

In the United States, Scudder recorded this species from Prescott, Arizona, and Scudder and Cockerell from the Organ Mountains, New Mexico.

Microcentrum laurifolium (Linnæus).

Carr Canyon, Huachuca Mountains, October 2, 3 and 8, 1905 (Biederman), 3 ♀.

One of these specimens belongs to the variety *b* mentioned by Saussure and Zehntner.

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[22] *A. brevicauda* (Scudder) is not included as it is unknown to the author, and its relationship is probably with *carita*. The same author's *A. consuetipes* has not been seen, and from the description would appear to have a unique position on account of its short legs.

Microcentrum retinerve (Burmeister).

Palmerlee, August (Schaeffer), 1 ♀.

This species has been recorded from Nogales, Arizona, by Caudell.

Conocephalus fuscostriatus Redtenbacher.

Carr Canyon, Huachuca Mountains, September 28 or 29, 1905 (Biederman), 1 ♂.

This specimen is inseparable from two males of this species from Thomasville, Georgia. This is the first record of the species west of Texas.

Xiphidion fasciatum (DeGeer).

Douglas, August (F. H. Snow), 1 ♂, 1 ♀.

Capnobotes fuliginosus (Thomas).

Carr Canyon, Huachuca Mountains, August, 1905 (Skinner), 1 ♂.

This specimen is distinctly larger than a male from Jerome, Arizona, fully equalling a female from the latter locality.

Eremopedes unicolor Scudder.

Carr Canyon, Huachuca Mountains, August, 1905 (Skinner), 5 ♂, 8 ♀. September 21, 24 and 28, 1905 (Biederman), 2 ♂, 4 ♀. Douglas, August, 1905 (F. H. Snow), 1 ♀.

The Carr Canyon series presents a very considerable amount of individual variation in size. The Douglas female is extremely large, the caudal femora particularly far exceeding the original measurements. However, aside from the very slightly narrower ovipositor, no other characters to separate it are apparent, and as the measurements of this specimen may be of interest they are given herewith.

Length of body (exclusive of ovipositor),	27.5 mm.
Length of pronotum,	8.9 "
Length of caudal femur,	28.5 "
Length of ovipositor,	20 "

Stenopelmatus oculatus Scudder.

Carr Canyon, Huachuca Mountains, August, 1905 (Skinner), 1 ♀. Huachuca Mountains, July 23, 1905 (Schaeffer), 1 ♂.

While one of these specimens appears to approach *californicus* in the small size of the apical spine of the internal margin of the caudal femora, yet, in view of the unreliability of spine formulæ and proportions in this genus, it appears best to place it where all other characters seem to place it—in Scudder's *oculatus*.

Ceuthophilus paucispinosus Rehn.

Carr Canyon, Huachuca Mountains, August, 1905 (Skinner), 3 ♂, 4 ♀. September 22, 23 and 28, October 8, 1905 (Biederman), 4 ♂. Palmerlee, August, 1905 (Schaeffer), 1 .

The very interesting series of this species contained in the collections available for study presents several facts in elaboration of the original description of this species, based on a single female from southern Arizona. One is that considerable size variation is present in both sexes, but more particularly in the male. Another is that in the male the ventral ridge of the caudal femora is more elevated and distinctly dentato-serrate (often strongly so), while in several of the specimens of the same sex the proximal fourth of the caudal tibiæ are strongly valgate, beyond which they are straight.

Measurements are here given of the maximum specimens of both sexes.

	♂	♀
Length of body, ...	20 mm.	18.5 mm.
Length of pronotum, ...	5.5 "	5 "
Length of cephalic femur, ...	8.5 "	7.8 "
Length of caudal femur, ...	17 "	15 "
Length of ovipositor, ...	11.2 "	

GRYLLIDÆ.

Ellipes minuta (Scudder).

Douglas, August (F. H. Snow), 1 specimen.

Nemobius neomexicanus Scudder.

Douglas, August (F. H. Snow), 1 ♀.

This species has previously been recorded from Florence, Arizona.

Gryllus personatus Uhler.

Carr Canyon, Huachuca Mountains, August, 1905 (Skinner), 2 ♂, 4 ♀. Palmerlee (Schaeffer), 1 ♀. San Bernardino Ranch, 3,750 feet, August, 1905 (F. H. Snow), 3 ♂, 3 ♀.

This series has been compared with a representation from Florence, Flagstaff and Phœnix, Arizona. There is considerable variation in the depth of the fuscous coloration and also in size, the latter being as individual as color variation, the largest male and the smallest females being from the same locality (San Bernardino Ranch). All the specimens are of the macropterous type.

Gryllus armatus Scudder.

San Bernardino Ranch, 3,750 feet, August, 1905 (F. H. Snow), 1 ♂, 1 ♀.

This species has also been examined from Florence and Phœnix, Arizona.

Gryllus alogus Rehn.

Carr Canyon, Huachuca Mountains, August, 1905 (Skinner), 2 ♀.

When compared with the type, from Albuquerque, New Mexico, these individuals are inseparable although both slightly smaller. An additional female from Carr Canyon is placed under this species with a query, agreeing in spine formulæ with *integer* and *pennsylvanicus*, but in general appearance and form similar to *alogus*. The positive determination of species of this genus will probably be impossible until extensive breeding experiments and careful quantitative studies of our "species" have been made.

Œcanthus niveus (DeGeer).

Carr Canyon, Huachuca Mountains, August, 1905 (Skinner), 1 ♂, 2 ♀. Palmerlee (Schaeffer), 1 ♀.

Œcanthus nigricornis Walker.

Carr Canyon, Huachuca Mountains, August, 1905 (Skinner), 3 ♀. September 30, 1905 (Biederman), 1 ♀. Palmerlee (Schaeffer), 2 ♀.

These specimens are inseparable from a Monte Redondo, Costa Rica, female.

Caudell has recorded this species from the Huachucas.

Œcanthus argentinus Saussure.

Carr Canyon, Huachuca Mountains, August, 1905 (Skinner), 3 ♂, 2 ♀. October 16–17, 1905 (Biederman), 1 ♂.

These specimens are assigned to this species with some little doubt, as they agree fairly well with the original description of Saussure, but do not tally so closely with the later one given by the same author.[23] The antennal markings are similar to those originally described, but have no supplementary spot or cloud on the first proximal joint as later stated. In other characters these individuals agree very fully with the 1897 description. The remarks made by Caudell[24] regarding Oracle and Hot Springs, Arizona specimens referred to this species are substantiated by the material before me.

II. Pima County.

The specimens here treated were collected by Prof. F. H. Snow, of the University of Kansas, during the summer of 1906. The localities represented are the Baboquivari Mountains and Tucson. The material from the former locality is of very considerable interest as it has been seldom visited and, as far as the author is aware, this series is the first collection of Orthoptera made in that isolated locality.

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[23] *Biol. Cent.-Amer.*, Orth., I, p. 254.
[24] *Proc. Ent. Soc. Wash.*, V, p. 166.

Two species previously known only from localities south of the United States are here recorded from north of the boundary line, while two are described as new.

MANTIDÆ.

Stagmomantis gracilipes n. sp.

Type: ♂; Baboquivari Mountains, Pima County, Arizona, 1906 (F. H. Snow). [Coll. University of Kansas.]

Allied to *S. venusta, heterogamia, montana* and *androgyna* Saussure and Zehntner and *limbata* Hahn. From *venusta, limbata* and *androgyna* it can be immediately separated by the slenderer pronotum and limbs, particularly the cephalic femora; from *heterogamia* it can be separated by the much greater size, narrower supra-coxal expansion of the pronotum and the comparatively longer limbs; from *montana* it differs in the smaller size, except the length of the cephalic femora which is about the same in both forms, in the narrower costal margin of the tegmina and in the wings being strongly marked and not vitreous.

Size medium; form slender. Head broad, the depth but little more than half the width. Pronotum slender, the greatest width contained nearly six times in the length; cephalic margin rounded, the collar with parallel sides, the expansion slight, shaft compressed but slightly expanding caudad, margins of the collar slightly crenulate, shaft distinctly carinate. Tegmina slightly more than twice the length of the pronotum; costal field moderately expanded proximad, not appreciable in the distal third, coriaceous; stigma linear, longitudinal, not sharply marked. Wings not exceeding the tips of the tegmina when in repose. Cephalic limbs quite slender, coxæ slightly less than two-thirds the length of the pronotum, distinctly but not strongly spined on the cephalic margin with two grades of spines, caudal face with the surface rugose owing to the presence of short spiniform tubercles, between which the surface is uneven; cephalic femora very slightly shorter than the pronotal shaft, the principal discoidal spine being situated very near the middle, lateral margins armed with five spines, one of which is small and genicular in position, internal margins armed with fourteen to fifteen spines, one small and genicular and the remainder divided

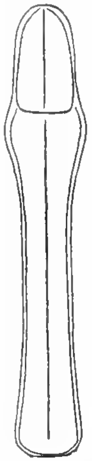

Fig. 15.—*Stagmomantis gracilipes* n. sp. Dorsal view of pronotum of type. (× 3.)

into two alternating series, discoidal spines four in number; cephalic tibiæ slightly more than half the length of the femora, external margins armed with eight to ten spines which leave unarmed a considerable proximal area, internal margins with a regularly enlarging series of eleven to twelve spines; cephalic tarsi somewhat longer than the tibiæ without apical claw, the metatarsi alone but little shorter than the tibiæ. Median and caudal limbs very slender, the caudal femora about five-sixths the length of the pronotum.


Fig. 16.—*Stagmomantis gracilipes* n. sp. Cephalic limb of type. (× 2.)

General color ochraceous, the head inclined toward ochraceous-rufous, the ventral surface of the thorax and abdomen chrome yellow, the median and caudal femora deepening to blackish brown proximad. Tegmina brownish hyaline, the costal field opaque, probably green in life, the costal and discoidal fields separated by a wash of russet which fades rapidly on the discoidal side. Wings with the costal margin marked with russet, the remainder with subquadrate patches of seal brown such as are frequently found in the genus.

Measurements.

Length of body (approximately[25]),	58	mm.
Length of pronotum,	19.5	"
Greatest width of the pronotum,	3.3	"
Length of tegmen,	40.5	"
Width of proximal portion of costal field,	1.8	"
Length of cephalic femur,	13.1	"
Length of cephalic tibia (exclusive of apical claw),	6.2	"
Length of median femur,	13	"
Length of cephalic femur,	16.5	"

The type is the only specimen of this interesting species which has come to the author's attention.

Vates paraensis Saussure.

Baboquivari Mountains, 1 ♀.

This specimen has been compared with an undoubted Guadalajara female of this species and is inseparable from it. In size it is slightly larger, but well within the measurements given by Saussure and Zehntner. The species described by the author as *V. townsendi* can readily be separated from *paraensis* by the more compressed pronotal shaft,

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[25] The distal section of the abdomen is missing.

the more expanded and sublamellate supra-coxal expansions of the same, the more strongly lobed limbs and abdomen and the distinctly emarginate marginal field of the tegmina. The Arizona specimens of *Vates* recorded by Caudell as *V. townsendi*[26] may probably be this species and not *townsendi*, which has stronger pronotal expansions in the female than we would suppose were possessed by the female of the species figured.

The only previous records of this species north of Panama were from Guadalajara, Jalisco, and Cuernavaca, Morelos, Mexico.

ACRIDIDÆ.

Telmatettix aztecus (Saussure).

Tucson, 1 ♀. Baboquivari Mountains, 2 ♂, 3 ♀.

These specimens have been compared with Yautepec, Morelos, and Teocelo, Vera Cruz individuals.

Clypeotettix schochii (Bolivar).

Baboquivari Mountains, 1 ♀.

This specimen is inseparable from Morelos and Vera Cruz specimens, and constitutes the first record for the species from the United States.

Paratettix toltecus (Saussure).

Tucson, 3 ♂.

Specimens from Arizona, New Mexico, Mexico, Nicaragua and Costa Rica have been used for comparison.

Achurum acridodes (Stål).[27]

Baboquivari Mountains, 1 ♂.

Mermiria neomexicana (Thomas).

Baboquivari Mountains, 1 ♂.

This is the first Arizona record of the species, which ranges south as far as the State of Durango.

Cordillacris pima n. sp.

Type: ♀; Baboquivari Mountains, Pima Co., Arizona. 1906. (F. H. Snow). [Coll. Univ. of Kansas.]

In many respects this species appears to connect the two types previously known in the genus, *i.e.*, *occipitalis* and *crenulata*. From the former type (*occipitalis*, *cinerea* and *affinis*) it can be separated by the more strongly bowed lateral carinæ of the pronotum, narrower tegmina and the distinctly slenderer caudal limbs. From *crenulata* the new form can readily be distinguished by the larger size, the slenderer and less inflated head, more retreating face, narrower tegmina and longer limbs.

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[26] *Journ. N. Y. Ent. Soc.*, XIII, p. 83, Pl. III, figs. 1, 2.

[27] For the definition of *acridodes* see *antea*, p. 31.

Size medium; form quite elongate. Head broad caudad, regularly narrowed cephalad; occiput and vertex distinctly ascending above the level of the pronotum, the interspace between the eyes no narrower than the fastigium, the latter obtuse-angulate with the margins sharp and bordered immediately caudad by a very narrow depressed space; angle of the fastigium viewed laterad very slightly acute-angulate, the immediate angle rounded, face very considerably retreating; frontal costa very narrow dorsad, regularly expanding ventrad, the portion dorsad of the ocellus decidedly sulcate, the portion ventrad of the ocellus slightly sulcate, the margins somewhat cariniform; eyes slightly longer than the infraocular sulcus; antennæ very considerably longer than the head and pronotum, the proximal portion depressed and subensiform, the extreme apex also being depressed. Pronotum short, the cephalic margin of the disk sinuate with a slight median emargination, caudal margin rotundato-truncate; median carina slightly elevated on the metazona; lateral carinæ slightly constricted caudad on the prozona, strongly flaring on the metazona; prozona slightly longer than the metazona; lateral lobes slightly longer than deep. Tegmina distinctly surpassing the apex of the abdomen, narrow, the apex rounded. Cephalic and median limbs slender; caudal femora quite slender, the greatest width contained about five and a half times in the length, caudal tibiæ very slightly shorter than the femora, armed on the lateral margin with ten spines.

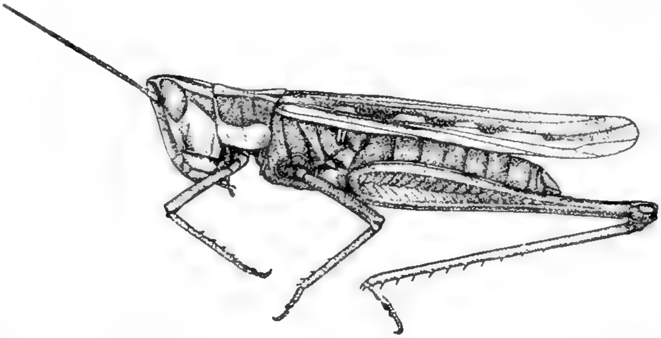

Fig. 17.—*Cordillacris pima* n. sp. Lateral view of type. (× 3.)

Fig. 18.—*Cordillacris pima* n. sp. Dorsal view of head and pronotum. (× 3.)

General colors chalk white and mummy brown, the maculations of the darker color distributed in the manner usual in this genus. Head with a distinct median bar of brown extending from the fastigium to the caudal section of the occiput where it is broken up, a narrow median line in this maculation and lateral margins of the same are bordered with buff; postocular bar distinct, genæ white, face pale buff; antennæ buffy proximad becoming glaucous green, with a faint touch of buffy on the tips. Pronotum with the dorsum chiefly buffy, the lateral carinæ buff, margined ventrad with a narrow line of black and the broad continuation of the postocular bar; the buff area on the disk of the prozona bears mesad an elongate trigonal faintly whitish area, while the lateral portions of the metazonal disk are distinctly velvety black, ventral portion of the lateral lobes white. Tegmina with the white discoidal maculations crudely hemispherical in shape and four in number, costal area also white, region of the anal vein buffy. Cephalic and median limbs whitish finely punctate with brown; caudal femora with the dorsal section of the lateral face purplish brown, the dorsal face with a small median and an elongate pregenicular blotch of the same color; caudal tibiæ lavender, very pale proximad, the spines pale buff tipped with black.

Measurements.

Length of body,	19.5 mm.
Length of pronotum,	3 "
Length of tegmen,	15.2 "
Length of caudal femur,	13.5 "

The type is the only specimen seen.

Scyllina calida (Bruner).

Baboquivari Mountains, 1 ♀.

This is the second record for the species from the United States.

Psoloessa maculipennis Scudder.

Baboquivari Mountains, 4 ♀.

One of these specimens is suffused with blackish dorsad, while another, which otherwise is of the normal type of coloration, has the femoral markings very small.

Psoloessa texana Scudder.

Baboquivari Mountains, 2 ♂, 2 ♀.

One of the male specimens of this species has a prominent longitudinal dorsal line of ochraceous flanked laterad by purplish brown, the latter color continuous from the vertex to the tegmina, which it almost entirely suffuses.

Psoloessa buddiana Bruner.

Baboquivari Mountains, 2 ♀.

Ageneotettix australis Bruner.

Baboquivari Mountains, 4 ♂, 1 ♀.

This species is now known from Maricopa, Cochise and Pima Counties.

Aulocara rufum Scudder.

Baboquivari Mountains, 1 ♂.

This is the second record of the species from Arizona; the nearest points from which the species has previously been recorded being San Bernardino Ranch, Cochise Co., Arizona, and La Cueva, Organ Mountains, New Mexico.

Arphia aberrans Bruner.

Baboquivari Mountains, 1 ♀.

This species is only known from the Mexican border of Arizona, *i.e.*, Nogales and the Huachuca Mountains.

Encoptolophus texensis Bruner.

Tucson, 1 ♂, 2 ♀.

Lactista oslari Caudell.

Tucson, 1 ♀.

The previously known localities for this species are Nogales,,Arizona, and Albuquerque, New Mexico.

Tomonotus ferruginosus Bruner.

Baboquivari Mountains, 2 ♂, 1 ♀.

One of the male individuals possesses a very peculiar coloration.

Tomonotus aztecus (Saussure).

Baboquivari Mountains, 1 ♀.

This individual agrees with a specimen mentioned by the author on a preceding page[28] in having the frontal costa hardly constricted ventrad of the ocellus.

Derotmema delicatulum Scudder.

Baboquivari Mountains, 1 ♂, 1 ♀.

The previous Arizona records of this species are from between Gila Bend and Yuma and Florence.

Mestobregma rubripenne (Bruner).

Baboquivari Mountains, 1 ♂, 1 ♀.

The shorter and more robust caudal femora of this species immediately separates it from *M. plattei*, its nearest ally.

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[28] P. 38.

Conozoa carinata Rehn.

Baboquivari Mountains, 2 ♂, 1 ♀.

These specimens fully agree with the typical series from the Huachuca Mountains, Cochise Co., Arizona.

Trimerotropis fascicula McNeill.

Baboquivari Mountains, 1 ♂.

In coloration this specimen is slightly paler than Huachuca Mountains representatives, with the internal and ventral faces of the caudal femora suffused with the same red color as the tibiæ, while the dorsum of the abdomen has a wash of the same color. The general size is slightly larger than Huachuca specimens and the proportionate length of the tegmina is about the same, much longer proportionately than in the type individuals.

Heliastus aridus (Bruner).

Tucson, 1 ♀.

Heliastus benjamini Caudell.

Baboquivari Mountains, 1 ♂, 1 ♀.

The previous localities for this species are Nogales and the Huachuca Mountains, Arizona. The male is more ferruginous than any other specimen examined by the author.

Schistocerca vaga (Scudder).

Tucson, 1 ♂.

This individual is small and rather paler than the majority of specimens of this species. The amount of color variation presented by individuals of this form is very considerable, the extremes having quite different appearances but being connected in any series by members of intermediate specimens.

Conalcæa huachucana Rehn.

Baboquivari Mountains, 1 ♀.

This specimen is inseparable from the female type, and is the first record of the species beyond the limits of the Huachuca Mountains.

Hesperotettix festivus Scudder.

Tucson, 1 ♀.

This individual has the pregenicular annuli very distinct, but shows no traces of the blackish pencilling of the pronotal sulci seen in *H. viridis*.

Melanoplus brownii Caudell.

Baboquivari Mountains, 1 ♀.

This specimen appears to belong to this species which was described from near Yuma, Arizona. Coloration counts for very little in *M.*

flavidus and its allies, and little stress should be laid on its determinative value. In measurements this individual differs from the original only in that the caudal femora are one millimeter shorter than the minimum there given.

TETTIGONIDÆ.

Arethæa constricta Bruner.

Tucson, 1 ♀.

This specimen is inseparable from Texas females of this species, and constitutes the first record from west of the Organ Mountains, southern New Mexico.

Scudderia mexicana (Saussure).

Baboquivari Mountains, 1 ♂.

Eremopedes unicolor Scudder.

Baboquivari Mountains, 1 ♂.

Huachuca Mountains specimens are usually smaller than this individual, which is very pale and buffy-brown in color.

Ateloplus notatus Scudder.

Tucson, 1 ♀. Baboquivari Mountains, 1 immature ♀.

These representatives have been compared with a female from Florence, Arizona, and show no differences except a more blackish coloration.

Gryllus armatus Scudder.

Tucson, 1 ♀.

Miogryllus lineatus (Scudder).

Tucson, 1 ♀.

This record is of very considerable interest, as no mature specimens of this species have been recorded since the types were collected along the Colorado River between Mohave City and the Virgin River.

Œcanthus californicus Saussure?

Baboquivari Mountains, 2 ♀.

These specimens are assigned here with some little doubt, as they have distinct blackish lines on the two proximal antennal joints. However, in the shape of the femora, the color of the head and the antennæ, aside from the markings, they agree with males of this species, while the pronotum has the sulci disposed in a similar fashion and differs only in the lack of caudal expansion, a character which appears to be sexual in this genus, due to the greater expanse of the male tegmina. Some little affinity is shown with the recently described *Œ. rehnii* Baker, but the specimens are clearly distinct from that species, while the heavier caudal femora immediately separate it from *argentinus*.

III. PHŒNIX, MARICOPA COUNTY.

The specimens considered in this portion of the paper were collected by Dr. R. E. Kunzé, and are now in the Hebard Collection.

A few specimens from Prescott have also been included, but where no locality is mentioned Phœnix is understood. A striking new species of *Ceuthophilus* is here described.

BLATTIDÆ.

Blatta orientalis Linnæus.

Prescott, July 14, 1904. 1 ♂, 1 ♀.

Homœogamia erratica Rehn.

September 17 and October 9, 1903; September 14, October 2, 5 and 7, 1904. 7 ♂.

These specimens represent the pale typical and the slightly infuscate form.

Homœogamia apacha Saussure.

April 9, 1902; June 7 and 9, 1904. 3 ♂. Prescott, July 14 and 18, 1904. 3 ♂.

The Phœnix specimens represent the typical form of the species, while the three Prescott individuals are of the very strongly infuscate form called *infuscata* by Caudell[29] on the basis of a Phœnix specimen. The interspaces between the eyes and between the ocelli in these specimens and in those of *erratica* agree in relative proportions with the material previously studied by the author.[30]

MANTIDÆ.

Litaneutria minor (Scudder).

June 16, August 21, September 11, 17 and 24, October 1, 2, 11 and 24, December 1, 1904. 5 ♂, 5 ♀.

Stagmomantis limbata (Hahn).

September 10, 1901; August 21 and September 29, 1904. 2 ♂, 1 ♀.

One of these males is much smaller than the other. The female is referred here with a little uncertainty, as it is similar to the one from San Bernardino Ranch, Cochise Co., Arizona, mentioned in this paper.[31] The costal field of the tegmina is no wider than in that

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[29] *Proc. U. S. Nat. Mus.*, XXVIII, p. 463.

[30] *Proc. Acad. Nat. Sci. Phila.*, 1903, pp. 181, 187–189; *Ent. News*, 1903, p. 327.

[31] *Antea*, p. 28.

specimen, the form is smaller than in the average of *limbata,* while the pronotum is distinctly though slightly constricted cephalad of the supra-coxal expansion. The wings are purplish black caudad while the tegmina are green. The left cephalic femur, tibia and tarsus of this specimen have been regenerated; the femur being slightly smaller than the right but otherwise normal, the tibia is a short rounded joint not a third the femoral length with the margins unarmed, while the tarsus is quite short.

PHASMIDÆ.

Diapheromera arizonensis Caudell.

September 7, 8 and 15, October 17 and 20, 1904, 21 ♀.

As the female of this species has not been well described, some notes may prove of service.

When compared with a female of *D. femorata* from Philadelphia, *arizonensis* is seen to be somewhat more robust, the head is distinctly broader and the eye larger, while the proximal joint of the antennæ is narrower. The median segment is slightly more transveres than in *femorata,* and the cerci are much shorter and blunter, while the three distal abdominal segments are distinctly shorter and the subgenital opercule is provided with a distinct apical finger-like lobe. Limbs slightly longer than in *femorata* with the femoral spines distinct. When compared with the closely allied Mexican *D. calcarata,* the female of *arizonensis* is seen to be somewhat slenderer, but with a broader head. The structure of the abdominal appendages and the terminal segments is the same as in *calcarata,* but the limbs of the latter species are distinctly more robust.

ACRIDIDÆ.

Orphulella graminea Bruner.

September 30, October 4–5. 14 ♂, 14 ♀.

These specimens agree with four paratypic specimens, two of each sex, received from Prof. Bruner. In size the majority of the female individuals are somewhat larger than the paratypic specimens, but no larger than the original measurements. In color some are distinctly mummy brown, others vinaceous-cinnamon and russet. The discoidal area of the tegmina is quite distinctly marked with quadrate blotches in about half of the specimens.

Encoptolophus texensis Bruner.

September 24. 1 ♀.

This specimen has the head, pronotum, pleura and dorsal aspects of the caudal femora suffused with pale green.

Conozoa behrensi Saussure.

September 18. 1 ♀.

Trimerotropis vinculata Scudder.

October 17. 6 ♂, 12 ♀.

Anconia integra Scudder.

September 24, October 11–18. 10 ♀.

This series presents all color variations, from the nearly uniform green type to a strongly maculate form with the pronotal markings very decided.

Schistocerca vaga (Scudder).

October 10–16. 4 ♂, 5 ♀.

These specimens vary considerably in coloration, several females having the dorsum of the pronotum almost unicolorous, while the variation in the intensity of tegminal maculations is very considerable.

Schistocerca shoshone (Thomas).

September 25 to December 15. 5 ♂, 9 ♀.

Considerable variation is exhibited by this series in the coloration of the caudal tibiæ, shades ranging from pale purplish pink to decided purplish red being present on those parts.

Hesperotettix festivus Scudder.

October 31, November 1–28, 1903. 4 ♂, 6 ♀.

Melanoplus herbaceus Bruner.

November 24 and 26, 1903. 12 ♂, 8 ♀.

These specimens are practically intermediate between true *herbaceus* and *flavescens* Scudder, which cannot be considered as other than a western race of *herbaceus*. In color and genital characters this series is truly intermediate, and in the author's opinion we must use the trinomial *M. herbaceus flavescens* for Scudder's form.

Melanoplus pictus Scudder.

November 18–28, 1903; October 10, 1904. 10 ♂, 10 ♀.

This series is clearly referable to this species which was described from Bradshaw Mountain, Yavapai-Maricopa Cos., Arizona. When compared with the original description, the only difference which appears is that the caudal tibiæ are "purplish fuscous" or near it in but one specimen, the others ranging from pale glaucous to rather bright blue. There is a certain amount of variation in the actual presence or the intensity of the yellowish line along the lateral angles of the prozona, and in structure there is an appreciable variation in the width of the interspace between the mesosternal lobes, the latter being subcontiguous in one male individual.

Melanoplus atlanis (Riley).

November 18–24, 1903. 7 ♂, 3 ♀.

These specimens are quite large when compared with Eastern specimens, a fact which is true of Florence, Arizona, individuals.

Melanoplus differentialis (Thomas).

September 4, October 16, 1904. 5 ♂, 1 ♀.

TETTIGONIDÆ.

Hormilia elegans Scudder.

September 5–7, 1904. 2 ♂, 6 ♀.

Three of the females present the type of coloration which has the dark areas of the tegmina large and deep in color, surrounding and isolating the light greenish portions. In this type the pronotum is richer in color, owing to the more definite whitish margins contrasted with the broad dark area which is placed on the caudal section of the pronotal disk, and also in the patch on the lateral lobes being larger and more conspicuous. One specimen is extremely pale, the dark markings being weak or mere suggestions of color.

Microcentrum laurifolium (Linnæus).

November 24 and 26, December 1, 1903. 1 ♂, 4 ♀.

Stenopelmatus oculatus Scudder.

Prescott, Arizona, July 14, 1904. Phœnix, September 16, 1903. 2 ♂.

Ceuthophilus lamellipes n. sp.

Types: ♂ and ♀; Phœnix, Maricopa Co., Arizona, November 18, 1903. (Kunzé.) [Hebard Collection.]

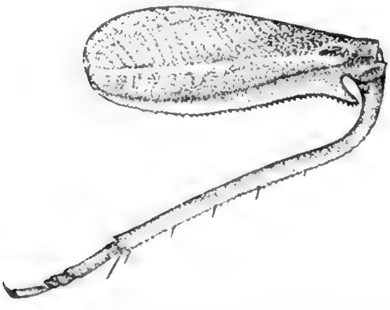

Fig. 19.—*Ceuthophilus lamellipes* n. sp. Caudal leg of male. (× 3.)

Allied to *C. pacificus*, *henshawi* and *salebrosus* Scudder, but in most every character closer to *salebrosus*[32] than to the others. From this it differs in the nearly smooth abdomen, the greater size, the different proportions of the caudal tarsal joints (second twice as long as the third), the different character of the serrations on the lamellate ventral carinæ of the caudal femora, the longer cau-

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[32] *Canad. Entom.*, XXXI, p. 120. [Tenino, Thurston Co., Washington.]

dal tibiæ and the presence of an apical hook on the inner valves of the ovipositor.

Fig. 20.—*Ceuthophilus lamellipes* n. sp. Lateral view of ovipositor. (× 6.)

Size medium; form moderately compressed. Head with the occiput and vertex declivent to the low, broadly trigonal, shallowly sulcate fastigium; eyes trigonal pyriform; distal joint of the palpi arcuate. Pronotum with the cephalic margin slightly emarginate, caudal margin subtruncate; lateral lobes with the ventral margin slightly arcuate. Abdomen smooth; ovipositor very slightly longer than the pronotum, tapering from the base to about the middle, distad of which it is subequal, the apex obliquely truncate, the inner valves each armed with five teeth, of which the two terminal ones are longer than the others and more recurved; styles of the female about equal to the ovipositor in length. Cephalic femora about a third again as long as the pronotum, moderately robust, the cephalic margin armed with a single pregenicular spine; cephalic tibiæ equal to the femora in length. Median femora in the male half again as long as the pronotum, in the female slightly less, the cephalic margin armed with three or four spines of which the distal is the longer, caudal genicular lobe spined. Caudal femora in the male moderately long, very considerably inflated, the greatest width contained about two and a half times in the length, dorsal face well supplied with sharp tubercles on the tracings of the scalariform pattern and other irregular lines, ventral carinæ elevated, distinctly lamellate, the margins serrato-dentate, separated from the genicular region by a narrow area where the lamellate ridges are roundly excised, immediately proximad of this the ridge develops an acute trigonal process, the ventral margin of which is serrato-dentate continuous with the proximal portions of the carinæ; ventral sulcus very broad and moderately deep, the trigonal processes of the margins diverging; caudal tibiæ of the male in actual length (following curve) longer than the femora, the proximal fourth forming a quarter circle, the distal three-fourths straight, four pairs of spurs present on the dorsal margins of the shaft, in length these hardly equal the tibial depth, the margins also well supplied with fine teeth, ventral margin somewhat crenulate proximad and with a single spine immediately proximad of the two apical ones, apical spurs long, the median internal one about equalling the dorsal length of the metatarsus; caudal tarsi with the third joint not more than half the length of the second. Caudal femora of female moderately inflated, the greatest width contained about three times in the length, dorsal surface with a few sharp tubercles, but the number or size not as great as in the male, ventral carinæ slightly elevated, finely serrato-dentate in the distal half and with an indication of the pregenicular diastema of the male; caudal tibiæ of female straight, slightly longer than in the male.

General color, clay color marked more or less with prout's brown. Antennæ cinnamon. Pronotum with a narrow median area and the ventral portions of the lateral lobes of the general color, as well as a large irregularly quadrate or rectangular patch on each side. Mesonotum and metanotum with an irregular system of broad alternating pale and dark bars, the abdomen bearing the type of markings only more numerous, smaller, and more restricted to the caudal margin of the segments. Cephalic and median limbs sometimes clouded with the darker color; caudal femora with the tubercles and serrations dark, in the female the pattern of musculation being more truly scalariform and not with a broad medio-longitudinal interruption as in the male.

Measurements.

	♂	♀
Length of body,	16.5 mm.	17.5 mm.
Length of pronotum,	4.5 "	4.2 "
Length of cephalic femur,	6.2 "	5.5 "
Length of median femur,	6 "	5.5 "
Length of caudal femur,	12.8 "	11.3 "
Length of caudal tibia,	13.2[33] "	11 "
Length of ovipositor,		4.5 "

In addition to the types a paratypic male, taken November 7, has also been examined.

GRYLLIDÆ.

Gryllus personatus Uhler.

September 7–12, November 24, 1903. 5 ♂, 18 ♀, 1 nymph (XI. 24).

This interesting series shows that a considerable amount of variation in size exists in this form. While this feature is very apparent it is not as conspicuous as the variation in color, which latter ranges from a decidedly straw-colored type (the predominating phase) to a blackish brown form with no trace of the usual coloration, except a very narrow pale margin to the ventral portion of the lateral lobes and a few small spots on the vertex and fastigium. In many respects this dark type superficially resembles Mexican specimens of *G. assimilis*, from which,

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[33] In straight line.

however, it can be separated by the form of the speculum of the male tegmina.

All the adult specimens seen are macropterous.

Gryllus armatus Scudder.

September 7-12, 1903. 1 ♂, 11 ♀.

But little variation in size is presented by this series, and in coloration a slight deepening of the shade of the tegmina and on the caudal femora a replacing of tawny by bistre is all that is noteworthy. The base color of the pronotum shows a tendency toward reddish in several specimens, the head, however, remaining shining black. All the specimens are macropterous.

Gryllus alogus Rehn.

November 18, 1903. 1 ♀.

Œcanthus californicus Saussure.

November 10 and 24, 1903. 2 ♂.

THE MORPHOLOGY OF DINOPHILUS CONKLINI n. sp.

BY JAMES A. NELSON, PH.D.

CONTENTS.

I. INTRODUCTION.

The systematic position of *Dinophilus* has been a subject of considerable interest to naturalists ever since the establishment of the genus by Oscar Schmidt in 1848, and the opinions held on this point have been—relatively speaking—many and various. In a former paper on the early development of this form (1904*a*) I gave a brief review of these; to repeat it here seems superfluous. In the paper just mentioned certain conclusions as to the relationships of *Dinophilus* were stated, based on a study of its development. In the studies of which the present paper is the result, an attempt has been made to test these conclusions by a study at first hand of the morphology of the same species. This seemed the more desirable, since in the last fifteen years there have appeared but three papers on the structure of members of this group, and those dealt with species different in many respects from the one studied by me. Moreover, the apparent rarity of *Dinophilus* and its sporadic occurrence was an additional incentive to making the best of the opportunity which presented itself in finding abundant material for the study of its morphology, as well as its development, in the aquaria of the University of Pennsylvania.

It gives me pleasure to take this opportunity to express my indebtedness to Prof. E. G. Conklin, of the University of Pennsylvania, for the privilege of taking *Dinophilus* material from the aquaria of the University; to the Carnegie Institution for the use of one of its rooms at Woods

Hole during the summer of 1903; and to Prof. L. B. Walton for extending to me the use of the biological laboratory at Kenyon College. I wish especially to thank Prof. J. H. Comstock for the unfailing kindness he has shown me at Cornell University. I wish also to thank my friends, Dr. J. Percy Moore, of the University of Pennsylvania, and Prof. A. D. MacGillivray, of Cornell University, for kindly advice and criticism.

II. Material and Technique.

All of the material employed in the preparation of this paper was obtained from the sea-water aquaria of the University of Pennsylvania. This material was collected in three lots at three different periods. The first lot was taken during the winter of 1901–2, and its preservation was only incidental to the collection of ova, which formed the basis of a former paper by me (1904) on the early embryology of this form. The individuals taken at this time were among the largest obtained. The second lot was taken during the latter part of June and the first few days of July, 1903. These individuals averaged possibly one-fourth to one-third smaller than those of the first lot. The third lot was obtained during the winter of 1903–4. The individuals comprised in this lot are intermediate in size between those of the first two lots, being much larger than those of the second lot, but scarcely equalling those of the first.

The methods of fixation employed were but three in number:

(1) Kleinenberg's picro-sulphuric for one-half to three-quarters of an hour, followed by a washing in 70 per cent. alcohol. This method of fixation, which has given excellent results for many ova, including those of this form, proved only an indifferent one for the mature individuals, and material fixed in this manner was unsuitable for the study of any of the finer structures. It has, however, the advantage of preserving the form and proportions of the object very well, and this material was made use of largely as mounted entire.

(2) A saturated aqueous solution of corrosive sublimate, containing 6 per cent. of glacial acetic acid, used boiling hot, and followed by a thorough washing in 70 per cent. alcohol. The material fixed in this manner has proved exceedingly valuable, and many of my best drawings were made from it. The form and relation of the different parts are admirably preserved, as well as those of the cells composing them, while in many cases the finer structures, such as cilia, maintain their integrity. After sectioning and staining the individuals collected in the summer of 1903, which were fixed by this method, a peculiar

differentiation of the nerve fibres became evident. The latter did not absorb the chromatin stain (iron-hæmatoxylin), but on the contrary remained clear and of a light straw yellow color, or, in sections where eosin was used as a contrast stain, were pale orange. In either case the nerve fibres are easily distinguished from the surrounding tissues. What happy accident caused this differentiation, which occurs in all the series made from the second lot of individuals, I have not been able to determine. It has, however, been of the highest value to me, since without its assistance it would have been an extremely difficult matter to trace out the various parts of the nervous system. That it is but an accident I feel sure, since a number of individuals of another lot, fixed and stained by the same method, showed the nerve fibres stained dark gray, as is the case where other fixatives were used.

(3) Flemming's fluid, from one-half to twenty-four hours. This method gave very irregular results, yielding some of the finest preparations, as well as some of the poorest. Different individuals, even of the same lot, vary much in the quality of the fixation. The best results were obtained with a fixation of half an hour, although the period of fixation seems to be of minor consequence, since good results were also obtained with a fixation period as long as twenty-four hours.

The stains employed were: the picro-hæmatoxylin of Conklin (1902) for the objects mounted entire, and Haidenhein's iron-hæmatoxylin for sections. A contrast stain was used in some cases, a saturated aqueous solution of eosin being employed for this purpose. Experience, however, has shown that the use of a plasma stain with the iron-hæmatoxylin is, in this form at least, unnecessary, if not actually undesirable. For the purpose of determining the presence of mucin in the hypodermis, Mayer's mucicarmine was employed. The formula is that given by Lee in the fifth edition of *The Microtomist's Vade-Mecum*, the material being stained from five to fifteen minutes in a 10 per cent. solution.

The sections were for the most part cut five μ in thickness, this being found to be the minimum compatible with perfect series. Many of the *Dinophilus* were embedded and oriented separately, but the best horizontal and sagittal series were obtained by embedding a large number in a Lefevre watch glass, and sectioning the mass entire.

The living animals were also studied, but, on account of the refractive nature of the protoplasm, proved very unfavorable objects, as far as the internal structure was concerned. Narcotization was successfully accomplished by the use of chlorotone, the animals soon becoming quiescent, in a relaxed condition, lying on one side, with a slight ventral flexure.

The small size of the cells of this species of *Dinophilus*, and the general lack of distinctness in the boundaries of tissues and organs, made imperative the use of the highest powers. In studying and drawing sections a one-twelfth Zeiss oil immersion was employed almost exclusively. This necessitated a brilliant illumination. After the loss of much time from cloudy and dark weather, I had recourse to artificial illumination, as recommended by Child (1900). For this purpose I used a burner of the Welsbach type, mounted about nine inches above the table. Two blue glasses were placed in the cell below the condenser, one dense and one thin. I heartily concur with Child in the opinion that this means of illumination is superior to daylight, at least when high powers are employed. The light, when filtered through the blue glasses, is almost perfectly white, does not tire the eyes, is of constant and unvarying intensity, and, above all, is always available.

In making the reconstructions which constitute Plate XII, fig. 1 and text fig. IV, a modification of the method given by Lee (*Microtomist's Vade-Mecum*, 5th ed., 1900) and ascribed to Woodworth, was employed. The camera lucida was, however, used in place of a micrometer. Such reconstructions proved of the greatest value in determining the relations and connections of parts which run through a number of sections.

III. Anatomy.

1. *External Form and Specific Characters of Dinophilus conklini.*

The *Dinophilus* which forms the subject of this paper has been found, after comparison with the descriptions of the other members of this genus, sufficiently different from them to warrant description as a new species. I take great pleasure in bestowing upon it the specific name *conklini*, in honor of Prof. E. G. Conklin, of the University of Pennsylvania, who was the first to find this form. This species has so far been found only in the aquaria belonging to the University of Pennsylvania. Prof. Conklin, however, informs me that he is of the opinion that it is brought in on the *Ulva* obtained by dredging at Sea Isle City, New Jersey. A comparison with other species and the enumeration of specific characters are postponed to the end of this section.

The females of *Dinophilus conklini* are very wormlike in their form and general aspect. Text fig. I, although drawn from a fixed and stained preparation, shows little or no distortion, and represents the animal in a state of moderate extension, such as it often naturally

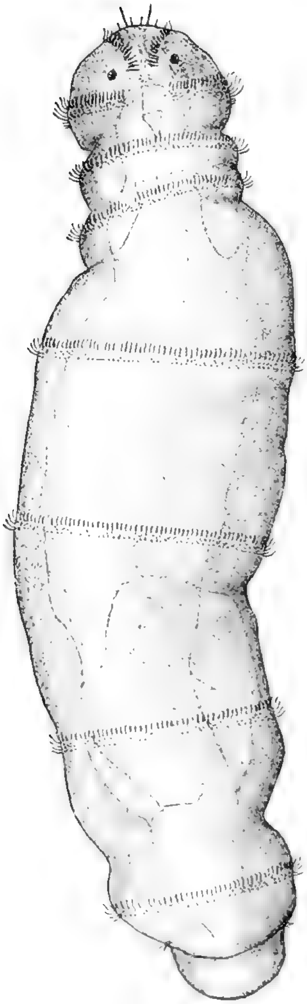

Fig. I.—Female individual of *D. conklini*, drawn from a fixed and mounted specimen. Details added from sketches of living animals. (× 142.)

assumes in crawling about over the seaweeds on which it is commonly found. The outlines of the example from which fig. 1, Pl. XII, was taken represent the animal in a somewhat greater state of extension, showing especially well the form of the last segment and the caudal appendage. The head is bluntly conical or rounded in front, and narrows posteriorly to a somewhat constricted neck, where it joins the trunk. Its dorsal surface is also rounded, and bears a pair of reddish eyes, reniform in shape, as is usual in this group. On its ventral surface the head is slightly flattened. The trunk is long fusiform, or cigar-shaped, tapering toward the posterior end, and divided by six constrictions into as many segments.[1] The first two segments are very short, scarcely equal to the head in diameter and are limited by relatively deep and well-marked constrictions. The three succeeding segments are subequal, nearly as broad as long, and separated by comparatively slight constrictions. In the first of the segments last described, namely, the third of the trunk, the latter reaches its greatest diameter. The sixth segment is short and rounded at its posterior end, and bears on its ventro-posterior surface the conical caudal appendage or tail, which in this species is unsegmented.

Like other members of the group, *D. conklini* is encircled by a number of bands or rings of cilia, and also possesses the usual ciliated tracts

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[1] In the descriptive portion of this paper the term "segment" will be used to designate a portion of the trunk bounded by constrictions, without reference to the question whether it is a true metamere. The problem of metamerism in *Dinophilus* is discussed in Section III, 7.

on the ventral surface. One of the latter, the preoral tract, clothes the ventral surface of the head, and at its posterior margin passes into the ciliated lining of the mouth. It serves the obvious purpose of creating currents of water which sweep particles of food toward and into the mouth. The second or postoral tract comprises a narrow strip beginning at the posterior border of the mouth and continued backward to the end of the caudal appendage. This strip is widest in its anterior portion, having here a width of approximately one-half of the diameter of the body. From this point it narrows posteriorly and is reduced to a third of its original width on reaching the caudal appendage.

The ciliated rings number nine; two belonging to the head and seven to the trunk. The two cephalic bands are not, however, continuous, each being interrupted on the middorsal surface of the head by a considerable gap; both of the two rings are thus divided, with the aid of the ventral ciliated tract, into two lateral halves. The two bands composing the first ring arise on the ventral surface, at the lateral edges of the ciliated tract, a short distance posterior to the anterior pole of the head; they then pass upwards and backwards in a gentle curve, and terminate between the eyes (see text fig. I). These bands are narrow, and composed of but few rows of cilia. The two bands representing the second cephalic ring embrace the head at its greatest diameter, and lie in a plane at right angles to the long axis of the animal. These bands are relatively broad and composed of numerous rows of long cilia. As is the case with all the ciliated rings the cilia beat rhythmically backwards, and are only clearly seen in their forward position, that of recoil.

In the first preoral or cephalic band of *D. vorticoides*, as described by Schimkewitsch (1895), there is a similar gap. It is possible that in other species of *Dinophilus* the cephalic bands are also not continuous dorsally, since the cilia are here not easy to make out, except when the animal is seen in profile, or by the study of sections of fixed and stained material. In the case of this species I was at first misled as to the course of the cephalic bands and figured them incorrectly (1904*a*, text fig. VI). This misapprehension was due to the figures and descriptions of other species, and also to the presence of sensory cilia on the dorsal surface of the head, as described below.

The discovery of the presence of a dorsal gap in the second cephalic ring was of particular interest to me, inasmuch as it tends strongly to confirm my conclusions as to the origin of this band and its homology with the prototroch of the trochophore larva, as expressed in 1904.

In the embryo of *Dinophilus*, the "trochoblasts," the cells which presumably form this ring, are last seen as a long band, continuous across the ventral surface, but interrupted dorsally by a wide gap. A similar gap is also present in the prototroch of some annelid larvæ, as, for example, in *Amphitrite* (Mead, 1897), and due to the same cause as in *Dinophilus*, namely, the large size of 2d (X), "the first somatoblast" of von Wistinghausen (1891), and the rapid growth of its dorsal products. This dorsal gap is eventually closed in the case of *Amphitrite*, but it is in this form much narrower than in *Dinophilus;* the cells composing the prototroch are relatively large, and soon become functional. It appears quite probable, therefore, that the dorsal gap seen in the second cephalic band of the mature *Dinophilus* is ultimately traceable to the peculiar size-relation and growth processes of the cleavage cells of the ovum of this species.

Just behind the second cephalic band is a pair of shallow grooves, which arise high up on the sides of the head and pass ventrad, widening and deepening slightly, to join the mouth at its lateral margins. These grooves are lined with short cilia throughout their extent. These are the "Wimpergruben" observed by Schmidt (1848) in *D. vorticoides*, by Hallez (1879) in *D. metameroides*, and by Korschelt (1882) in *D. apatris*. They are supposed by the authors mentioned to function as sense organs, but their relation to the mouth seems to indicate that they may also act as food-gathering organs, creating currents which sweep the food particles down into the mouth. It may be remarked in passing that the "Wimpergruben" of this species of *Dinophilus* are strikingly similar to the ciliated grooves of *Ælosoma tenebrarum*, as described by Miss Brace (1901).

The seven ciliated bands of the trunk are simple narrow transverse circlets, uninterrupted on the dorsal surface, with the exception of the last. Below they merge with the ventral ciliated strip. Each band encircles the middle of its respective segment. The terminal or circumanal ring is scarcely worthy of the name, since it consists only of two short ciliated bands. These arise at edges of the ventral ciliated area, at the point where the last segment joins the caudal appendage, and pass upward on the posterior edges of the segment for a short distance (see text fig. I).

In common with other species of this group, *D. conklini* possesses conspicuous sense hairs on the anterior surface of the head. Two of these are of considerable size and symmetrically placed, pointing forward and slightly outward, while scattered between and around them are a number of smaller hairs. These are in fact tapering projections of naked protoplasm; the large sense hairs, as Korschelt (1882) has observed, are capable of movement. This movement consists in a gentle waving to and fro of the tips, especially noticeable when these cilia come into contact with foreign objects, and demonstrating clearly their tactile function. On the dorsal surface of the head, just behind the eyes, is another group of sense hairs, all of which are very small.

Like both *D. gyrociliatus* and *apatris*, which it closely resembles in other respects, *D. conklini* is colorless. Although lacking in color, it is relatively opaque; this quality appearing to be due to the refractive qualities of the protoplasm, rather than to anything contained within the body of the animal. When seen by reflected light its shining opaque whiteness makes it a conspicuous object when viewed against the dark background formed by the seaweeds on which it is commonly found. This lack of transparency naturally renders more difficult the study of the internal structure of the living animal.

The size of this species is subject to great variation. Measurements of the length of adult examples (in alcohol) of the first lot, taken in the winter of 1901–2, vary from 0.57 mm. to 0.91 mm.; the average of this lot being about 0.73 mm. This variation in length is doubtless in part due to the differing degree of contraction of the examples taken, but it also, to a considerable extent, represents a real variation in size. Fully extended living individuals would yield measurements possibly one-tenth to one-fifth greater, but it is doubtful if any would exceed 1 mm. The examples of the second or summer lot, although less contracted by the fixing fluid than those of the first, show a range of 0.309 mm. to 0.60 mm., the average length being only 0.46 mm. From the third lot (winter 1903–4) only a few measurements were taken. The maximum of these was 0.74 mm., while the average was 0.616 mm. From these measurements it seems to follow that summer individuals are much smaller than those taken in cold weather. This may really be the case, but unfortunately these observations are not extensive enough to form the basis of any certain conclusions regarding this matter. All the examples taken were, or appeared to be, sexually mature. Considerable variation in size has also been noted by Korschelt (1882) in *D. apatris*, and by Weldon (1886) in *D. gigas*. The first mentioned author says, "Seine Länge ist bei geschlechtsreife Thiere ziemlich verschieden." Weldon states that "The length of the body varied greatly, the smallest specimens found being about 0.75 mm., while the largest were nearly two millimeters in length." Whether all these were sexually mature is not stated.

Of the males of this species, only one was observed. This was still confined in the egg capsule, together with female embryos, but was nevertheless fully formed and swimming about as freely as its limited quarters would allow. In all essential characters it resembles the male of *D. apatris* Korsch. Its form (text figs. II, A and B) is that of a short cylinder with rounded ends, slightly constricted at its middle. About the anterior end is a ring of cilia situated in a groove. This ring is continuous below with a strip of cilia clothing the ventral surface. At its posterior end was seen the outlines of the conical penis, which is directed downward and backward, as Korschelt (1882, 1889) has figured it. Of the interior of the body little else could be discerned except a number of refractive granules, which were probably spermatozoa.

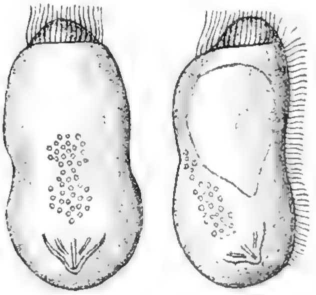

Fig. II.—Male individual of *D. conklini*, drawn from a living specimen. A, dorsal surface ; B, lateral surface.

As will appear from a glance at the table of species given below, *D. conklini* stands very close to *D. apatris* Korsch. and *D. gyrociliatus* O. Sch. From *D. apatris* it differs in the proportions of head and trunk, in the presence of dorsal gaps in the preoral ciliated bands, in having but two large sense hairs instead of four, and in the presence of a cicumanal or terminal band. *D. conklini* moreover lacks a character which seems to be distinctive of *D. apatris*, namely, that of having the head joined to the trunk by the intermediation of a short piece, which has the appearance of a much shortened segment, without the ring of cilia. The characters distinguishing *D. gyrociliatus* and *D. conklini* are much slighter. Indeed the sole external difference distinguishing the two species is the presence of the dorsal gaps in the two preoral bands of cilia in *D. conklini*. This alone would seem far too slender a basis on which to erect a new species, if it were not that it is accompanied by considerable differences in the internal organs, the nephridia in particular.

In the table below an attempt has been made to set forth in brief form the distinguishing characters of the different species composing the group, and the literature directly relating to each. That this table is imperfect is certain, but this is due at least in part to the imperfectness of many of the descriptions, especially the earlier ones. Later descriptions and figures, when such exist, have been used in the belief that they are more likely to be accurate. The literature list is as accurate and complete as lay in the writer's power to make it, but it has been found wellnigh impossible to collect all of the scattered references to the genus. If either the table of species or the literature list proves helpful to any student of the group, or serves to faciliate comparison of the characters of the various species, it will have fulfilled its purpose. The characterization of the genus has been added for the sake of completeness.

Genus **DINOPHILUS.**

Minute wormlike forms, generally displaying an external division into segments, delimited by constrictions; each trunk segment, including the head, bearing one or two bands or circlets of long cilia; in addition to these a ciliated strip clothes the ventral surface. The last segment bears a conical caudal appendage. The anterior surface of the head usually provided with sense hairs. Alimentary canal well developed (except in the degenerate males of certain species), consisting of a mouth opening on the ventral surface of the head; an œsophagus provided on its posterior inner surface, where it joins the mouth, with an eversible proboscis; a capacious stomach, and a short intestine terminating dorsad to the caudal appendage. Cœlom represented by the cavities of the gonads. A primary body cavity of varying extent always present. Nervous system consisting of a simple brain, a pair of circumœsophageal commissures, and, continuous with the latter, two ventral cords, embedded in the hypodermis. In some members of the group, at least, are also present transverse commissures and pairs of ganglia correlated with the segments as indicated on the exterior. Nephridia, when present, of the protonephridial or larval type, and arranged metamerically.

Table of Species of Dinophilus.—

A.—Sexes monomorphic.
  B.—Gonads paired, extending to the anterior extremity of the trunk. Two bands of cilia borne by each trunk segment.
    C.—Trunk segments 6.
      D.—Caudal appendage 3-segmented, ... *vorticoides.*
      DD.—Caudal appendage unsegmented, ... *gardineri.*
    CC.—Trunk segments 5, ... *tæniatus.*
  BB.—Gonads Y-shaped; only one band of cilia borne on each trunk segment, ... *gigas.*

AA.—Sexes dimorphic, the males much reduced and degenerate in structure; corresponding with this condition is a dimorphism of the ova. Ovary unpaired. Only one band of cilia borne on each trunk segment, with the exception of the last, which may bear two.
B.—Trunk segments 6.
C.—Body not covered with a coat of cilia between the bands.
D.—Circumanal band present.
E.—Cephalic bands without dorsal interruptions; anterior pair of nephridia simple, . . . *gyrociliatus.*
EE.—Cephalic bands with dorsal interruptions; anterior pair of nephridia complex, ... *conklini.*
DD.—Circumanal band wanting, ... *apatris.*
CC.—Body covered with a coat of cilia between the bands, *metameroides.*[2]
BB.—Trunk segments 5, ... *pygmæus.*

List of Species of Dinophilus.—

1. **Dinophilus vorticoides.**[3]

Schmidt, 1848.—Schultze, 1849.—Diesing, 1850.—Beneden, 1851.—Quatrefages, 1851.—Beneden, 1861.—Diesing, 1862.—Graff, 1882.—Weldon, 1886.—Harmer, 1889a.—Schimkewitsch, 1895.—Schultz, 1902.

Head equal in width to first trunk segment, bearing two ciliated bands; the first with a dorsal gap (Schimkewitsch), the second uninterrupted. Ovaries four-lobed. Color, orange. Length, (?). Habitat, Faroe Islands (Schmidt), Belgian coast (Beneden), White Sea (Mereschkowsky, Schimkewitsch).

2. **Dinophilus gardineri.**

Moore, 1899.—Schultz, 1902.

Head not wider than first trunk segment, bearing two ciliated bands(?). Body covered with a coat of cilia in addition to the ciliated bands. Caudal appendage short. Color, orange red. Habitat, brackish pools, Woods Hole, Massachusetts, U. S. A.

3. **Dinophilus tæniatus.**

Harmer, 1889, 1889a.—Schimkewitsch, 1895.—Schultz, 1902.—Shearer. 1906.

Head slightly narrower than first trunk segment, bearing two uninterrupted ciliated bands. Circumanal band present. Female with ovaries four-lobed, male with a median penis and lateral seminal

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[2] That this species is dimorphic is assumed on the ground that Hallez found no males. If this assumption is correct it is probable that the ovary is unpaired.

[3] Graff (1882), following Diesing (1850), considers this species identical with *Vortex capitata* Oersted (1843) and *Goniocarena capitata* Schmarda (1859). Oersted's original description being inaccessible, it seemed advisable to allow Schmidt's name to stand provisionally.

vesicles. Color, bright orange. Length, 2.0 mm. Habitat, Plymouth, England.

4. **Dinophilus gigas.**

Weldon, 1886.—Korschelt, 1887.—Harmer, 1889a.—Schimkewitsch, 1895.—Schultz, 1902.

Head slightly wider than first trunk segment, bearing one ciliated band. Trunk segments seven. No circumanal band. Long sense hairs in two symmetrical patches on the anterior surface of the head. Color, a brilliant orange. Length, 0.75–2.0 mm. Habitat, Mounts Bay, Penzance, England.

5. **Dinophilus gyrociliatus.**

Schmidt, 1857.—Diesing, 1862.—Korschelt, 1882.—Meyer, 1886.—Repiachoff, 1886.—Korschelt, 1887.—Harmer, 1889a.—Schimkewitsch, 1895.—Schultz, 1902.

Head not wider than first trunk segment, bearing two complete ciliated bands. Caudal appendage unsegmented. Two large sense hairs on the anterior surface of the head symmetrically placed(?). Colorless. Length, (?). Habitat, Naples, Italy.

6. **Dinophilus conklini** n. sp. Pls. XII, XIII.

Head not wider than first trunk segment, bearing two ciliated bands. An imperfect circumanal band present. Caudal appendage unsegmented. Two symmetrically placed large sense hairs on the anterior surface of the head, in addition to several smaller ones. Colorless. Length, 0.50–1.0 mm. Habitat, aquaria, Philadelphia, Pa., U. S. A.; New Jersey coast, U. S. A.(?).

7. **Dinophilus apatris.**

Korschelt, 1882.—Repiachoff, 1886.—Harmer, 1889a.—Schimkewitsch, 1895.—Prowazek, 1900.—Schultz, 1902.—Malsen, 1906.

Head wider than any of the trunk segments, bearing two ciliated bands. Head joined to trunk by a short piece having the appearance of an imperfectly developed segment without the ciliated band. Caudal appendage unsegmented. Four very large sense hairs on the anterior surface of the head in two symmetrical pairs. Colorless. Length, 1.2 mm. Habitat, aquaria, Freiburg (Korschelt) and Berlin (Prowazek). Also found at Trieste, Austria (von Malsen).

8. **Dinophilus metameroides.**

Hallez, 1879.—Korschelt, 1882.—Graff, 1882.—Weldon, 1886.—Korschelt, 1887.—Harmer, 1889.—Schimkewitsch, 1895.—Schultz, 1902.

Head bearing two ciliated bands. Trunk segments sharply demarcated, the first much longer than the others. Caudal appendage 5-6 annulate with long papillæ. Mouth a longitudinal cleft. Color, red. Length, (?). Habitat, Wimereaux, France.

9. Dinophilus pygmæus.

Verrill, 1892.—Schimkewitsch, 1895.—Schultz, 1902.

Head equal in width to first trunk segment, bearing two complete ciliated bands. No circumanal band present. Caudal appendage short and unsegmented. Male unknown. Color, (?). Length, 0.7 mm. Habitat, Woods Hole, Massachusetts, U. S. A.

Unrecognized Species.—

Dinophilus sphærocephalus Schmarda, 1859. Guayaquil, S. A. Description scanty and inadequate.

Dinophilus borealis Diesing, 1862. This species is considered by Diesing to be equivalent to *Plagiostomum boreale* O. Schmidt, and *Vortex vittata* Frey and Leuckart. It is probably a true turbellarian.

Dinophilus ——— Jensen, 1878.

Dinophilus caudatus Levinson, 1879–80. Levinson, curiously enough, considers this species identical with *D. vorticoides* O. Sch., and also with *Planaria caudata* of Fabricius (*Fauna Groenlandica*) and Müller (*Zoologica Danica*). I was unable to satisfy myself that this was the case, and therefore allowed Schmidt's name to stand.

Dinophilus rostratus Schultz, 1902. This curious form is clearly not a member of the genus *Dinophilus*, whatever its relationships may be.

2. *Body Wall.*

The body wall consists of the hypodermis and the circular and longitudinal muscles. It also contains the longitudinal nerve cords, as well as sensory cells; these are described in the section on the nervous system.

The hypodermis is a simple epithelium whose cells rest internally upon a thin basement membrane, and are clothed externally by a cuticle. The body wall, generally speaking, is quite thin relative to the size of the animal, but its thickness differs much in the various parts of the body, and also varies in proportion to its degree of contraction. In the region of the head, more particularly on its ventral side, the hypodermis reaches its greatest thickness, about 15 μ. In the trunk there is a thickened portion along the ventral side,[4] roughly coincident with the ciliated area of this region; it is slightly thicker near the middle of its length than at the ends (figs. 6, 7, 8 and 9). In the

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[4] Shearer (1906) has compared this thickened area with the "crawling pad" of the *Turbellaria*. It is, however, rather to be compared to the ventral plate of annelid larvæ, since it is formed in the same manner and from the same cleavage cells (Schimkewitsch, 1895; Nelson, 1904).

posterior part of the last segment, especially on the dorsal side, the hypodermis is also much thickened. On the dorsum and sides of the trunk, however, the thickness of the body wall is closely related to the external segmentation. At the middle region of each segment the hypodermis reaches the thickness attained by its ventral portion (5–8 μ); it gradually becomes thinner toward the limits of each segment, its minimum, ca. 3 μ, being reached in the intersegmental regions. These differences in the height of the hypodermal cells find expression on the external surface of the body wall alone, which consequently in longitudinal section presents an undulating outline. In cases where the contraction of the animal has been excessive, the exterior of the body wall may even have the appearance of being deeply indented in the intersegmental regions.

Supporting Cells.—The hypodermal cells are differentiated into supporting cells, ciliated and non-ciliated, and gland cells. The non-ciliated supporting cells (fig. 14, also figs. 2–8), which make up the greater portion of the hypodermis, are simple epithelial cells, flat in the thinner portion of the body wall, but in the thicker portions becoming cuboidal and even columnar, as in some parts of the head. In the ventral portion of the latter, for example, the hypodermal cells are so closely set together that the bases of some of them seem to have been forced inward, and have the appearance of pyriform processes, each of which contains a nucleus (Pl. XIII, fig. 23). The cytoplasm of the non-ciliated cells is clear; high magnification presents an alveolar appearance. Throughout the region of the head, next to the hypodermis, is a distinct layer of vacuoles (figs. 2 and 12), similar to that described by Meyer (1901) as occurring in the larva of *Lopadorhynchus*. A layer of smaller vacuoles is also discernible in the hypodermis of the trunk (fig. 6). The nuclei are spherical or ovoid, provided with an open reticulum of linin, bearing minute chromatin granules and a large and prominent chromatin nucleolus (karyosome). The ciliated cells may, in sections, be at once distinguished by their darker aspect, and are, as described in the preceding section, distributed to form two ventral tracts and nine bands. The latter are, with the exception of the second cephalic band, composed of but one row of cells, their outer surfaces elongated in the direction of the band (fig. 27), and meeting only at their extreme ends. The second cephalic ring or band is, on the other hand, composed of two rows of cells (fig. 28, *c.r.* 2), similar to those of the other bands. This difference has also been noted by Schimkewitsch (1895) in the White Sea *Dinophilus* (*D. vorticoides*). The cells composing the cephalic bands are wedge-shaped, in conformity with the general thickness of the hypodermis of this region; the point of the wedge being directed inwards (figs. 19 and 20). The nuclei of these cells are situated near their inner ends, and often compressed laterally.

The ventral ciliated areas of the trunk and head are essentially similar in structure. That of the trunk contains both ciliated and non-ciliated cells in the proportion of about two to one (fig. 28). The outer surfaces of these cells are irregularly polyhedral and not elongated in the direction of the long axis of the body, as Schimkewitsch (1895) has described them in *D. vorticoides*. The cells composing the ventral ciliated strip are cubical or columnar near the midline, but toward the outer margin of the strip the cell walls slant inwards, so that the cells here have the form of pyramids or truncated cones, as illustrated in fig. 14.

The nuclei of the cilia-bearing cells resemble those of the non-ciliated supporting cells. The cytoplasm of the ciliated cells is also finely alveolar. Embedded in the cytoplasm, at a short distance from the cuticle, are the end knobs of the cilia. These are oval in form, separated from one another by a distance of about 1 μ. From the outer ends of these arise the cilia, which pass to the distal surface of the cell and, piercing the cuticle, reach the exterior. The inner ends of the knobs are attached to the intracellular fibrillæ usually present in cilia-bearing cells; these have the appearance, in the best preserved material, fixed in Flemming's fluid, of true fibrils, homogeneous in structure. These fibrillæ are exceedingly conspicuous in material fixed in sublimate, appearing in such preparations as tapering rods (figs, 6, 7, and 9). They pass inward to the base of the cell, and do not always converge toward the nucleus. In some cases two or more fibrillæ may be seen to join together, and finally to terminate on the basement membrane at a considerable distance from the nucleus, as seen in the middle cell in fig. 14. To these fibrillæ, which are always more or less intensely stained, the ciliated cells owe largely their darker aspect, as compared with the non-ciliated supporting cells.

The hypodermis, as already noted, is everywhere covered externally by a cuticle. The latter is refractive, nearly homogeneous, or with faint striations parallel to its surface. Its thickness ranges from ca. 0.9 μ on the ventral surface of the trunk to ca. 1.1 μ on the ventral surface of the head, where the hypodermis also reaches its maximum thickness.

Gland Cells.—The hypodermis is very rich in unicellular glands, most of which are of large size relative to that of the supporting cells. These glands are of three kinds or types; those of the first two types containing mucin, staining intensely with Mayer's mucicarmine; the nature of the secretion of those of the third type is undetermined.

The glands of the first type (fig. 15) are but few in number, and scattered irregularly over the ventral surface of the trunk. In form they are flask- or sac-shaped, with a narrow and constricted mouth. The mucus with which they are filled appears nearly homogeneous, although under a high magnification it presents, in some cases, a finely fibrillar structure. It has, however, never been observed to break up into blocks, as often happens in mucous glands, as, for example, in those of *D. vorticoides*, as described by Schimkewitsch (1895). Flattened out against the wall of the gland, and usually a little to one side of its base, is found the shrunken nucleus (*n.*), together with the dark staining and scanty remnant of the original cytoplasm. None of the glands of this type were seen in the act of discharging their contents.

Fig. III.—Diagrams illustrating the distribution of the hypodermal mucous glands (second type), from camera drawings of fixed specimens. A, head, seen from dorsal surface. 1–4, mucous glands; *c.gl.*, cephalic glands; *c.gl.d.*, duct of cephalic gland. B, entire animal, seen in side view.

The glands of the second type (fig. 16) are also mucous glands, their contents staining intensely in Delafield's hæmatoxylin, in Conklin's modification of this stain (1902) and picrocarmine, as well as in Meyer's mucicarmine. They thus become very conspicuous in examples mounted entire, when stained in any of these stains. Examination of individuals thus mounted discloses the interesting fact that these glands have, for the most part, a fairly constant and symmetrical arrangement, and, with the exception of two groups on the last segment, vary but slightly in number. Their usual arrangement is that illustrated in text fig. III, A and B. As may be seen on examination of this figure, the head bears seven of these glands, one median unpaired gland near the anterior pole of the head (1), and three pairs symmetrically grouped on its anterior surface (2, 3, and 4). On the trunk their distribution is metameric as well as symmetrical, a row of these glands encircling each of the trunk segments—except the first and last—near its middle, just anterior to the ciliated bands. The second segment commonly possesses five pairs of glands, the third but three pairs, while the fourth and fifth segments have four pairs each. On the sixth segment the glands of this type are divided into two small groups, one occupying a crescentic area just above the anus, on the postero-dorsal portion of the segment (fig. 18); the other group lies on the ventral surface of the caudal appendage.

All the glands of this, as well as those of the succeeding type, although unicellular, greatly exceed in size any of the hypodermal supporting cells; the gland, for example, represented in fig. 16 being 21 μ in length. Owing to this circumstance only those glands which lie in the thicker portions of the body wall, namely, those of the head and posterior portion of the sixth segment, are permitted to assume a position perpendicular to the body wall. The others, which are situated in the thinner portions of the latter, are compelled to lie in a plane parallel to the surface of the body, their ducts being bent sharply near their termination in order to reach the exterior.

The individual glands are long pyriform in shape, generally somewhat bent, and often strikingly similar in outline to an old-fashioned powder horn. At the base a crescentic theca of alveolar protoplasm is present in every case, staining deeply in iron-hæmatoxylin. Within the protoplasm is contained a clear oval or crescentic nucleus (*n.*) enclosing a large karyosome. The mucin which fills the gland is always split up into distinct fibrils, longitudinally arranged, thus giving the glands of this type a characteristic striated appearance. Filling the mouth of the gland is a deeply stained plug of protoplasm. None of the preparations studied showed a gland of this type in the act of discharging its excretion.

The glands of the third type (figs. 17 and 18, *gl.* 3) are much more numerous than those of either of the preceding types. Their precise manner of distribution, however, could not be determined with as much certainty as that of the preceding type, owing to the fact that they are not distinguishable on individuals mounted entire, but only in sections. A study of the latter shows that on the head the glands are scattered rather irregularly over its dorsal and lateral surfaces. On the trunk these glands accompany those of the preceding type, and are confined principally to the areas occupied by the latter. Thus on each trunk segment, with the exception of the sixth, they also occupy a narrow area just anterior to each ciliated band. Each of the trunk segments, from the second to the fifth, inclusive, thus possesses a glandular area which encircles it like a girdle, interrupted, however, by the ventral strip of cilia. In these areas the glands of the third type are, together with those of the second, crowded so closely that sections through these regions appear as though honeycombed with glands. In the areas of the sixth segment, previously described as occupied by glands of the second type, those of the last type are also present in such numbers that the hypodermis of these areas is filled with closely crowded glands, as may be seen in fig. 18. At the lateral margins of the ventral ciliated area, on each side, there is also an irregular row of these glands, extending the length of the trunk.

The form of the glands of this type is that of a short tube, considerably bent or contorted, rounded at the base and tapering toward the mouth. The contained secretion is granular, often exhibiting a reticular structure, staining dark gray with iron-hæmatoxylin, and unaffected by mucicarmine. A nucleus (*n.*) with a large plasmasome is usually to be seen near the fundus; the protoplasm surrounding it, however, is not clearly distinguishable from the secretion. These glands are met with in various stages of activity, some of which are illustrated in fig. 18. In contrast to those of the preceding type, discharging glands are frequently met with, as may be seen in the figure just mentioned. Those whose contents have been expelled, as in the example represented in fig. 17, exhibit in the portion devoid of secretion a black-staining residue which lines the walls and extends across from side to side as a coarse network.

Schmidt (1848) and Hallez (1879) describe rodlike bodies (battonets) as occurring in the cytoplasm of *Dinophilus*. Nothing corresponding to them exists in *D. conklini* unless it be the large mucous glands of the second type, which are somewhat rodlike in form. Korschelt (1882) found in *D. apatris* large glands on the ventral side and also on the dorsum of the last segment; to these he ascribed the function of secreting an adhesive fluid, and applied the name "Klebsdrüsen." A group of pyroform glands similar in function, but of greater length, were also found by him on the caudal appendage; to these he gave the name "Spinndrüsen," in allusion to the long threads of a mucus-like substance thrown out by them. Repiachoff (1886) studied the hypodermal glands of *D. gyrociliatus,* and found that glands similar to the Klebsdrüsen occur not only on the caudal appendage, but on the head and on the anterior part of the trunk as well, where they form ringlike groups corresponding to certain shining belts. Moreover, each of these glandular rings was placed before a corresponding ring of cilia. In the White Sea *Dinophilus* Schimkewitsch (1895) found a similar condition. These metamerically arranged glands Repiachoff considered to be true mucous glands, while the Klebsdrüsen were of a different nature. The results of these authors are difficult to reconcile with one another, in the light of my own observations, since, as has been shown, the true mucous glands are comparatively inactive, and would therefore be unlikely to function as adhesive glands. On the other hand, the non-mucous glands—those of the third type—are functionally very active and constantly emitting their secretion, and these might very well correspond to the Spinndrüsen, and possibly also to the Klebsdrüsen of Korschelt. A final decision, if it is possible to arrive at one, must however rest on direct observation of the living animal, and therefore be for the present postponed.

Muscles.—The body wall is provided with only two sets of muscles; one of these is composed of longitudinal muscle fibres which extend throughout the whole length of the trunk, the other comprises a few muscles traversing the head. A careful search with a one-twelfth oil immersion lens failed to yield any convincing evidence of the presence of a layer of circular or oblique muscles, although in one or two cases isolated circular muscles were found. One of these is shown in fig. 8, on the right side of the figure. The negative evidence in the case seems fairly conclusive, inasmuch as the longitudinal muscles, as well as other muscle fibres, stain intensely in the stain employed, iron hæmatoxylin. Other muscle fibres should therefore, if present, be also plainly discernible. In this connection it is to be noted that *Protodrilus* Hatschek (1880) also lacks the layer of circular muscles.

The longitudinal muscles are distributed in three pairs: (1) a medio-ventral pair lying in the mid-ventral line (fig. 6, *v.l.m. 1*); (2) a ventro-lateral pair (*v.l.m. 2*), the two members of which lie at an angle of about 45° from one another, as seen in transverse sections of the trunk, and (3), corresponding with the latter, in the dorsal half of the body, a dorso-lateral pair (*d.l.m.*). Each muscle is composed of a number of long spindle-shaped fibres, arranged in a single layer in close contact with the hypodermis. Of these fibres the medio-ventral pair of muscles has the fewest, not more than two or three being seen on each side, in transverse sections; while the ventro-lateral and dorso-lateral may show a dozen fibres apiece in the anterior region of the pharanx; the number decreases caudad of this point to six or seven fibres in the middle region of the trunk. Each fibre measures somewhat less than 1 μ in diameter in its thickest part. It was not possible to determine the precise length of the fibres, but it is probably about one-third or one-fourth of the length of the entire animal. Scattered along the muscles, apparently at irregular intervals, are small spherical nuclei (see fig. 4, *v.l.m. 2*), each containing a conspicuous karyosome and surrounded by a small and somewhat irregular mass of cytoplasm, the whole having much the appearance of a small mesenchyme cell. The cytoplasmic masses are, in transverse sections, seen to surround one or more muscle fibres. This relation is also shown in fig. 13, which shows a portion of one of the muscles of the head. The nuclei together with the surrounding cytoplasm, on account of their intimate connection with the muscle fibres, are evidently the undifferentiated portions of the muscle cells.

The posterior attachment of all of the longitudinal muscles is the same. As these muscles, passing caudad, reach the last segment they leave the hypodermis (fig. 8), cross the body cavity and, reaching the wall of the rectum, follow it to its union with the hypodermis. At this point the muscles are attached to the body wall by means of fine fibrillæ, formed by a brushlike subdivision of the muscle fibres. The anterior attachments of the three pairs of muscles are quite different. From the anterior part of the last segment the two muscles of the medioventral pair run close together in the ventral midline to the posterior border of the first trunk segment, where they diverge (compare figs. 5 and 6, *v.l.m. 1*) and, traversing this segment, are attached by a brush of fibrillæ to the posterior wall of the œsophagus, at the point where the latter joins the ventral hypodermis, that is, to the inner surface of the outer lip. The ventro-lateral muscles, on the other hand, preserve the same relative distance from one another throughout the trunk. On reaching the anterior edge of the mouth each of these muscles gives off one or two fibres which pass directly forward and pierce the lateral lobes of the brain, where they divide into minute branches. These penetrate between the hypodermal cells and are attached to the cuticle by conical enlargements of the terminal branches. This manner of attachment to the cuticle, common to all of the muscles terminating in the head, is well illustrated in fig. 23, *l.m.i.* The remainder of the muscle fibres rapidly converge cephalad of the mouth, and meet at the posterior surface of the brain in the midline. Here they break up into their component fibres. Some of these run directly cephalad to the hypodermis, piercing the brain on their way, meanwhile dividing into minute branches which pass between the hypodermal cells and attach themselves to the cuticle as described above. By far the greater number of the fibres, however, cross in the midline, forming a sort of chiasma, the fibres of one side passing over to the opposite side, where they pierce the lateral lobe of the brain on that side and, breaking up into fibrillæ, are attached to the cuticle of the antero-lateral aspect of the head, near the cells belonging to the first preoral ciliated ring (fig. 19, *v.l.m. 2*). The dorsal longitudinal muscles, on reaching the level of the mouth, bend downward and run directly forward, to penetrate the lateral portion of the brain of the same side. Here they meet the fibres of the ventro-lateral muscle of the opposite side, and accompany them to their attachment.

The muscles traversing the head cavity are four in number. The first of these is composed of but a few fibres, which pass in a dorso-ventral direction through the head cavity, just behind the brain (fig. 23, *d.v.m.*). The second traverses this space from side to side, while the third and fourth form a pair which cross it obliquely. All of these exhibit the usual brushlike subdivision of the ends of their fibres, and the attachment to the cuticle already described.

Muscles of the simple type described above have been found in all the species of *Dinophilus* whose finer anatomy has been carefully studied. Korschelt (1882) first found them in *D. apatris*, where they form two layers, one of circular and one of longitudinal muscles, the latter having the greater development. The muscles of *D. gigas* (Weldon, 1886) comprise delicate transverse muscles on the ventral side, and a bundle of fibres on each side of the trunk, running through its whole length, just above the lateral nerve cords. Weldon believed that the fibres of the circular muscles were continuous with processes of certain of the hypodermal cells. Harmer (1889*a*) mentions, in his paper on *D. tæniatus*, longitudinal muscles which are similar to those of *D. gigas*. Schimkewitsch (1895) studied the muscles of living examples of the White Sea *Dinophilus* (*D. vorticoides*) with the aid of methylin blue. Three layers of muscles were found in contact with the body wall: an outer circular layer, whose fibres have a regular metameric arrangement; a layer of oblique fibres, and a layer of longitudinal fibres, part of which are gathered together to form a pair of ventral longitudinal muscles. The latter run through the entire length of the trunk; at its anterior end some of them are attached to the body wall on the fold which separates the head from the trunk, while others pass into the head, cross, and penetrate the brain, as described for *D. conklini*.

3. *Nervous System.*

(*a*) CENTRAL NERVOUS SYSTEM.—The central nervous system comprises a brain, a pair of circumœsophageal commissures, and, continuous with the latter, a pair of longitudinal nerve trunks, provided with ganglia and transverse commissures.

The brain (figs. 1, 2, 19, 20 and 23), which is situated in the anterior portion of the head, is made up of two distinct portions, an internal portion composed of interwoven nerve fibres, the neuropil (*np.*), and an external portion formed of several layers of ganglion cells (*g.c.*), the outermost of which are in direct contact with the hypodermis. The neuropil, which in sections may always be readily distinguished by its yellowish tinge, as well as by its histological structure, has the general shape of a plano-convex lens, with the convex surface directed forward. It is, as may be seen in either horizontal or transverse sections, divided into three subequal lobes; one dorsal and median, and two lateral. The latter probably correspond to the "lobi optici" of Schimkewitsch (1895). Near its centre it is, in addition, pierced by a cleftlike aperture (fig. 2). Both the lateral incisions and the median aperture are traversed by the anterior portions of the longitudinal muscle fibres (*l.m.f.*) described in the preceding section. The general course of the nerve fibres which make up the neuropil is not immediately apparent; the first impression received is that of a closely matted and tangled mass. A careful inspection, however, shows that the fibres composing the three lobes for the most part run parallel to their surfaces, while those of the lower half of the fibrous mass, below the median aperture, run from side to side. The latter constitute the transverse commissure of the brain (figs. 2 and 20, *br.com.*).

The neuropil mass is covered on its anterior, dorsal and lateral surfaces by several layers of ganglion cells; its posterior surface is bounded by the cavity of the head, while its lower portion is separated from the ventral hypodermis by a narrow cleft (fig. 2). The ganglion cells are imperfectly divided into four groups, giving to the brain as a whole a lobed outline (figs. 1, 2, 19, 20 and 23). Three of these groups correspond to the median and lateral lobes of the neuropil, and are due to the same circumstance, namely, the arrangement of the anterior portions of the longitudinal muscle fibres. The fourth group covers the anterior surface of the brain, and is somewhat irregular in outline (figs. 19 and 23). Of these four groups the dorso-median is noteworthy in that it is situated comparatively remote from the rest of the brain, and is connected with the neuropil by a distinct bridge of nervous fibres (fig. 23, *n.f.*). In fig. 23 a fifth group of ganglion cells is also to be seen just below the brain, on its ventral side, and extending out toward the hypodermis. The presence of this group is, however, apparently unusual, since it could not be found in other examples.

The ganglion cells of the brain are all very similar in size and form, and have the appearance of being multipolar, axons and dendrites not being distinguishable in most cases. Some of the ganglion cells are, however, demonstrably bipolar, as, for example, the sensory neurons of the tactile cilia. It is probable that all the ganglion cells are of this type, namely, bipolar. The branching processes (dendrites) form a loose meshwork; some extending peripherally between the hypodermal cells; some—probably axons—extend centrally to enter the neuropil mass. In figs. 19 and 20 many of the ganglion cells appear as if seated on tiny papillæ of the neuropil. These papilla-like projections are, of course, only the central processes of the ganglion cells themselves which enter the neuropil and there divide into fibrillæ.

The cytoplasm of the ganglion cells, in contrast to that of the neighboring supporting cells of the hypodermis, stains rather deeply in iron-hæmatoxylin. On examination under a high power it presents a granular appearance (fig. 12). The nuclei of the ganglion cells are elliptical in outline and are very constant in size in the same individual, measuring from 1.42 x 2.25 μ in small individuals to 2.25 x 3.06 μ in the largest. They are rich in chromatin, which is divided into several large subequal granules, none of which exceeds the others sufficiently to be considered a karyosome, as in the nuclei of the other tissue cells. This peculiarity of the nucleus of the ganglion cells renders them, in this form, easily distinguishable wherever they occur. The same distinction, curiously enough, occurs in *Histriobdella* (*Histriodrilus*), as may be readily gathered from Foettinger's (1884) figures, although the author does not allude to it in the text.

Embedded in the posterior portion of the neuropil are cells having a cell-body indistinct in outline, and a large vesicular nucleus with a conspicuous karyosome. These cells are similar in form and size to those of the mesenchyme, which form with their branches a delicate network traversing the head cavity (figs. 19, 20 and 23), and are doubtless to be classed with them.

The circumœsophageal commissures spring from the ventro-lateral portions of the neuropil, below its lateral lobes, uniting at this point with the lateral portions of the transverse commissures, with whose fibres they are continuous (figs. 1, 20 and 23, *c.com.*). Each is at this point nearly round in section and lies in contact with the ventral hypodermis. Scattered over its surface are a small number of ganglion cells. As the two commissures reach the anterior border of the mouth they are reunited by a bundle of nerve fibres, the preoral transverse commissure (figs. 1 and 20, *pr.com.*). This is of uniform diameter throughout, and about one-third of that of the circumœsophageal commissures at this point. It lies partially embedded in the anterior wall of the œsophagus, just above the point where the latter meets the hypodermis of the ventral portion of the head, as is shown in fig. 23. Accompanying it, on its inner side, next to the œsophageal wall, are a few muscle fibres which terminate on either side in the body wall. In the series from which fig. 1 was taken, a series remarkably favorable for the study of the nervous system, clear evidences were found of nerve fibres which were given off to the inner surfaces of the hypodermal cells from the circumœsophageal commissures, at a point opposite to that of the junction of each with the preoral commissure. These nerve fibres have the appearance of being, to some extent at least, continuous with those of the preoral commissures. Moreover, a ganglion cell was found on each side, laterad of the junction of the preoral and circumœsophageal commissures, and having the appearance of belonging to the fibres just mentioned (see fig. 1).

Just posterior to its union with the preoral commissure, each circumœsophageal commissure gives off a large branch, the œsophageal nerve (figs. 1 and 3, *oes.n.*). This nerve at first runs in a dorso-posterior direction, following the œsophagus, and meeting in its course the ducts of the salivary glands (*s.g.d.*). It then accompanies these backward, but, before reaching the glands themselves, in the middle of the first trunk segment, it suddenly disappears. It possesses a large calibre throughout its course, and is elliptical or flattened in section, being closely applied to the outside of the œsophageal wall. Near its point of origin it is surrounded by a few ganglion cells, but these do not follow it but a very short distance (fig. 1).

After giving off the œsophageal nerve the commissures pass backward around the œsophagus, just below the lateral longitudinal muscles, and are now completely embedded in the hypodermis, just outside of the line of junction of the latter with the œsophageal wall (figs. 3 and 4). In section their form has changed from round to long-elliptical; this alteration being correlated with a decrease in the thickness of the hypodermis. The commissures are now so completely incorporated with the hypodermis that they can only be distinguished by their staining reaction and, to a limited extent, by their histological structure. At the posterior border of the mouth each circumœsophageal commissure, in the example from which fig. 1 was made, exhibits an opening or fenestra. Just beyond this point, in the posterior part of the first trunk segment, each commissure gives off a large nerve laterad to the ventro-lateral longitudinal muscle, which it accompanies for an indeterminate distance. It was successfully traced, however, only as far as the middle of the second trunk segment. This muscle nerve is flat and embedded in the hypodermis throughout its course, lying just beneath the muscle. It rapidly diminishes in thickness as it passes caudad, and for this reason could not be traced farther with certainty. At the point where the muscle nerve is given off ganglion cells reappear, and the circumœsophageal commissures may be considered to have passed into the lateral nerve cords. The latter, composed of nerve fibres longitudinally disposed, remain buried in the hypodermis while traversing the trunk to the posterior portion of the last segment. Here they end, after giving off a branch laterad to the body wall. They are situated apart, throughout their length, at an average distance of about one-half of the diameter of the body, or, as seen in cross sections of the trunk, about 60 degrees of the circle. They are thus slightly mesad of the ventro-lateral longitudinal muscles. In the second trunk segment and the anterior half of the third the ventral cords broaden out greatly, having a rather irregular contour on their mesial side, and are united by three transverse commissures. These commissures, broad where they join the longitudinal nerve cord, become so narrow at the midline that their continuity can only be demonstrated in good transverse sections (fig. 9). Above, below, and laterad of the nerve cords in this region of the body, but within the hypodermis, are numbers of ganglion cells (fig. 9, *g.c.*). The cell bodies of these latter cannot be distinguished from those of the surrounding hypodermis cells; their nuclei, however, are readily distinguishable, being precisely like those of the ganglion cells of the brain, except as to size, ranging from 1.12 μ x 1.87 μ to 1.80μ x 2.25 μ. Their average size is therefore nearly one-third smaller. These cells together form a long and diffuse ganglion, extending from the anterior of the second trunk segment to the middle of the third. At the latter point the ventral nerve cords rather suddenly contract, almost immediately widening again, and in the posterior half of the third trunk segment are again united by two commissures, situated apart at a distance of ca. 15 μ. Ganglion cells are also present here, forming a second pair of ganglia; the number of ganglion cells is, however, much less than in the preceding, and the second pair of ganglia are consequently of much less extent (fig. 9). The third pair of ganglia are similar to the second pair, but are composed of still fewer cells, and situated between the fourth and fifth trunk segments. Two commissures here join the ventral cords with one another. Between this pair of ganglia and the preceding, in the left ventral nerve cord, another opening or fenestra is seen in fig. 1. Between the fifth and sixth segments is the fourth pair of ganglia, again united by two transverse commissures, but possessing only a very few scattered ganglion cells. Posterior to this point, the ventral nerve cords, which have been gradually tapering caudad, suffer a sudden diminution in calibre. A fifth pair of ganglia in the sixth segment is possibly indicated by the presence of three or four ganglion cells on each side.

Nerves given off laterad from the ventral cords to the hypodermis were not observed, but this by no means argues their absence, since in the nature of the case they would be difficult to observe, unless of considerable size.

(*b*) SENSE ORGANS.—*The Eyes.*—These organs are situated, as shown in text fig. I, on the dorso-lateral surface of the head, about midway between its anterior tip and the second ciliated ring; their distance from one another is about one-half of the width of the head at this point. Their structure is essentially the same as that described for the eyes of other members of this group (fig. 10). Each consists of a cup-shaped mass, composed of reddish pigment granules, the mouth of which encloses a subspherical lens, slightly bilobed, the two lobes separated by a well-marked partition. Below the lens, in the lower part of the pigment cup, is a small space filled with a colorless fluid. Each eye is directed forward and outward, and lies embedded in the hypodermis ca. 4 μ below its outer surface. The cellular structure of the eye is not clear. Although the lens is sharply divided into two lateral halves, and in some cases the pigment cup faintly so, no nuclei are discernible within the eye itself, even when depigmented, nor could the eye be definitely connected with any of the adjacent cells. About the base of the pigment cup are clustered a number of ganglion cells belonging to the dorso-median group; it would perhaps be more correct to say that the base of the pigment cup is embedded in this group. Some at least of these cells, on account of their position, must function as percipient elements, although no differentiation serving this end could be observed. Korschelt (1882) describes a distinct optic nerve, connecting the eye with the brain; on the other hand Weldon (1886), Harmer (1889*a*) and Schimkewitsch (1895) all agree that, in the species studied by each, the eyes are embedded in the dorsal portion of the brain.

Sense Hairs.—Much time was spent in searching for these before they were recognized in fixed and stained material. In life the two larger sense hairs appear as tapering homogeneous threads of protoplasm, and such structures were sought for in sections. When they were finally identified by their position, they were found to be composed of a considerable number of cilia fused together, and borne by a cell essentially similar to those which constitute the adjacent ciliated bands (fig. 12). The smaller sense hairs (fig. 20, *t.cil.*) differ from the larger in being composed of fewer cilia, and borne by smaller cells. In view of the function of these hairs, a nervous connection was to be looked for. This was demonstrable in a few cases, the clearest of which is shown in fig. 12. Two sensory neurons, similar to the adjacent ganglion cells, in this case at least of the bipolar type, lie between the neuropil and the sense cell. Their peripheral processes are in close contact with the base of the sense cell, while their shorter central processes join with the neuropil. The composite nature of the sense hairs has been already noted by Schimkewitsch (1895) who speaks of the "Buscheln,'' and figures the pair of large sense hairs as made up of smaller elements. Miss Moore (1899) says of *D. gardneri* that "the head bears two tufts of long cilia in front . . . . these are probably of a sensory nature.'' Sense hairs of precisely similar structure, being composed of fused cilia, springing from cells like those which bear the locomotory cilia, are described by Meyer (1901) as found on the ventral surface of the umbrella of the trochophore of *Lopadorhynchus*.

Ciliated Grooves.—These structures have been noticed under the section on The External Form. Their histological structure offers nothing worthy of comment. The ciliated cells composing these grooves are similar to the other cilia-bearing cells of this form. There is no good evidence of any direct connection with the nervous system, although it is possible that they may be innervated by nerves given off from the preoral transverse commissure.

Problematical Sense Organs.—These are narrow oval areas, with the long axis of the oval vertical, measuring ca. 10 x 22 μ, situated, one on each side, in the constriction between the head and the first trunk segment, and slightly dorsad of the mid-level. A section through one of these organs is represented in fig. 11. The cuticle is seen to be thickened over the whole ciliated surface, and especially at its centre. In the middle of each the cilia are lacking over a space about one-third of the diameter of the whole, their place being supplied by a number of spherical bodies, borne on slender rods, which project barely above the surface of the cuticle. Midway between the outer and inner surfaces of the body wall the rods stain more intensely and appear to thicken, forming a well-marked zone. Centrad of this zone the rods are just visible, but can with care be seen to terminate against the basement membrane. On the inner side of the basement membrane, at this point, a group of œsophageal muscle fibres are inserted (*oes.m.*). In the belief that this curious structure was sensory in function, a careful search was made to determine whether a demonstrable connection with the nervous system was present, but none could be found.

From the description given above it is apparent that *D. conklini* possess a very much simplified nervous system of the ladder type, and one which is embryonic in many particulars, as, for example, in the close association of the whole with the hypodermis (ectoderm), and especially the slight differentiation of the portion belonging to the trunk, where the lateral trunks with their ganglia are not merely in contact with the body wall, but included in it.

The first description of the nervous system of *Dinophilus* is that given for *D. apatris* by Korschelt (1882). The studies of this investigator were confined almost wholly to entire individuals, living or mounted in balsam. From one of the latter, stained in alum carmine, he described and figured a brain, from which arose two pairs of nerves: one pair running forward to the eyes, while the other, which passed backward, he regarded as the roots of longitudinal nerves.

The next paper on *Dinophilus*, that of Weldon (1886), gave a fairly complete account of the nervous system of this species (*D. gigas*). According to Weldon, the brain, which fills the preoral lobe, consists of a central mass of nerve fibres, surrounded by ganglion cells, which are, as indicated by his figures, in close contact with the hypodermis. From the brain arise the lateral nerve cords, which are also in close contact with the hypodermis, and consist of nerve fibres and ganglion cells. The latter, however, almost entirely disappear in the posterior region of the body, and apparently show no traces of separation into ganglia. Transverse commissures also appeared to be wanting. In regard to the last two points, there seems room for reasonable doubt if more perfect series of sections than it was at that time possible to make would not reveal the presence of both ganglia and transverse commissures in this species.

In respect to the points last mentioned, the account of Harmer (1889*a*) is much more satisfactory. This author found in *D. tæniatus* a brain definitely separated from the hypodermis, and a nervous system of the ladder type, which, although remaining in contact with the body wall, lies outside of its basement membrane. The ganglion cells, although investing the nerve cords along their whole length, are united at intervals into compact groups to form five pairs of well-defined ganglia, each of which is united by a transverse commissure. Each pair of ganglia corresponds to a trunk segment, although situated slightly posterior to the middle of the segment, as indicated on the exterior by the constrictions and ciliated rings.

In the same year with Weldon's paper (1886) there appeared one on *D. gyrociliatus* by Repiachoff. This investigator described and figured the brain of this species and the anterior portions of the two circumœsophageal commissures. The brain is, as in the other species, composed of a central mass of nerve fibres (neuropil) invested on all except its posterior surface with ganglion cells. These latter are closely united to the ectoderm, as in *D. gigas,* whereas in *D. tæniatus* they are distinctly marked off from it.

Schimkewitsch (1895) has, in his account of the structure of *D. vorticoides,* found in the White Sea, given the most complete account of the nervous system of *Dinophilus,* as well as of other organs. The nervous system of this species is, as a whole, essentially like that of *D. tæniatus,* but differs from it in two important particulars. The ganglion cells do not invest the lateral nerve cords throughout their length, but are completely segregated into ganglia, the first pair of which, together with their transverse commissure, lies entirely outside of the hypodermis. If the nervous system be used as a criterion, then *D. vorticoides* has reached the highest stage of development attained by any member of the group thus far investigated. Judged in this aspect, *D. gigas* should be placed at the foot of the scale; *D. conklini* second, *D. tæniatus* third, and lastly *D. vorticoides.*

Harmer (1889*a*) has made a somewhat detailed comparison between the nervous system of *Dinophilus* and that of the archiannelids. *Dinophilus* agrees with all of the members of that somewhat heterogeneous group in the general plan of the nervous system and in its close relation to the hypodermis (ectoderm). With *Protodrilus* (Hatschek, 1880) and with *Histriobdella* (*Histriodrilus,* Foettinger, 1885) it further agrees in the separation of the lateral halves of the ventral nerve strand. However, in a new species of *Histriobdella* described by Haswell (1900) the lateral halves of the ventral nerve cord are complètely fused. Goodrich (1901), in discussing the systematic position of *Saccocirrus,* has drawn attention to the well-known fact that the epithelial position in this form is shared by chætopod annelids belonging to widely separated groups, as, for example, the *Eunicidæ* (Spengel, 1881), *Syllidæ* (Malaquin, 1893), *Polynoidæ, Chætopteridæ, Maldanida* (MacIntosh, 1885), and *Myzostomidæ* (Graff, 1877). The same may naturally be said of *Dinophilus.* Moreover, two other special features, namely, the separation of the lateral halves of the ventral nerve cord and the subdivision of the transverse commissures, it shares with many *Hermellidæ* and *Serpulidæ* (Meyer, 1886). Both the epithelial position of the nervous system and the separation of the nerve cords are found in *Nerilla* (Pereyaslawzewa, 1896), which is unquestionably a polychætous annelid, while with the nervous system of *Ælosoma* (Brace, 1901), the most primitive member of the Oligochæta, there is the closest resemblance. For example, *A. tenebrarum,* described by Miss Brace, possesses not only a brain closely soldered to the hypodermis, but also widely separated ventral nerve cords, metamerically arranged groups of ganglion cells, and two or more transverse commissures for each segment, all completely embedded in the ventral hypodermis.

This widespread ectodermal position of the nervous system is of course readily explained as a retention on the part of these forms of an embryonic condition—a permanently arrested stage of development—apparently correlated with their small size and the resulting simplification of their economy. That the same explanation will apply to *Dinophilus* is sufficiently obvious; the more so in the light of the researches of Schimkewitsch (1895) on the embryology of this form, as well as the evolution of the nervous system, as seen in the differing stages of development shown by the various members of the group, and described above.

There remain three special features of the nervous system of *D. conklini.* The first of these is the presence of a preoral transverse commissure. This structure may be accounted for in one of several ways. In the first place it might be supposed to represent a commissure originally postoral, and belonging to the trunk, but which has become preoral in position by the shifting of the mouth in a caudal direction. This would be a perfectly allowable assumption, supported by analogy with related forms, since in both the flatworms and annelids the position of the mouth is by no means a fixed one, but quite subject to shifting. However, although the posterior limb of the triradiate mouth does extend caudad into the trunk region, the evidence of any considerable movement caudad on the part of the mouth as a whole is too slight to lend this explanation of the occurrence of a preoral transverse commissure any considerable degree of probability.

In the next place this commissure may be regarded as having arisen entirely *de novo* in response to the peculiar physiological needs of the animal. Such an explanation is certainly permissible, but it would be worth while first to inquire whether a corresponding structure exists in any of those groups to which *Dinophilus* can be considered related, and from which it may have derived this structural peculiarity. Such a group is found in the annelids, whose larva, the trochophore, represents either an ancestral condition, or else a stage interpolated in the ontogeny very early in the racial history. In this larva, thanks to the researches of Kleinenberg (1886), confirmed by Meyer (1901), it is known that at an early stage there is present, embedded in the ectoderm, beneath the prototroch, a circular cord of nerve fibres, considered by Kleinenberg as the primitive nervous system of the larva, and homologous with the nervous system of the medusa. At a late period in the development, during the metamorphosis of the larva into the segmented worm, this nerve-ring is crossed, on the future ventral surface of the worm, by the circumœsophageal commissures, forming a structure shaped like the letter H (see Kleinenberg's fig. 31, Taf. IX). This intercalated segment of the nerve-ring persists for a long period, but finally suffers complete absorption and disappears. Now, one of the chief functions of the nerve-ring is that of innervating the prototroch, the principal organ of locomotion of the larva, and of controlling its motions. If, then, the prototroch should persist, it would be quite probable that at least a portion of the nerve-ring would persist with it, and it would quite likely be that portion which persists longest in the ontogeny. This, I believe, is what has happened in *Dinophilus.* Moreover, there are also indications of the persistence of the lateral portions of the nerve-ring (see fig. 1). When it is remembered that the second preoral ciliated band is in all probability homologous with the prototroch of the annelid larva, it will be apparent that there are good reasons for considering the preoral transverse commissure of *Dinophilus* as the persisting remnant of the nerve-ring of the trochophore larva of the annelids, preserved not merely by force of inheritance—since a multitude of examples might be cited to show that this is not of itself sufficient to save an organ or structure from disappearance—but rather by the physiological needs of the animal.

The œsophageal or stomatogastric nerve is not only found in *D. gigas* (Weldon, 1886), *D. tæniatus* (Harmer, 1889*a*), and *D. vorticoides* (Schimkewitsch, 1895), but in annelids generally, as, for example, *Oligognathus* (Spengel, 1881) and *Saccocirrus* (Fraipont, 1884).

The nerve innervating the ventro-lateral longitudinal muscles has not yet been described in any species of *Dinophilus*; but renewed research of other forms might bring it to light. Its close connection with the muscle recalls the precisely similar relation found between the longitudinal nerves and muscles found by Meyer (1901) to exist in the trochophore larva of *Lopadorhynchus*, and strongly hints that, as in that form, it may be due to a common origin from the ectoderm.

4. *Alimentary Canal.*

The alimentary canal of *D. conklini* does not differ in its essential features from that described for other members of the group, and resembles very closely that of *D. apatris* and *D. gyrociliatus*. On the ventral side of the head is the mouth opening, which is triradiate or Y-shaped, the vertical limb of the Y being directed caudad. The latter is not confined to the head segment alone, but extends backward into the first segment of the trunk as far as its middle region (see text fig. I and fig. 23). Korschelt (1882) has described a similar condition in *D. apatris*, the mouth in this species extending back from the head into the short segment-like piece which lies between the head and the first trunk segment. In Schmidt's drawing (1856) of *D. gyrociliatus* the mouth is represented as confined exclusively to the head, but in another of the same species published by Meyer (1886) the relation of the mouth to the head and trunk is shown to be the same as that just described for *D. conklini.* The possible significance of this relation will be discussed later.

The mouth leads dorsad directly into the œsophagus; caudad it opens into the cavity containing the proboscis (fig. 23), an organ common to all or nearly all of the members of this group. Forming the dorsal wall of the proboscis cavity and separating it from the œsophagus is a crescentic fold extending across the posterior wall of the œsophagus and partially closing its lumen; the two lateral halves of this are called by Harmer (1889*a*) "the inner lips" (figs. 4 and 23, *i.l.*), in contradistinction to "the outer lips" (*o.l.*) which are formed by the union of the walls of the body and œsophagus. From the inner lips the œsophagus ascends, curving slightly backward, to the dorsal body wall, where it bends sharply to the rear and, pursuing a horizontal course for a short distance, reaches the stomach. This it enters at a point considerably dorsad of the mid-level. The lumen of the œsophagus in its ascending portion is scarcely more than a cleft, being very narrow in its transverse diameter, although long in an antero-posterior direction. In its anterior portion, however, next to the wall of the œsophagus, the lumen widens out suddenly, forming here a small open channel. The narrow portion of the œsophageal lumen answers to that limb or radius of the Y-shaped mouth which is directed caudad, the open channel to the anterior two limbs. At the upper end of the ascending ilmb the lumen gradually becomes circular in section, and remains so for the remainder of its course. In *D. gyrociliatus* Schmidt (1857), and in *D. apatris* Korschelt (1882), have each described a proventriculus (Vormagen), which is simply an enlargement of the horizontal limb of the œsophagus. In isolated individuals of *D. conklini* there is an indication of such a structure in a slight dilation of this portion of the œsophagus, but this dilation is apparently not permanent, but merely temporary.

The cells which form the walls of the œsophagus are relatively large, and very similar, except in their size, to those of the body wall. Correlated with the shape of the œsophageal lumen in its ascending limb is a marked difference between the height of the cells of the lateral and the anterior and posterior walls, since the exterior of the œsophagus in section preserves a regular oval or circular contour. Those which form the anterior and posterior walls are low and cuboid, while those composing its lateral walls are high, and, although rather irregular, both in size and shape, may, on the whole, be considered columnar in form (cf. figs. 3 and 23). The cells of the remainder of the œsophagus are fairly regular both in form and size, usually cuboid, arranged in a single layer. All of the œsophageal cells are clothed with a thin cuticle, a continuation of that covering the body, and also bear long cilia. These spring from distinct basal knobs, which form a uniform layer a short distance below the cuticle, a narrow subcuticular layer intervening.

In many individuals a large number of the nuclei of the œsophageal wall are undergoing a process of degeneration, some of the stages being represented in figs. 31 and 32. The various stages of this process have not been carefully studied, but it is evident that bound up with this process, possibly resulting from it, is the expulsion of the cell from its epithelium. Such a cell is shown in fig. 31. Two possible explanations of this phenomenon present themselves. The function of the cells may be that of secretion, and their degeneration and expulsion the result of old age, like the "cellules de ferment" of the mid-intestine of *Lagis koreni*, described by Brasil (1904). On the other hand the degeneration and expulsion of these cells may have for its purpose the liberation of the cell contents, which have acquired digestive properties, in the lumen of the œsophagus. This would then be an example of holocrine secretion (Ranvier).

Closely connected with the œsophagus is an organ which is common to all members of this group, and variously termed "proboscis," "muscular appendage," "Pharanx," and "Pharangealtasche" by different authors. On account of its brevity and definiteness I prefer to use the earlier one of "proboscis" ("trompe," Hallez; "Rüssel," Korschelt). The proboscis of *D. conklini* lies just behind the mouth, and in side view presents a reniform outline, its concave surface directed forward and applied to the posterior wall of the ascending limb of the œsophagus (fig. 23). In cross section (figs. 4, 5, and 23, *pro. 1* and *pro. 2*, and fig. 30) it is elliptical, the long axis of the ellipse lying transversely. The greater portion of this organ lies within the body cavity between the two limbs of the œsophagus, and practically filling up this space. The anterior and more pointed end of the proboscis (*pro. 1*) projects into the pocket-like cavity opening between the inner and outer lips, and is covered by a reflection of the cuticle which lines the cavity. This portion of the proboscis also differs histologically from the remainder, being composed of cells substantially similar to those of the œsophageal wall, but slightly darker and less distinctly granular, which pass over, on the dorsal side, into those forming the inner lips, as shown in fig. 23. Beneath the fold of cuticle which connects the proboscis with the outer lips, in the same figure (23), may be seen a network of protoplasm which finally unites with the epithelium of the outer lips (*o.l.*). This network encloses a nucleus, in the section figured, and is, together with the tip of the proboscis, as well as the inner lips (*i.l.*), merely a continuation of the epithelium forming the œsophageal wall. Laterad of the midline this epithelium is clearly seen to be continuous over the whole of the pocket, from the upper lips to the posterior margin of the mouth. This continuity of the œsophageal epithelium is still more plainly seen in *D. tæniatus* (Harmer, 1889), and in *D. vorticoides*, as seen in the figures of Schimkewitsch (1895). In both these forms it passes unbroken over the proboscis to the posterior border of the mouth. This is especially well seen in Schimkewitsch (Taf. VI, fig. 37). The remainder of the proboscis, that is, all of the organ behind the pointed tip, presents a histological structure which is extremely curious. This peculiarity of structure has been either entirely misunderstood by previous writers or passed over with scant notice. A careful study of sections shows that the part in question, constituting the major portion of the proboscis, is divided into about thirty narrow chambers by as many transverse cuticular partitions (fig. 23, *pro. 2*), regularly placed from one to three micra apart. These partitions bear on each of their two surfaces a single layer of slender fibrillæ, of uniform diameter, and having the same general appearance and staining reaction as muscle fibres (figs.

4, 5 and 23, *pro. 2*). The fibrillæ in each layer are parallel to one another, and accurately spaced about 1.5 μ apart, running diagonally from one side to the other of the proboscis, at an angle of approximately 45 degrees to the horizontal plane. The fibrillæ on opposite sides of the same partition, however, are not parallel, but, while intersecting the horizontal plane at the same angle, the fibrillæ of one layer cross those of the other at right angles. Thus it follows that only the fibres of alternating layers are parallel, while those of any two consecutive layers run at right angles to one another. As a result of this arrangement, in cross sections through the proboscis, in which two layers of fibrillæ are included, these latter, being seen simultaneously, create the appearance of a lattice work, which is very regular whenever the section is parallel to the partitions (fig. 30). The spaces between the partitions are filled with a pale and vacuolated cytoplasm, near the centre of which is a much flattened nucleus, with a large karyosome. The greater portion of the proboscis is thus composed of a series of disk-like cells, placed like coins in a pile, and separated by cuticular partitions. Near the centre of each is a nucleus, while each of its faces bears a layer of fibrillæ. This peculiar and somewhat complex structure demands an explanation, but it must be confessed that I have none to offer, based on my own observations, inasmuch as living material has been inaccessible to me since the necessity of its study in regard to the point in question became apparent. Some of the observations of Korschelt (1882), made on *D. apatris*, however, bear on this point. This investigator described and figured the two portions of the proboscis, but interpreted the striated appearance of the hinder portion as produced by *circular* muscles. He then proceeds to say: "Die ganze Rüssel strekt sich dabei und verlängt sich durch Contraction der Ringmuskeln." In speaking of the degree of extension of the proboscis he states that "seine Vorderende bis in die gegend der Augen vorgeschnellt werden." So great a degree of extension could hardly be accomplished by the action of extrinsic muscles alone. Moreover, the diagonal fibrillæ by their contraction would produce the same mechanical effect as circular muscles, viz., an extension of the proboscis brought about by a lessening of its diameter. In view of this fact, and of the observations of Korschelt, it may, I think, be permissible to assume, provisionally at least, that the function of the diagonal fibrils of the proboscis is the extension of that organ.

In addition to the intrinsic musculature the proboscis of *D. conklini* is also provided with a set of extrinsic muscles. These are eight in number, arranged in four pairs: protractors, flexors, retractors, and levators. These are composed of but one or two fibres apiece. The first of these muscles, the protractors (fig. 5, *pro.pr.*), lie close together near the midline, beneath the proboscis. They are attached to the ventral body wall, just inside of the attachment of the median ventral longitudinal muscles. From here they pass directly backwards, and are inserted on the ventral side of the proboscis about midway of its length. At their attachment and insertion these, as well as the other proboscis muscles, display the brushlike tufts, formed by division of the fibrils, that were observed in the case of the trunk muscles. The second pair, the flexors (fig. 4, *pro.f.*), join together the two ends of the proboscis, passing over its convex anterior face. The retractors (fig. 4, *pro.r.*) are attached to the ventro-lateral portion of the horizontal limb of the œsophagus, above the proboscis, and descend to their insertion in its anterior portion. The levators are attached to the lateral body wall and inserted on the sides of the proboscis, near its middle.

The stomach is a cylindrical or barrel-shaped organ, occupying the body cavity from the anterior limits of the third trunk segment to the middle of the fourth. These two segments, it will be remembered, far exceed the others both in length and diameter, so that the stomach is therefore a relatively large organ, its length being nearly one-half that of the trunk. Its diameter approaches that of the body cavity of the segments in which it lies; the space that remains between the stomach and body wall being reduced to a narrow cleft. The anterior end of the stomach is more or less distinctly truncate; its posterior end, on the other hand, is conical, tapering to join the intestine. This junction, like that with the œsophagus, is dorsal to the median axis.

The stomach wall (figs. 6 and 35) is from 11 μ to 30 μ in thickness, and composed of a uniform layer of cuboid or low columnar cells, whose inner ends bear long cilia. Each cell displays at its central end a shallow layer of homogeneous protoplasm, staining deeply in iron-hæmatoxylin after fixation by sublimate, less densely after Flemming's mixture; just below this layer are the close-set basal knobs of the cilia. The body of the cell consists of dark staining and much vacuolated cytoplasm, within which, usually near the base of the cell, is an ovoid or spherical nucleus, provided with the usual karyosome. The cytoplasm of the cells of the stomach presents a somewhat varied appearance, according to the fixative employed. Sections cut from material fixed in corrosive sublimate (fig. 6) show the cytoplasm much vacuolated, indeed so much so that the protoplasm is reduced to scarcely more than a coarse and densely staining reticulum. Within the meshes of this reticulum may be discerned, moreover, pale yellow, somewhat refractive granules. In material fixed in Flemming's fluid (fig. 35) the picture is strikingly different. The cytoplasm presents the same vacuolated appearance, but here each vacuole constantly encloses a yellowish-brown spherule; while in many individuals the cells moreover contain many black-stained inclusions of the most varied shapes, some of which are shown in fig. 35. That these latter are fatty in their nature is indicated by the fact that they are visible only in material fixed with a mixture containing osmic acid, and also by their intense blackness. The yellowish contents of the vacuoles, whether appearing as pale granules or as spherules, is doubtless only the precipitate of the fluid contained in them during life.

The above description applies to the majority of the cells which make up the stomach wall. In addition to these, and scattered among them in considerable number, are unicellular glands (fig. 6, *g.gl.*, and fig. 34). These stain more deeply than their neighbors, being especially dark at their bases. Their cytoplasm is not visibly vacuolated, and presents a granular appearance. In the example shown in fig. 34 a portion of the cytoplasm at the central end of the cell is seen to have been transformed into a coarsely granular secretion, which is escaping into the lumen of the stomach through a break in the cell wall. These cells have evidently a digestive function. Another peculiar structure was also frequently noted, which may be considered as having to do with the digestive functions, although this is not certain. Embedded in the stomach wall of many individuals there were frequently observed large spherules, whose diameter was approximately one-half of the thickness of the stomach wall, and which possessed a staining reaction similar to that of the surrounding cells—although perhaps a trifle darker—and having a homogeneous appearance (fig. 33). Contained within this spherule there appears constantly a spherical mass of chromatic substance, approaching in size and appearance the nucleolus of the surrounding cells. In addition there is also scattered through the spherule tiny granules of chromatic material. In close contact with the spherical body is a cap-shaped nucleus, *n*. That this close association with a nucleus is not accidental is indicated by the fact that it was found in ten successive instances. The whole structure—the spherical body with its chromatic enclosures, its homogeneous appearance, and its close contiguity to a true nucleus—closely resembles the figures given by Brasil (1904) of the "grosses boules hyalin" found in the mid-intestine of *Lagis koreni*, and which are concerned with the degeneration of the cells in which they occur.

The intestine (figs. 7 and 8, *int.*) takes its rise from the posterior portion of the stomach, dorsad of the median axis of the animal, whence it runs caudad to the anus in a nearly straight course, with but a slight sigmoid flexure. Like the stomach and œsophagus, it is lined throughout its course with long cilia. The anus, as already described, opens at the posterior termination of the trunk, just dorsad of the caudal process. The outer diameter of the intestine in its middle portion is about one-half of that of the stomach, but is contracted both at its junction with the stomach and at the anus. The intestinal wall is approximately 3 μ in thickness and composed of a single layer of cells which vary much in form, from a flattened squamous type to the cubical. This irregularity in the form of the constituent cells of the intestinal wall is associated with an irregularity in the contour of its inner surface, the latter being raised into numerous longitudinal ridges rather irregularly arranged, most numerous and attaining their greatest height midway between stomach and anus, and disappearing near the two latter points. The cells themselves present the same cytological characters as those of the œsophagus, namely, a thin cuticle, a narrow subcuticular border, a layer of end knobs, from which arise the long cilia, and a clear and transparent cytoplasm, enclosing an ovoid nucleus with a karyosome.

The musculature of the alimentary canal is very slight, aside from that of the proboscis and the few fibres which accompany the preoral transverse commissure. The latter are to be reckoned with those of the alimentary canal, since they serve to draw together the lateral halves of the mouth. No traces were found of the radially arranged muscles about the mouth described by Korschelt (1882). The largest and most evident muscles are comprised in two small groups, one on either side of the vertical limb of the œsophagus, passing from its lateral walls to the body wall on either side (fig. 3, *œs.m.*). These serve, as do similar muscles in annelids and other forms, to dilate the œsophagus. A few muscle fibres encircle the œsophagus at irregular intervals, and are only visible in longitudinal sections, where they appear as black points on the outer surface of the œsophageal wall. Some of these are represented in fig. 23. It is possible that such fibres are present also on the stomach and intestines, but I have not been able to satisfy myself of their presence. There is however, encircling the posterior end of the intestine a very short distance anterior to the anus, a muscle composed of one fibre, which thus serves as a *sphincter ani* (fig. 8, *int.m.*).

The glands occurring in the epithelium of the alimentary canal have already been mentioned. There remains to be described the "salivary glands" (Speicheldrüsen, O. S. Schmidt), and a set of huge glands which I have termed "cephalic glands." The description of these latter glands is brought into this section not so much because of their hypothetical relation to the digestive system, as for the sake of convenience.

The salivary glands (fig. 5, *s.gl.*) are similar to those of *D. gyrociliatus* (Schmidt, 1856; Repiachoff, 1886) and *D. apatris* (Korschelt, 1882). They consist of two groups of large unicellular glands, each group numbering in the neighborhood of a dozen cells, situated laterad to the œsophagus, in the angle formed by the junction of the latter with the stomach, and forming an ovoid or pyriform mass. The cytoplasm of these gland cells stains from a brownish yellow to a deep black in iron-hæmatoxylin, and has a homogeneous, compact appearance, but frequently encloses vacuoles of a lighter tint. The nuclei are spherical and contain large nucleoli. From each cell proceeds a slender duct, which passes along each side of the horizontal limb of the œsophagus, in contact with it, the ducts of each side uniting to form a bundle (fig. 4, *s.gl.d.*). Arriving at the ascending limb of the œsophagus, each bundle splits up into its component ducts. These enter the œsophagus, penetrating between the cells of its lateral and posterior walls, each at a different point, and open into its lumen (fig. 3, *s.gl.d.*). In *D. apatris* these glands are said by Korschelt to open between the œsophagus and proventriculus. In *D. gigas* (Weldon, 1886) gland cells are found lying outside of the pharangeal (œsophageal) wall, while similar glands lie at the base of the hypodermis forming the outer lips. Harmer (1889*a*) describes "racemose" salivary glands opening into the anterior division of the œsophagus. Schimkewitsch (1895) says of the salivary glands of *D. vorticoides:* "sie öffnen sich mit einigen Bündeln der ganzen Ösophagus entlang seitlich und naher zum Rucken." He also speaks of them as "mit Mucin erfüllt." It is quite evident that in *D. conklini* the contents of these glands is not mucin, although staining densely in hæmatoxylin, for in all of my preparations which were stained in Meyer's mucicarmine, a specific mucin stain, not one of these glands is tinged with it in the slightest degree, while the hypodermal mucous glands are all deeply colored.

The cephalic, like the salivary glands, form two groups or complexes of large unicellular glands. These are situated in the dorsalmost portion of the head cavity, just in front of the vertical limb of the œsophagus, each group symmetrically disposed a short distance on either side of the midline (see text fig. III, A. and B). Each gland cell, of which each group contains three to five, is pyriform in shape (fig. 22), with the smaller end directed downwards, and continued as a very slender duct. The ducts from each group unite to form a bundle (text fig. III, A, and fig. 20, *c.gl.d.*). Each of these passes downward and slightly forward, penetrating in their course the lateral portions of the brain. On meeting the ventral hypodermis the ducts of each side diverge, most of them turning inwards (mesiad), and, penetrating the hypodermis, open on the ventral surface; the mouths of the ducts forming a line transverse to the long axis of the animal, just posterior to the anterior end of the head. Just before its termination, each duct displays a bulbous enlargement, forming a small reservoir. The cephalic gland cells much resemble those of the salivary glands in their cytological characters and staining reaction. Like the latter, the protoplasm of the cephalic glands absorbs many chromatin stains with avidity, being stained with especial intensity in Delafield's hæmatoxylin and in carmine, while unaffected by mucicarmine. With iron-hæmatoxylin it is usually colored only a dark gray. In certain cases, as in the one represented in fig. 22, intracellular spaces, which previously had evidently been occupied by secretion, were present in the cytoplasm.

Glands corresponding to the cephalic glands have been described only in the account given by Schimkewitsch (1895) of *D. metameroides*, although this author suggests their occurrence in *D. tæniatus*, inferring this from Harmer's (1889*a*) description and figures of the brain.

The function of the cephalic glands is problematical. Their situation, just anterior to the preoral field of cilia which serves to sweep food particles into the mouth, suggests that they may perform a digestive function. Whether this is the case or not, their great size indicates that their function must be an important one in the economy of the animal.

5. *Excretory Organs.*

Nephridia.—Dinophilus conklini possesses five pairs of nephridia, metamerically arranged and corresponding to the five posterior trunk segments. The first of the five pairs differs from the others in that its structure is relatively much more complex; for that reason it will be more convenient to defer the consideration of this pair to the last, and to describe first the simpler structure of the posterior four pairs. These are very tenuous and ill defined in structure, in fact so much so that for a long time I failed to recognize them as definite organs, and mistook them for mere strands of mesenchymatous or connective tissue. In general structure, however, they were found to correspond closely to the nephridia of *D. gyrociliatus*, as figured by Meyer in 1886. Each nephridium is a thin-walled tube, ciliated throughout, and composed of some four to six cells. Throughout its length it adheres closely to the body wall, except in the case of the nephridia of the fifth pair, which float more or less freely in the body cavity. The course of each nephridium is winding, but its general direction is transverse to the long axis of the body, the morphological inner or central end being dorsal, the outer ventral. The lumen is from 1–2 μ in diameter, and widest near the middle of its course. At the central (dorsal) end (fig. 24) of each nephridium it gradually becomes narrower, and finally terminates blindly in a flat mass of granular protoplasm, containing, besides one or two nuclei, greenish refringent bodies, irregularly ovoid in shape. Goodrich (1897) has described similar bodies in the nephridia of *Sternaspis*. Toward the peripheral (ventral) extremity of the nephridium, which usually lies just laterad of the ventral nerve cords, the lumen again slightly decreases in calibre. The precise point where the external opening is situated could in no case be determined with certainty, although prolonged and careful search was made with the highest powers at my command. This difficulty is caused partly by the small size and lack of definiteness of the parts concerned, and also by the fact that it is only possible to study the nephridia in sections, since the opacity of the living animal and the close proximity of the ciliated walls of the alimentary canal make a study of the nephridia during life extremely difficult. It is, however, doubtless true also that the external openings are usually closed, and open for discharge only at intervals, as happens in the nephridia of some annelids, *e.g.*, *Ælosoma*. Shearer (1906) finds that each of the ducts of the nephridia of *D. tæniatus* terminates in a vacuole in the ventral hypodermis, but that no external opening could be demonstrated.

The nephridia forming the first pair are, as already stated, relatively complex, and are also much larger, more definite in structure, and more readily observed. Nevertheless, the tracing out of the entire course of these nephridia is by no means a simple task, and has been accomplished solely by reconstructions from sections, one of which is shown in text fig. IV, representing the left anterior nephridium, as viewed from the interior of the body of the animal. The morphological central end (text fig. IV, figs. 25*a* and 26*a*, *c.e.n.*) begins as a slender strand of protoplasm, attached to the lateral wall of the first segment. As it passes caudad it widens out, and in the second trunk segment becomes triangular in shape, thin at its edges, the external edge attached to the body wall and to neighboring parts of the nephridium, the inner or mesial edge frequently extending to meet and fuse with its fellow of the opposite side. One or two nuclei are seen to lie in this portion of the nephridium. Within its substance, near its ectal margin, beginning near the anterior limit of the second trunk segment and running parallel to the long axis of the body, is a canal, the *inner canal* of the nephridium (text fig. IV, figs. 25 and 26, *i.c.n.*), its anterior end conical and terminating blindly in the protoplasm. This canal is lined with long cilia directed caudad, and has a maximum calibre of about 3 μ. Near the middle of the second segment the inner canal contracts rather suddenly to about one-third or one-fourth of its former diameter, and sends off a slender connecting branch to the *lateral glandular portion* of the nephridium (text fig. IV, figs. 25*c–e*, and fig. 26, *l.g.n.*). The latter is a large flat biscuit-shaped mass of protoplasm, irregularly lobed or incised, and pressed closely against the lateral body wall. On its mesial side it is in contact with the salivary gland (*s.gl.*). Within the lateral glandular portion are three or four large spherical nuclei, containing very large karyosomes. No cell boundaries are visible. The cytoplasm has a coarsely granular appearance and stains very densely. The whole mass is permeated throughout by a

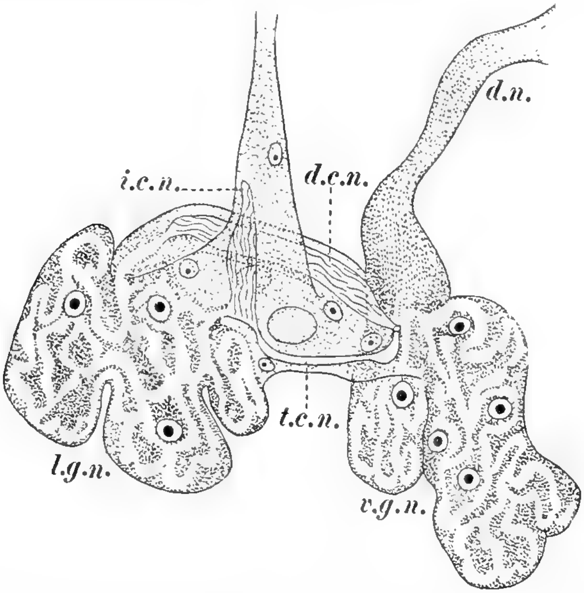

Fig. IV.—Nephridium of the first pair, belonging to the left side, as seen from the interior of the body. Reconstructed from sections. × 1053. For explanation of reference letters see Explanation of Plates.

system of ramifying intracellular spaces or canals, forming a veritable labyrinth. These canals are filled with a pale staining granular substance, probably the precipitate of a fluid.

After sending off its branch to the lateral glandular portion of the nephridium, the inner canal continues backward a short distance, its diameter meanwhile diminishing to ca. 0.5 μ, then bends almost directly downward, widening as it does so, and passes into the transverse canal (text fig. IV, figs. 25*e* and 26*a*, *t.c.n.*). The length of the latter is about the same as that of the inner canal, but its diameter is much less, probably in most cases not exceeding a micron. Owing to its minuteness it is difficult to determine whether it is furnished with cilia or not, but its appearance in fig. 25*e* seems to indicate that it contains at least a single cilium or flagellum. The transverse canal terminates in the antero-lateral portion of the *ventral glandular portion* of the nephridium (text fig. IV, figs. 25*d*, 25*e*, and 26, *v.g.n.*). This body is very similar to the lateral glandular portion, and will therefore require no further description. It lies just above the lateral nerve cord of that side, and posterior to the middle of the second trunk segment, whereas the lateral glandular portion is situated at precisely the middle of the segment.

The transverse canal serves to link together the two glandular portions of the nephridia, but these are further connected by a large ciliated canal, *the diagonal canal* (text fig. IV, figs. 25*b*, 25*c*, and 26, *d.c.n.*), which arises at the anterior end of the lateral glandular portion and passes diagonally backward to the anterior end of the ventral glandular portion. It enters the latter near the termination of the transverse canal; the two canals in fact being connected with one another at this point.

The duct of the nephridium springs from the ventral glandular portion at the point where the latter is connected with the transverse and diagonal canals (text fig. IV, figs. 25*a*-*c*, *d.n.*). The duct is here relatively large, but narrows rapidly as it passes cephalad. A short distance from its point of origin it dips downward and becomes buried in the substance of the body wall laterad of the ventral nerve cords, and is recognizable in sections only as a brownish ovoid area in the hypodermis (fig. 5, *d.n.*). It thus pursues a direction cephalad and slightly mesiad until it reaches the middle of the first trunk segment. Here it bends sharply inward (mesiad), widening considerably at the same time, and opens to the exterior at the postero-lateral border of the mouth (text fig. IV). The duct is similar in structure to that of unicellular glands, such as the salivary gland of *Dinophilus*, and appears to be merely a process of one of the cells of the ventral glandu lar portion, the cell wall covering this process serving as the walls of the duct. This duct, as indicated above, is filled with a brownish excretion.

Embedded within the cytoplasm which surround the diagonal and transverse canals are found greenish refringent bodies (figs. 25*c*, 25*d*, and 26*b*, *r.b.*) of an irregular ovoid shape, and similar in general appearance to those seen in the nephridia of the posterior segments. In the nephridium represented in text fig. IV and figs. 25*c* and 25*d* there are two of these, of nearly the same size. In the nephridium represented in figs. 26*a* and 26*b* there are also two subequal refringent bodies, and in addition a densely staining inclusion.

From the foregoing description it is seen that in the first pair of nephridia of *Dinophilus conklini* we have to do with relatively complex and highly differentiated structures. A contemplation of text fig. IV will show, however, that these nephridia are derived from simple nephridia, of the type termed by Hatschek (1888) "protonephridia," like those of the four succeeding pairs, by a growth and differentiation of their component cells, chiefly at two points, namely, those occupied by the glandular bodies. The blind ciliated anterior end is clearly to be recognized as the inner or central end of the simple nephridium, and the canalar plexuses, with their connecting transverse and oblique canals, as its middle part. Obviously one of these connecting canals is of secondary origin and one of primary, corresponding to the original lumen of the primitive nephridium. The size of the diagonal canal, and the fact that its connection with the lateral glandular portion is some distance removed from the union of the latter with the inner canal, speaks in favor of its being the representative of the primitive lumen; the transverse canal would then have to be considered as a sort of short cut for the products of excretion from both the inner canal and the lateral glandular portion of the nephridium. The terminal duct has also evidently undergone modification in that its external opening has been shifted forward to the edge of the mouth.

The function of the glandular bodies with the contained canalar plexuses can only be guessed at. It is at least certain that it is one not performed by the other nephridia. That this function is truly of a glandular nature is indicated by the fact that the ducts are always filled by a homogeneous substance of a brownish color, much resembling mucus in appearance.

The highly differentiated groups of the *Oligochæta* and *Hirudinea* alone appear to exhibit conditions comparable to those seen in the anterior pair of nephridia of *Dinophilus conklini*. A breaking up of the canal to form a plexus is found in the median portion of the nephridium of the leech (Graf, 1898), and also in the *Enchytræidæ* (Bolsius, 1892) and the *Discodrilidæ* (Moore, 1897). Certain nephridia of some members of the *Naidomorpha, Lumbriculidæ* (Vejdovsky, 1884), and *Tubificidæ* (Stolc, 1888) possess on that part of the nephridium just following the funnel an oval swelling of a brown color, and within which the nephridial lumen forms a network. In the case of *Nais,* however, this swelling appears to consist of but a single cell.

Shearer (1906) has recently made a detailed study of the nephridia of *D. tæniatus.* He finds that in their general form and arrangement they correspond to the description given by Harmer (1889*a*). He adds, however, the important fact that the inner end of each nephridium bears a large number of the curious structures discovered by Goodrich, and called by him "solenocytes" (1898). The cilia of the solenocytes traverse the length of the nephridium, giving it the appearance of being lined with cilia. As to the presence or absence of these structures in the posterior four pairs of nephridia of *D. conklini,* I am not able to decide with the material at hand. It seems, however, quite certain that solenocytes are not present in the nephridia of the first pair. Here the images afforded by my material are quite clear, the finer structure in the most favorable instances being quite well preserved, and affording a good basis for decision. If present at all the solenocytes should be found cephalad of what I have termed the "anterior canal," and within the strand of protoplasm in which this canal runs (see fig. 26*a* and text fig. IV). This portion of the protoplasmic strand, however, appears uniform in structure, and contains nothing which would indicate the presence of solenocytes.

Amœboid Cells.—In many series of sections there appear large cells of irregular form, situated in the cavity of the head and in the body cavity of the neck region, dorsad and laterad to the anterior portion of the œsophagus (figs. 3 and 4, *am.c.*). Their cytoplasm is coarsely granular in appearance, and is frequently seen to contain densely staining inclusions of various shapes and frequently of large size. The nuclei of these cells are vesicular and contain but little chromatin, outside of the large spherical karyosome. In at least one instance a number of these cells were found in an evident state of degeneration, some within the cavity of the head, others buried in its ventral hypodermis. This latter circumstance, together with the varying location of these cells within the limits indicated, and the fact that their shape conforms to the outline of the adjacent tissues, strongly indicates that their nature is amœboid. Their origin is obscure; but their close resemblance in size and staining reaction to many of the cells composing the lateral walls of the ascending limb of the œsophagus, in addition to the fact that, in those individuals in which these amœboid cells occur, they are always found in the neck region in a normal condition, seems to point to the œsophagus as their place of origin.

The function of these cells is somewhat problematical. Their amœboid and phagocyte-like appearance, the frequent occurrence of inclusions, and their degeneration within the ectoderm near the exterior, point strongly to the conclusion that they perform the function of phagocytes. This conclusion attains a considerable degree of probability in the light of the researches of Schaeppi (1894) and Graf (1898) on polychætous annelids and leeches respectively. In representatives of both these groups there are found in the body cavity amœboid cells ("Chlorogogen," "Excretophores"), whose function is to ingest and remove waste matters. Moreover, Graf found that in the leech these cells sometimes degenerated in the epidermis. There seems, therefore, much reason to believe that the amœboid cells in *Dinophilus* are also "excretophores."

6. *Sex Organs.*

Ovary.—The ovary in its position and general structure resembles that of *Dinophilus apatris* and *Dinophilus gyrociliatus,* as described by Korschelt (1882) and Repiachoff (1886) respectively. It lies on the ventral side of the alimentary canal, occupying the concavity formed by the junction of the stomach and intestine, and commonly fills up this space and crowds the intestine towards the dorsal side. The ovary consists essentially of three parts: the oögonia; the oöcytes; and the peritoneal sac enveloping the whole.

The oögonia form a pyriform mass of closely packed cells (fig. 21, *oög.*), its smaller end directed caudad. The apex of the oögonial mass is formed of the younger cells, which are still in a state of multiplication. In fig. 21 a zone of dividing cells is seen extending across this portion of the ovary. Beyond this zone the oögonia may be seen to increase gradually in size toward the anterior end of the oögonial mass, where the oögonia, having completed their growth, become oöcytes. The manner of formation of the large ova which are destined to form the female individuals, by the fusion together of several oögonia, was first noted by Schimkewitsch (1895), and has been more fully described by Conklin (1906) for the form under discussion, and by von Malsen (1906) for *D. apatris,* and will not be dwelt upon here. The cytoplasm of the oögonia is finely granular, and stains more or less densely, doubtless owing to the presence of small yolk granules. The nuclei possess the general character of those of the tissue cells, being vesicular, and containing a large chromatin nucleolus.

The oöcytes, or ovarian eggs, constitute the greater part of the ovary, and form a closely packed mass entirely filling up the remainder of the space below the intestine, which lies close to the dorsal body wall. The oögonial mass is commonly crowded to one side of the oöcytes, thus lying laterad and often somewhat ventrad of the latter. In some cases, indeed, a large oöcyte, apparently full grown, is found in the posterior portion of the ovarian chamber, caudad of the oögonia. The mature female ova are in the neighborhood of 100 μ in diameter, closely approximating that of the body of the parent. The diameter of the ova destined to form males is much smaller, *i.e.*, about 30 μ.

The first maturation division, as least as far as the metaphase, occurs within the ovary, and has been observed by both Conklin (1906) and myself. Von Malsen (1906) states that in one instance only did he find maturation spindles within the ovarian chamber. It is curious to note that in those preparations which showed the karyokinetic figures, all of the mature oöcytes appear to be dividing simultaneously and at the same rate, since all of the spindles were in the same phase, namely, the metaphase. The probable explanation of this phenomenon is that, as in *Ophryotrocha* (Korschelt, 1903), the oöcytes remain at this stage of division until penetrated by the sperm. All of these dividing ova displayed a well-marked peri-vitelline layer, which stains strongly in Meyer's mucicarmine. This layer, however, does not extend completely around the ova, but is seen only on their free surfaces, its formation being in some way prevented by contact with other ova.

The peritoneal investment of the ovary consists of an extremely delicate epithelium which encloses the oögonia and oöcytes as in a bag, and is attached posteriorly to the apex of the pyriform oögonial mass (see figs. 7 and 21, *per.*). From the outer surface of the peritoneum thin strands of protoplasm are here and there given off to the neighboring alimentary canal and body wall. The existence of this epithelial covering was for a long time a matter of much doubt in my mind, and it is only after careful study of sections of the best preserved material that I have arrived at the conclusion stated above. In some cases the peritoneum is well marked and easily demonstrated, as in fig. 7; in others, as in the section represented by fig. 21, the peritoneum is exceedingly tenuous. That it is a true epithelial layer is shown by the presence in it of small nuclei. Von Malsen (1906) also observed this layer, but saw only that portion of it which lies ventrad of the ovary, the dorsal portion being concealed by the close apposition of the ovary and the alimentary canal. For this reason he interprets it as a portion of the splanchnopleure, apparently assuming with Repiachoff (1886) the presence of a continuous peritoneal lining throughout the body cavity. The ovary would then, according to von Malsen, lie *outside* of the cœlom, between the alimentary canal and the peritoneum.

The presence of a definite peritoneal investment surrounding the ovary of *D. conklini* is in accord with the observations of both Harmer (1889*a*) and Schimkewitsch (1895). In the two forms investigated by these authors—*D. tæniatus* and *D. vorticoides*—the gonads consist of long paired sacs, from the walls of which arise the sexual products. These sacs, moreover, in *D. vorticoides*, according to the researches of Schimkewitsch, arise from the paired mesoderm bands. There can, therefore, be little doubt that the gonads with their enclosed cavities, as Meyer (1901) has also pointed out, are homologous with the peritoneum and cœlom of the *Annelida*.

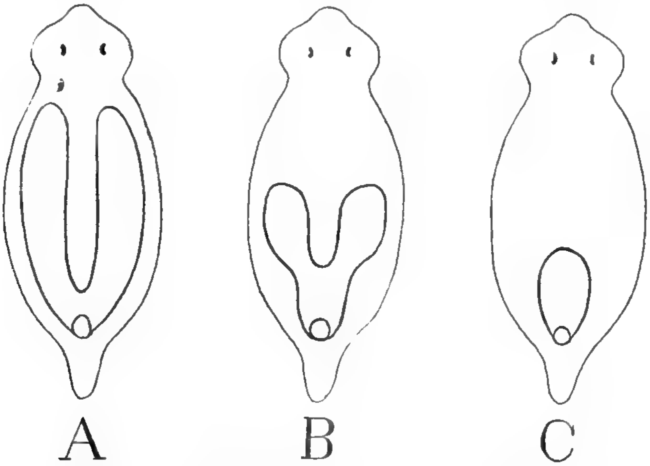

Fig. V.—Diagrams illustrating the reduction of the sex glands in *Dinophilus*, as represented by A, *D. vorticoides* and *tæniatus;* B, *D. gigas;* C, *D. conklini.*

It is evident, however, that, in the light of this interpretation, the cœlom of *D. conklini* is greatly reduced, as compared with those species mentioned above. This reduction becomes more comprehensible when the condition in *D. gigas* is taken into consideration. The sex gland of this species is, according to Weldon (1886), Y-shaped, the unpaired limb lying posterior, the two anterior limbs extending forward a short distance under the hinder portion of the stomach. Weldon describes no peritoneal investment of the sex glands, it is true, but this might easily have been overlooked, inasmuch as it is probably very thin. Indeed, in the anterior portion of the testes of *D. metameroides*, Schimkewitsch (1895) states that the peritoneum becomes reduced to a mere *membrana propria*. For this reason, and because of the occurrence of a peritoneum enclosing the sex products in at least two other species, it is not unwarrantable, to say the least, to assume its presence in *D. gigas*. The condition obtaining in this species would then be almost precisely intermediate between that found in *D. vorticoides* and *tæniatus*, on the one hand, and *D. conklini* (and probably also *apatris* and *gyrociliatus*) on the other. In other words, there has been within the *Dinophilidæ* a progressive reduction in the shape and extent of the sex glands, and also of the cœlom, represented by the cavity within them; this reduction beginning at their anterior ends, and its stages exemplified by the three species named. These are represented diagrammatically by text figs. V, A, B, and C. In the first stage, (A), represented by *D. vorticoides* and *tæniatus*, the sex glands are paired, extend throughout the greater portion of the trunk, and are united only at their posterior ends. In the second, (B), represented by *D. gigas*, the paired portions are much shortened, while the unpaired median part, which joins the former, has increased somewhat in length. In the third and last stage, represented by *D. conklini*, the lateral paired portions have disappeared altogether, leaving only the posterior unpaired part. That the paired condition, represented in A, is probably the more primitive one need scarcely be pointed out; the unpaired is therefore specialized. It is also to be noted in this connection that those species possessing the unpaired sex gland are also sexually dimorphic.

In *D. vorticoides, tæniatus*, and *gigas* the reproductive cells appear to be produced directly from the wall of the sex glands (cœlomic epithelium) by transformation of its cells. Moreover, the production of germ cells appears not to be definitely localized, but to take place throughout the length of the glands. The condition in *D. conklini* is evidently quite different. Here a circumscribed portion of the cœlomic epithelium is, as in the higher *Vermes*, differentiated to form a well-defined gonad, in the shape of the pyriform mass of oögonia.

Korschelt (1882) was of the opinion that the germ cells arose in the walls of the alimentary canal. Von Malsen (1906) has recently thought to have found confirmation of this view and has described and figured the germ cells as arising in the ventral wall of the stomach, and migrating thence by amœboid movement into the oögonial mass at some distance from its posterior end. This is certainly an error and, I believe, based on defective fixation. Von Malsen states that in his studies on the oögenesis of *Dinophilus* he relied chiefly on sections made from material fixed in Kleinenberg's picro-sulphuric. This fixative, as I have already stated in the section on technique, is unreliable, at least for the study of the morphology of *Dinophilus conklini.* Sections made from material fixed in this fluid yield images which could easily lead one to believe in a close connection between the ovary and the alimentary canal, and at the outset I was myself inclined to such a view. Better preserved material, however, has demonstrated conclusively that no such close connection exists. Moreover, in *D. conklini* the oögonial mass is commonly separated from the alimentary canal by the large oöcytes, thus effectively barring any communication between the oögonia and the alimentary canal.

A median generative pore—sperm duct or oviduct—situated on the ventral side, near the posterior end of the body, has been seen in three species of *Dinophilus,* namely, *D. vorticoides* (Schimkewitsch, 1895), *D. tæniatus* (Harmer, 1889*a*), and *D. apatris* (Korschelt, 1882). In the last-named species the oviduct was seen during life, but was not found in preserved material. It is with regret I confess that so far I have been unable to demonstrate an oviduct in *D. conklini,* although a careful search for it has been made. That it exists there is scarcely the slightest doubt. Weldon (1886) was also unable to discover the genital opening in *D. gigas,* and has assumed that a rupture of the body wall occurs on the maturing of the genital products, allowing the latter to escape; this occurrence being accompanied by the degeneration and death of the animals. Whether this be true of *D. gigas* or not, it is probably not true of *D. conklini*—although this species, as does *D. gigas,* rather suddenly disappears on the arrival of warm weather—since von Malsen (1906) has shown that in *D. apatris,* a species very similar to *D. conklini,* the egg-laying period is one of considerable extent.

7. *Discussion and Conclusions.*

Metamerism.—In *Dinophilus conklini,* as in other members of the group, there is a distinct and well-marked metamerism. This is expressed by the body wall in its external divisions, its ciliated rings, and its mucous glands; by the nervous system in its pairs of trunk ganglia, and by the nephridia in their arrangement in five pairs. The metamerism is that of the annelids, and expressed in the same terms, but with an important exception: in *Dinophilus* it is apparently not manifested in the sex organs, the homologues of those organs and tissues which are, in the annelids, the products of the mesoderm bands.

The number of segments, as indicated by the body wall in its external divisions and ciliated rings, does not agree with that indicated by the other metamerically arranged parts. The former—the trunk segments as delimited by constrictions and their ciliated bands—indicate six trunk segments, while the latter, namely, the mucous glands, the nerve ganglia and the nephridia, testify to only five. Examination of text fig. III and fig. 1 will show that the segment not represented by ganglia or mucous glands is the first postoral. It may be added that this segment is also not represented by the nephridia, since, although the first pair of nephridia do actually extend into this segment, the greater part of these organs lie in the segment following, and obviously belong to the latter. That division of the trunk, then, immediately following the neck and bearing the first band of cilia is evidently not a true metamere, but is to be interpreted as a minor annulus, a subdivision of a metamere having occurred, as in all leeches and in some *Oligochæta* and *Polychæta*. The next succeeding annulus, the second, is clearly the corresponding major annulus, and the two together compose the first trunk metamere. The development of an additional annulus in this region is probably to be traced to the demand for greater room on the part of those structures which lie within the first trunk metamere, namely, the proboscis, a relatively large organ, the first pair of nephridia and the first pair of trunk ganglia; the two latter much exceeding in size those of the succeeding segments.

Five trunk metameres are also present in *D. tæniatus* (Harmer, 1889*a*) and in *D. vorticoides* (Schimkewitsch, 1895), as indicated by the number of the trunk ganglia and of the nephridia. Meyer (1886) shows five pairs of nephridia also in his figure of *D. gyrociliatus*; the number of trunk ganglia, is, however, unknown, since the nervous system of this species has so far not been carefully investigated. This species (*gyrociliatus*), as judged by Meyer's figure, displays a condition precisely similar to that obtaining in *D. conklini*, since there apperas to be present six trunk segments, in the second of which the first pair of nephridia are situated. The first trunk metamere is therefore evidently also composed of two annuli, of which the posterior is the major. In *D. vorticoides* (Schimkewitsch, 1895) one of the trunk metameres appears also to have been subdivided into annuli, since the trunk bears twelve double rings of cilia. As to the particular metamere which has subdivided, it is impossible to conclude from Schimkewitsch's figures.

although it seems probable that it is one of those in the posterior part of the body. From the evidence at hand it is seen that four of the nine species of *Dinophilus* are composed of six segments (metameres), counting the head, and this raises the question as to whether this number is characteristic of the group; the answer to which must necessarily be found in further research.

Cephalization.—Among the evidences of specialization exhibited by *Dinophilus conklini* is a well-defined tendency to cephalization on the part of the nervous system and the nephridia. A glance at fig. 1 will serve to show that this is true of the nervous system, especially as regards the number of nerve cells. That a like tendency is exhibited by the nephridia also will be plain on considering the great size and complexity of the first pair of nephridia as compared with the succeeding four.

Relationships.—The systematic position and affinities of *Dinophilus* have been long debated, and is a question concerning which every one who has investigated this form has expressed an opinion. In a previous paper on the embryology of *Dinophilus* (1904*a*), I have given a brief historical sketch of the various views expressed by different authors on this subject, so it need only to be referred to here. Broadly speaking, these views may be divided into three classes, according as they regard *Dinophilus* as most nearly related to the *Turbellaria*, to the *Rotatoria*, or to the *Annelida*.

In respect to the morphological evidence on which the first of these views is based, Lang (1884) has summed this up so concisely and completely that I cannot do better than to quote his words in full:

"I believe that Korschelt[5] is on the wrong track; there are no *Turbellaria* with an anus, none with ciliated rings. The pharanx of *Dinophilus* has nothing in common with the pharanx of the *Turbellaria*. None of the *Turbellaria* have a straight alimentary canal so much differentiated. The sex organs are constructed differently in the two groups; in the *Turbellaria* complicated ducts are always present. The sexual dimorphism removes *Dinophilus* from the *Turbellaria*, as well as the well-developed body cavity. I do not believe that, as Korschelt supposes, the ova arise from the epithelium of the alimentary canal. They indeed lie in the body cavity close to the alimentary canal, but I am strongly of the opinion that a fine endothelium is here present, from which they develop. Everyone knows how difficult

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[5] Lang here refers to Korschelt's earlier view (1882). Korschelt has since expressed the opinion that *Dinophilus* is closely allied to the annelids

endothelium is to recognize. The distinction between *Dinophilus* and the *Turbellaria* is much greater, if it is compared to the larvæ of the latter. Yet the resemblance should be greater if, as Korschelt supposes, *Dinophilus* be a primitive Turbellarian form.''

The weight of the evidence furnished by our present knowledge of the morphology and embryology of the annelids, as well as that of *Dinophilus*, is, I think, heavily in favor of a close relationship of the latter with the annelids. There is scarcely a character in the structure of *Dinophilus* which is not held in common with some member of that group. The general external form, including the distribution of the cilia and the caudal appendage, are found in several annelid larvæ, such as *Harpochæta* (Korschelt, 1893); the ciliated rings may persist to maturity, as in *Ophyrotrocha* (Korschelt, 1893) and *Nerilla* (Pereyaslawzewa, 1896), as well as in *Protodrilus* (Hatschek, 1880). The metamerism is also like that of the annelids, expressed by the same organs—with the exception of those arising from the mesoderm bands—and developed in the same manner, as the investigations of Schimkewitsch (1895) and myself (1904*a*) have shown. The nephridia are precisely like those seen in many annelid larvæ. Moreover, Shearer (1906) has recently found that the nephridia of *D. tæniatus* possess the curious structures termed by Goodrich (1898) "solenocytes," and found by him characteristic of many members of the *Polychæta*. The type of the nervous system of *Dinophilus* is unquestionably the embryonic annelid type; even its distinctive features, such as its epithelial position and the wide separation of the two halves of the ventral cord, are found not only in larval stages, but also in adult stages of several members of the *Annelida*. The preoral commissure of *D. conklini* can also, I think, only be satisfactorily explained by deriving it from the nerve ring of the trochophore larva. The alimentary canal is, in its main features, strictly comparable to that of the annelids; while the proboscis, in its general structure, is like that of many *Polychæta*, as, for example, the *Eunicidæ* (Lang, 1891).

A possible relationship with the *Rotatoria* has been pointed out by several investigators; of these probably Schimkewitsch (1895) has stated the case for the rotifers most clearly. After a very fair presentation of the claims of *Dinophilus* to a place among the annelids, he says:

''Ohne Zweifel sind auch einige Züge vorhanden, die *Dinophilus* mit den Rotatorien verbinden: die furchung des Eies, die Anwesenheit des Schwanzanhanges, der mit dem Fusse der Rotatorien übereinstimmt, der geschlechtliche Dimorphismus: man muss auch gestehen, dass im Baue des Nervensystems und der Hauptmusculatur der Rotatorien die Tendenz zur Erwerbung der Metamerie bemerkt werden kann: bei *Dinophilus* aber erstreckt sich diese Tendenz auch auf das Mesoderm und die Excretionsorgane. Auch bei den Rotatorien erscheinen, wie bei *Dinophilus* die Genitalhöhlen als einzige Homologa des Cöeloms."

According to this view the metamerism, as well as many other annelidan features, would have to be regarded as having arisen independently. From this standpoint *Dinophilus* would, so far as its resemblance to annelids is concerned, be a good example of convergence. In regard to the points of resemblance which Schimkewitsch has pointed out: the segmentation of the egg has been shown to be strictly annelidan in its type. The caudal appendage of *Dinophilus* much more closely resembles that of some polytrochal annelid larvæ than the foot of the *Rotatoria*. The sexual dimorphism quite clearly arose within the group, and is one which is found in other groups than the rotifers. The condition of the sex organs in the less specialized members of the *Dinophilidæ* (*e.g.*, *D. vorticoides*) Meyer (1901) regards as representative of the primitive condition of the cœlomesoblast in the annelids, and one which is quite different from that found in rotifers, since the unpaired condition found in *D. conklini* is evidently a derived one. Moreover, the opinion is widely held that the *Rotatoria* constitute a highly specialized group of somewhat uncertain affinities, since much doubt has been thrown on its formerly assumed close relation to the trochophore. In short, when the various morphological characters can be duplicated within the annelids, or accounted for by derivation from that ancient and primitive group, it seems superfluous to suppose that they have arisen independently, and to derive *Dinophilus* from such a comparatively specialized group as the *Rotatoria*.

Dinophilus has also been often compared to the trochophore larva of annelids, but this comparison is somewhat inexact, if the term trochophore is employed in the strictest sense. The resemblance is rather to that intermediate stage in the metamorphosis represented by some larvæ of the polytrochal type. The head of *Dinophilus* is, for example, in no way comparable to the inflated cephalic vesicle of the typical trochophore; the trunk with its various organs is distinctly metameric, and therefore to be compared with the trunk of the worm. On the other hand, such features as the ciliated bands, particularly those preoral in position, the ventral ciliated tract, and the preoral commissure, have obviously been derived from the trochophore stage. On the whole, *Dinophilus* can best be considered as a very young polychæte worm, retaining some of its larval features, with setæ and parapodia undeveloped, and whose peritoneum and cœlom have been transformed into a generative organ.

8. *Summary.*

External Form.—The head of the female (text fig. I) is bluntly conical in front and tapers rapidly behind to a well-defined neck. A pair of red kidney-shaped eyes are borne on the dorsal surface of the head. On its anterior surface are two long sense hairs, symmetrically placed, and a number of smaller ones. A group of small sense hairs is also present on its dorsal surface. The body is cigar-shaped, and divided by constrictions into six segments, each of which bears a single band of cilia. A circumanal band of cilia is also present, but is interrupted on the dorsal surface. The head bears two rings of cilia, one in front of the eyes, and one behind them, the latter band encircling the head at its greatest diameter. Both of these bands are interrupted by a dorsal gap. The anterior cephalic bands bend backward between the eyes. On each side of the head, behind the second cephalic ring, is a shallow ciliated groove which runs ventrad to the lateral borders of the mouth. A strip of cilia clothes the ventral surface of the animal from the anterior tip of the head to the end of the caudal appendage. The males (text fig. II) are minute in size, short cylindrical in form, and slightly constricted in the middle. A circular band of cilia is borne at the anterior end, and a ciliated strip covers the ventral surface. A conical penis is found near the posterior end of the body.

Body Wall.—The body wall is composed of a one-layered hypodermis, covered on the exterior by a thin cuticle. It is thin in the intersegmental regions, thick in the intrasegmental. A ventral thickened area extends the entire length of the animal.

Gland Cells.—The body wall contains glands of three types. The glands of the first type are mucous in character, scarce, and confined to the ventral surface. Those of the second are also mucous glands, long-pyriform in shape, metameric and symmetrical in their distribution, and fairly constant in number (text fig. III). The glands of the third type are non-mucous, very long-pyriform in shape, and found principally near the middle of the trunk segments, and on the head.

Muscles.—The muscles comprise two sets, longitudinal and transverse. The former are divided into three pairs. One pair lies close together on the ventral side of the trunk, and traverses the latter from the anus to the posterior side of the mouth. The second pair are ventro-lateral in position and run from the anus to the anterior portion of the head, penetrating the brain in their course. The third pair is dorso-lateral in position and also runs from the anus to the head. Fibres from the second pair (ventro-lateral muscles) meet and cross in the head cavity. The second set of muscles comprises muscle fibres which traverse the head cavity in a dorso-ventral direction, from side to side, and also obliquely.

NERVOUS SYSTEM.—*Central Nervous System.*—The central nervous system (fig. 1) includes a simple brain, in close contact with the hypodermis, circumœsophageal connectives, and a pair of ventral nerve cords. The latter traverse the whole length of the trunk and are throughout embedded in the hypodermis. They are connected by transverse commissures, three being present in the second trunk segment, and two in each of the three following. A preoral transverse commissure is also present, which appears to be the homologue of the ventral portion of the nerve-ring of the trochophore larva of the annelids. Ganglion cells are present, also embedded in the hypodermis, and arranged to form four well-defined pairs of ganglia. A fifth is possibly indicated. Large nerve-trunks are given off from the circumœsophageal commissure to the œsophagus and the ventro-lateral muscles.

Sense Organs.—The eyes consist each of a bilobed lens and a pigment cup. The inner end of the latter is buried in the outer surface of the brain. The large sense hairs on the anterior surface of the head are connected with the brain by sensory neurons. Problematical sense organs are found on the sides of the neck.

ALIMENTARY CANAL.—The mouth is triradiate and is situated on the ventral side of the head. It opens into an œsophagus which passes upward, then backward for a short distance, to empty into a capacious stomach which fills the body cavity in the third and fourth trunk segments. Near the anterior border of the fifth trunk segment the stomach joins the intestine, which passes in an almost straight course to the anus. The latter is situated dorsad of the caudal appendage. The alimentary canal is lined throughout with long cilia. The œsophagus is provided with a large proboscis (fig. 23, *pro.*). The latter is in shape ovoid, flattened dorso-ventrally, and is situated just within the mouth, in an involution of the posterior wall of the ascending limb of the œsophagus, and is attached to the œsophageal wall at the bottom of the involution. The proboscis is made up of flat cells arranged like coins in a pile, and separated by chitonized partitions. On each side of every partition is a layer of muscular fibres. The function of the latter appears to be that of elongating the proboscis. This organ is moreover provided with a set of extrinsic muscles.

Glands.—The œsophagus is provided with so-called salivary glands, which consist of two sets of unicellular glands, one on each side of the œsophagus. The ducts from these glands pass forward separately to empty into the anterior part of the œsophagus. Unicellular digestive glands are found in the walls of the stomach. In the dorsal part of the cavity of the head there are two groups of large pyriform glands, which send down slender ducts to the ventral surface of the head. The function of these glands is unknown.

EXCRETORY ORGANS.—*Nephridia.*—Five pairs of nephridia are present. The nephridia belonging to the posterior four pairs are simple tubes of delicate structure, with a blind inner end. The anterior pair are relatively large and complex organs (text fig. IV), consisting of an anterior canal, representing the blind inner end of the simple type of nephridium; two large glandular bodies, connected with transverse and diagonal canals, and a long duct opening on the posterior border of the mouth.

Amœboid Cells.—Large amœboid cells are found in the anterior part of the body cavity, and also in the head cavity. Their function is probably phagocytic.

SEX ORGANS.—*Ovary.*—The ovary lies on the ventral side of the alimentary canal, in the angle formed by the junction of the stomach and intestine. It consists essentially of a very thin peritoneal sac, to the posterior portion of which is attached a pyriform mass of oögonia, forming a gonad, which lies inside of the sac. The peritoneal sac is usually distended with ova, some of which were seen undergoing the first maturation division. No oviduct was found.

CONCLUSIONS.—*Metamerism.*—A well-marked metamerism is present, expressed by the body wall and its mucous glands, the nephridia, and the nervous system. The presence of five trunk metameres is indicated, the most anterior of which is subdivided into two annuli.

Cephalization.—A marked tendency to cephalization is shown by the nephridia and the nervous system.

Relationships.—The morphological evidence indicates close affinities with the chaetopod annelids.

LITERATURE LIST.

BENEDEN, J. P. VAN. 1851. Notice sur un nouveau Némertien de la côte d'Ostende. *Bull. acad. roy. Belge*, XVIII, 1.

——. 1861. Recherches sur la faune littorale de Belgique. *Mém. acad. roy. Belge*, XXXII.

BOLSIUS, H. 1892–3. Notice sur l'anatomie de l'organe segmentaire d'Enchytræides. *Anat. Anz.*, VIII, pp. 210–215.

BRACE, EDITH M. 1901. Notes on the Nervous System of Ælosoma. *Journ. Morph.*, XVII, 2.

Brasil, L. 1904. Contribution a la connaissance de l'appareil digestif des Annelides polychètes. L'épithélium intestinal de la pectinaire. *Arch. zool. exp.*, IV, 2.

Child, C. M. 1900. The Early Development of Arenicola and Sternaspis. *Arch. Entw.-Mech.*, IV, 9.

Conklin. E. G. 1902. Karyokinesis and Cytokinesis in the Maturation, Fertilization, and Cleavage of Crepidula and other Gasteropods. *Journ. Acad. Nat. Sci. Philadelphia*, 2d ser., XII, 1.

——. 1906. Sex Differentiation in Dinophilus. *Science*, N. S., XXIV, p. 294

Diesing, C. 1850. Systema Helminthorum. *Vindobonæ.*

——. 1862. Revision der Turbellarien. *Sitzungsb. Kais. Acad. Wiss. Wien*, XLV, 1.

Foettinger, A. 1884. Recherches sur l'organisation de Histriobdella homari, P. J. van Beneden, rapportée aux Archiannélides. *Arch. de Biol.*, V.

Fraipont, J. 1884. Le systeme nerveux . . . . des Archiannélides. *Arch. de Biol.*, V.

Goodrich, E. S. 1897–8. Notes on the Anatomy of Sternaspis. *Quart. Journ. Micr. Sci.*, XL.

——.1897–8*a*. On the Nephridia of the Polychæta. Part I. On Hesione, Tyrrhena, Nepthys. *Quart. Journ. Micr. Sci.*, XL.

——. 1898–9. On the Nephridia of the Polychæta. Part II. Glycera and Goniada. *Quart. Journ. Micr. Sci.*, XLI.

——. 1901. On the Structure and Affinities of Saccocirrus. *Quart. Journ. Micr. Sci.*, XLIV.

Graf, Arnold. 1898. Hirudineenstudieren. *Nova Acta Acad. Leop. Car.*, LXXII.

Graff, Ludwig von. 1877. Das Genus Myzostoma. *Leipsig.*

——. 1882. Monographie der Turbellarien. *Leipsig.*

Hallez, P. 1878. Contributions à l'histoire des Turbellariés. *Bull. Scient. departm. du Nord*, 2d ser., I.

——. 1879. Contributions à l'histoire naturelle des Turbellariés. *Trav. Inst. zool. Lille*, II.

Harmer, S. F. 1889. On a New Species of Dinophilus. *Proc. Cambridge Phil. Soc.*, VI.

——. 1889*a*. Notes on the Anatomy of Dinophilus. *Journ. Marine Biol. Assn. United Kingdom*, I, 2.

Haswell, Wm. A. 1900. On a New Histriobdellid. *Quart. Journ. Micr. Sci.*, XLIII.

Hatschek, B. 1878. Studien über Entwicklungsgeschichte der Anneliden, *Arb. zool. Inst. Wien*, I.

——. 1880. Protodrilus Leuckartii. Ein neue Gattung der Archianneliden. *Arb. zool. Inst. Wien*, III.

——. 1888–91. Lehrbuch der Zoologie. *Jena.*

Jensen. 1878. Turbellaria ad litora Norvegiæ occidentalia. *Bergen.*

Kleinenberg, Nicholas. 1886. Die Entstehung des Annelids aus der Larve von Lopadorhynchus, nebst Bemerkungen über die Entwicklung anderer Polychæten. *Zeit. f. wiss. Zool.*, XLIV.

Korschelt, Eugen. 1882. Ueber Bau und Entwicklung des Dinophilus apatris. *Zeit. f. wiss. Zool.*, XXXVII.

——. 1887. Die Gattung Dinophilus und der bei ihr auftretende Geschlechtsdimorphismus. *Zool. Jahrb.*, II, 3–4.

——. 1893. Ophryotrocha puerilis Clap.-Metschn. und die polytrochen Larven eines anderen Anneliden (Harpochæta cingulata nov. gen., nov. spec.). *Zeit. f. wiss. Zool.*, LVII, 2.

Korschelt, E., und Heider, K. 1903. Lehrbuch der vergleichenden Entwicklungsgeschichte der wirbellosen Thiere. Allgemeiner Theil. *Jena.*

Lang, Arnold. 1884. Die Polycladen. *Fauna und Flora des Golfes von Neapel.* XI, pp. 678–9.

——. 1891. Text-Book of Comparative Anatomy. English Translation by H. M., and Mathilda Bernard. *New York.*

Levinson, G. N. R. 1879. Bidrag til Kundskab on Grönlands Turbellarienfauna. *Vidensk Meddel. fra den naturh. Foren in Kjöbenhavn.*

MacIntosh, W. C. 1885. Report on the Annelida Polychæta collected by H. M. S. "Challenger" during the years 1873–76. *Challenger Reports*, XXXIV.

Malaquin, A. 1893. Recherches sur les Syllidiens. *Lille.*

Malsen, Hans Freiherr von. 1906. Geschlechtsbestimmende Einflüsse und Eibildung bei Dinophilus apatris. *Archiv. f. micr. Anat.*, LIX, 1.

Mead, A. D. 1897. The Early Development of Marine Annelids. *Journ. Morph.*, XIII, 2.

Mereschkowsky, C. 1879. Ueber einige Turbellarien des Weissen Meeres. *Archiv. Naturg.*, XLV, 1.

Meyer, Eduard. 1886–7. Studien über den Korperbau der Anneliden. *Mitth. zool. Stat. Neapel.*, VII.

——. 1901. Studien über den Korperbau der Anneliden. V. Das Mesoderm der Ringelwurmer. *Mitth. zool. Stat. Neapel.*, XIV.

Moore, Anne. 1899. Dinophilus gardneri (sp. nov.). *Biol. Bull.*, I.

Moore, J. Percy. 1897. On the Structure of the Discodrilid Nephridium. *Journ. Morph.*, XIII, 3.

Nelson, Jas. A. 1904. The Early Development of Dinophilus as Compared with that of the Annelids. *Amer. Nat.*, XXXVIII.

——. 1904*a*. The Early Development of Dinophilus: a Study in Cell-Lineage. *Proc. Acad. Nat. Sci. Philadelphia*, LVI, 3.

——. 1906. The Nervous System and Nephridia of Dinophilus. *Science*, N. S., XXIV, p. 298.

Oersted, A. S. 1843. Forsøg til en ny Classification af Planarierne (Planaria Dugès.) grundet paa Mikroskopiskanatomiske Undersøgelser. *Krøner Nat. Tidssk.*, IV.

Pereyaslawzewa, Sophie. 1896. Mémoire sur l'organisation de la Nerilla anténnata O. Schmidt. *Ann. Sci. Nat.*, Ser. 8, 1.

Prowazek, S. 1900. Zur Entwicklungsgeschichte des Wurmes Dinophilus apatris. *Naturw. Wochenschr.*, XV.

Quatrefages, A. de. 1851. Sur le nouveau Némertien de la cote d'Ostende, genre Dinophilus. *Bull. acad. roy. Belge*, XVIII.

Repiachoff, W. 1886. Zur Anatomie und Entwicklungsgeschichte des Dinophilus gyrociliatus O. Schmidt. (Russian.) *Zapiski Nowoross. Obschestwa*, etc., X, 1. *Odessa.*

Schaeppi, Th. 1894. Die Chlorogogen von Ophelia radiata. *Jena Zeit. f. Naturw.*, XXVIII.

Schimkewitsch, W. 1895. Zur Kenntniss des Baues und Entwicklung des Dinophilus vom Weissem Meere. *Zeit. f. wiss. Zool.*, LIX, 1.

Schmarda, L. K. 1861. Neue wirbellose Thiere, beobachtet und gesammelt auf einer Reise um die Erde. *Leipsig.*

Schmidt, Oscar. 1848. Neue Beiträge zur Naturgeschichte der Würmer. *Jena.*

——. 1857. Zur Kenntniss der Turbellaria rhabdocoela und einige andere Würmer des Mittelmeeres. *Sitzungsb. Akad. Wiss. Math.-Naturw. Klasse, Wien*, XXIII.

Schultze, Max. 1849. Ueber die Microstomeen, eine Familie der Turbellarien. *Arch. Naturg.*, XV, 1.

——. 1851. Beiträge zur Naturgeschichte der Turbellarien. *Greifswald.*

Schultz, Eugen. 1902. Dinophilus rostratus nov. spec. *Wiss. Meeresunters.*, V.

Shearer, Cresswell. 1906. On the Structure of the Nephridia of Dinophilus. *Quart. Journ. Micr. Sci.*, L, 4.

Spengel, J. W. 1881. Oligognathus bonelliæ, eine schmarotzende Eunicie. *Mitth. zool. Stat. Neapel.*, III, 15.

Stolc, A. 1888. Monografie Ceskych Tubificidů. *Abh. Böhm. Ges.*, VII, 2.

Vejdovsky, F. 1884. System und Morphologie der Oligochæten. *Prag.*

Verrill, A. E. 1892. Dinophilidæ of New England. *Trans. Connecticut Acad. Arts and Sci.*, VIII.

Weldon, W. F. R. 1886. On Dinophilus gigas. *Quart. Journ. Micr. Sci.*, XXVII.

Wistinghausen, C. von. 1891. Untersuchungen über die Entwicklung von Nereis Dumerilli. *Mitth. zool. Stat. Neapel.*, X.

EXPLANATION OF PLATES XII AND XIII.

The figures have been drawn by the aid of the camera lucida at the level of the table, under Zeiss homo. imm. $\frac{1}{12}$, using the oculars 2 and 4 of Zeiss, and 3 and 5 of Leitz. The magnification, in diameters, of each of these combinations was determined, and the particular magnification employed in each figure is indicated after the description of that figure.

REFERENCE LETTERS.

am.c., amœboid cell.
br., brain.
br.com., transverse commissure of brain.
c.com., circumœsophageal commissure.
c.e.n., central (anterior) end of nephridium.
c.g., cilia of ciliated groove.
c.gl., cephalic gland.
c.gl.d., duct of cephalic gland.
c.r. 1–9, 1st to 9th ciliated rings.
cut., cuticle.
d.c.n., diagonal canal of nephridium of 1st pair.
d.l.m., dorso-lateral longitudinal muscle.
d.n., duct of nephridium of 1st pair.
d.v.m., dorso-ventral muscle of head.
e., eye.
g.c., ganglion cells.
g.gl., gastric gland.
g. 2–5, ganglia of the 2d to the 5th trunk segments.
gl. 1–3, hypodermal glands of the 1st to the 3d type.
hyp., hypodermis.
i.c.n., inner (anterior) canal of nephridium of 1st pair.
i.l., inner lip.
int., intestine.
int.m., muscle encircling terminal portion of intestine—sphincter ani.
l., lens of eye.
l.g.n., lateral glandular portion of nephridium of 1st pair.
l.m.c., transverse muscles of head.
l.m.f., longitudinal muscle fibres.
l.m.i., insertion of longitudinal muscles.
l.n., lateral nerve cord.
m., mouth.
mes., mesenchymatous tissue.
m.n., nerve to ventro-lateral longitudinal muscle.
n., nucleus.
n.f., nerve fibres.
np., neuropil.
œs., œsophagus.
œs.m., œsophageal muscles.
œs.n., œsophageal nerve.
o.l., outer lip.
ooc., oöcytes.
oog., oögonia.
p.c., pigment of eye.
per., peritoneum.
pr.com., preoral commissure.
pro. 1, anterior epithelial portion of proboscis.
pro. 2, posterior muscular portion of proboscis.
pro.f., flexor of proboscis.
pro.l., levator of proboscis.
pro.pr., protractor of proboscis.
pro.r., retractor of proboscis.
r.b., refringent body.
s.gl., salivary glands.
s.gl.d., duct of salivary glands.
st., stomach.
st.w., stomach wall.
t.c.n., transverse canal of nephridium of 1st pair.
t.cil., tactile cilia.
t.com., transverse commissure.
v.g.n., ventral glandular portion of nephridium of 1st pair.
v.l.m. 1, median ventral longitudinal muscle.
v.l.m. 2, ventro-lateral longitudinal muscle.

PLATE XII, Fig. 1.—The nervous system, slightly schematized, and represented as seen from the dorsal side. Reconstructed from a series of 102 sections of a single individual. The outlines of the body, the mouth, and the ciliated bands are also represented. × 450.

Fig. 2.—Cross section through the brain, showing the neuropil, ganglion cells, and eyes. × 665.

Fig. 3.—Cross section through the anterior portion of the mouth, showing the openings of the ducts of the salivary glands, the œsophageal muscles, the œsophageal nerves, and the longitudinal muscles. × 665.

Fig. 4.—Cross section through the posterior portion of the mouth, showing the œsophagus, the proboscis, and the ducts of the salivary glands. × 665.

Fig. 5.—Cross section through the trunk, just posterior to the mouth, showing the salivary glands, the muscle-nerves, besides the features represented in the preceding figure. × 665.

Fig. 6.—Cross section through the trunk, taken at the level of the 3d trunk segment, showing the stomach, the longitudinal muscles, and the lateral nerve cords. × 665.

Fig. 7.—Cross section through the posterior portion of the trunk, at the level of the anterior half of the 6th trunk segment, showing the intestine, the ovary, and the peritoneum enveloping it. × 665.

Fig. 8.—Cross section through the posterior end of the trunk, just anterior to the anus, showing the hypodermal glands on the dorsal side, and the intestine with a sphincter muscle encircling it. × 665.

Fig. 9.—Cross section through the ventral hypodermis in the posterior portion of the 3d trunk segment, and passing through the posterior commissure of that segment. Ganglion cells and a portion of a nephridium are also shown. × 665.

Fig. 10.—The eye, from a coronal section, showing the bilobed lens, the pigment cup, and the adjacent ganglion cells of the brain. Flemming's fluid. × 1115.

Fig. 11.—Problematical sense organ, also insertion of the œsophageal muscles on the hypodermis. Corrosive-acetic. × 1115.

Fig. 12.—Portion of a coronal section through the head, showing one of the two tufts of tactile cilia borne on the anterior surface of the latter, and the connection of the cilia-bearing cells with the ganglion cells of the brain. Flemming's fluid. × 1115.

Fig. 13.—Two muscle fibres from one of the diagonal muscles of the head, showing the nucleus and cell body attached to the fibres. × 1115.

Fig. 14.—Section through a portion of the ventral hypodermis, showing ciliated and non-ciliated cells, the cuticle, and also the median ventral longitudinal muscle fibres. Flemming's fluid. × 1115.

Figs. 15–17. Hypodermal glands of the first, second and third types, respectively. × 1115.

Fig. 18.—Four glands from the dorsal hypodermis of the posterior end of the trunk. Three of them are non-mucous glands (*gl.* 3.); the remaining one (*gl.* 2.) contains mucus. × 1115.

PLATE XIII, Fig. 19.—Coronal section through head, showing the brain and the insertion of the longitudinal muscles. × 665.

Fig. 20.—Coronal section through head, taken at a lower level than the figure preceding, showing the transverse commissure of the brain, the orign of the circumœsophageal commissures, and the preoral commissure. × 665.

Fig. 21.—Ovary, from a sagittal section. The ventral hypodermis is also represented, as well as the outlines of the stomach and intestinal walls. × 665.

Fig. 22.—Cephalic gland, drawn from two sagittal sections. The outlines of the neuropil, of ganglion cells, and of a hypodermal cell are also indicated. Flemming's fluid. × 665.

Fig. 23.—Sagittal section through the head and anterior portion of the trunk, showing the brain, the preoral transverse commissure, the mouth, the œsophagus, the proboscis, and muscle insertions. × 665.

Fig. 24.—Portion of the lateral body-wall of the 3d trunk segment, showing the inner end of the right member of the second pair of nephridia. Corrosive-acetic. × 1115.

Fig. 25*a–e*.—Five consecutive cross sections through the left nephridium of the first pair; fig. 25*a* being the most anterior of the series. Corrosive-acetic. × 1115.

Figs. 26*a–b*.—Two consecutive coronal sections through one of the nephridia of the first pair; fig. 26*a* lying uppermost. Corrosive-acetic. × 1115.

Fig. 27.—Three cells of the ciliated band of the first trunk segment, from a tangential section. Flemming's fluid. × 1115.

Fig. 28.—The second cephalic ciliated band and the ciliated groove, from a tangential section. × 1115.

Fig. 29.—The ventral hypodermis, showing ciliated and non-ciliated cells, from a horizontal section. × 665.

Fig. 30.—Cross section through the proboscis, showing two layers of the intrinsic muscle fibres. Flemming's fluid. × 665.

Figs. 31 and 32.—Degenerating cells of the œsophageal wall. Corrosive-acetic. × 1115.

Fig. 33.—A spherical body with its accompanying nucleus, from the stomach wall. Corrosive-acetic. × 1115.

Fig. 34.—Digestive gland, from the stomach wall. Corrosive-acetic. 1115.

Fig. 35.—Cells from the stomach wall. Flemming's fluid. × 665.

MARCH 5.

ARTHUR ERWIN BROWN, D.Sc., Vice-President, in the Chair.

Twenty-five persons present.

The Publication Committee reported the presentation of a paper entitled "Note on the Genus Kuhlia," by Dr. Theodore Gill (February 27).

The death of Frederick E. Stearns, a Correspondent, February, 1907, was announced.

DR. A. E. BROWN criticised the theory that species arise only by mutation, as maintained by De Vries. (No abstract.)

MARCH 19.

ARTHUR ERWIN BROWN, D.Sc., Vice-President, in the Chair.

Twenty-three persons present.

PHILIP P. CALVERT, PH.D., made a communication on a Mexican journey and its entomological results, illustrated with lantern slides from kodak views taken by Mrs. Calvert and by an exhibition of insects collected. (No abstract.)

Mr. C. C. Beddoes was elected a member.

The following papers were ordered to be printed:

A NEW TURBELLARIAN FROM HAWAII.

BY HAROLD HEATH.

The species of flatworm described in the present paper is represented by four individuals dredged by the U. S. F. C. Str. "Albatross" in the Auau Channel between Maui and Lanai Islands, Hawaii, where the depth is 28–43 fathoms and the bottom consists of sand and gravel. With one exception the specimens were in perfect condition and swam actively by means of undulatory movements of the lateral margins of the body, as is the habit of several other species of Turbellaria. Cocaine was used as a narcotizing agent and formaldehyde as a preservative.

The largest specimen is almost circular in outline and measures 35 by 39 mm.; while the next largest is more oval with a length of 42 mm. and an average width of 27 mm. In each case the body is only slightly colored and is restricted to the dorsal surface, where the minute black pigment cells form stippled streaks and blotches. As in other Planoceridæ the mouth is about median, the male copulatory apparatus is directed backward, and in common with other species of the genus *Planocera* the nuchal tentacles are located about one-fourth of the body length from the anterior end. Around the bases of each there is a group of large eyes, while the intermediate brain region is occupied by the smaller voriety which forms two irregular clusters.

The digestive system presents no especially peculiar features. The external mouth, mesially situated, leads into the much plicated pharynx (Pl. XIV, fig. 1), whose length nearly equals one-fourth that of the body. Laterally it is produced into four pairs of diverticula, of which the anterior may be somewhat indistinct. Directly above, that is dorsal to the outer mouth, the opening from the pharynx leads into the main division of the gut, which in turn communicates with five pairs of intestinal branches. These are invariably empty and relatively slender and practically of even calibre throughout their entire extent. Their general arrangement and method of branching may be seen in fig. 1, which likewise shows frequent anastomoses. Lang[1] states that when these occur they appear most clearly in the young

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[1] *Die Polycladen, Fauna und Flora des Golfes von Neapel*, 1884.

individuals, and that in the sexually mature animals they are very seldom seen. Evidently the present species is one of the exceptions, since in fig. 1, which represents an animal with the ovaries barely developed, the anastomoses are not so numerous as in a larger individual where the female reproductive system is fully functional.

The brain holds a position about one-fourth the length of the animal from the anterior end of the body, and after treatment with equal parts of formaldehyde and glycerine may be seen with the greatest distinctness to originate two extensive networks, the well-known ventral one and a dorsal system which has, so far as I know, never been seen in whole mounts, though it was traced with considerable accuracy by Lang from a study of sections. The ventral set of nerves develops from the ventral half of the brain by means of several pairs of nerves which have essentially the same origin as those of *P. graffii* (Lang's fig. 4, Pl. 31). These form an extensive meshwork over the entire under surface of the animal, conforming in general to the plan of *P. graffii*, though the main fibres are more delicate and their branching is not so regular.

The dorsal system may be clearly seen with the naked eye to form an extensive network over the entire dorsal surface of the body. Its fibres are generally smaller than those of the ventral side and the branching occurs with less frequency, thus forming meshes of larger size. Three pairs of nerves give it origin, their position and mode of branching being sufficiently well shown in fig. 2 to require no further comment.

In the most favorable specimen the testes are seen to be scattered over the ventral surface, with the exception of the area bounded by the two innermost longitudinal nerves. Under low magnification their arrangement suggests that they and the delicate canals (vasa efferentia) leading from them form an anastomosing system, and in certain favorable situations, and especially in sections, it is possible to demonstrate that such is actually the case. These minor canals combine to form the vasa deferentia, which usually extend anteriorly as well as posteriorly on each side from their T-shaped union with the single branch extending inward to the midline, but in the present species an anterior division has never been discovered. Throughout its entire extent each vas deferens is a moderately convoluted canal which may form a slight anastomosis at some point, as is shown in fig. 1.

The tube resulting from the fusion of the vasa deferentia in the midline passes at once into the small yet muscular seminal vesicle (fig. 5) which is somewhat elliptical in form. From here the canal passes slightly to the left in order to skirt the granular gland, and then by a fairly direct route leads into the bases of the copulatory organ. A short distance from its entrance into this last-named organ it combines with the short duct from the granular gland.

The copulatory apparatus is a cylindrical body of comparatively large size, occupying the midline and all the available space between the body walls. Its inner third is spongy in character and is penetrated by a single canal, the ductus ejaculatorius, which continues to the exterior. The remaining two-thirds, constituting the eversible portion, is provided with powerful muscular walls and is lined with a multitude of spines which belong to three distinct classes (fig. 5). Those adjoining the outer opening, and consequently basally situated when the penis is protruded, appear in sections to be at least eight in number. Of these two are of large size, hook-like (fig. 6), and are clearly seen in surface views to be symmetrically disposed on each side of the midline. The other six, or possibly eight, are considerably smaller, less curved, and although not clearly visible in surface views appear likewise to be symmetrically disposed a short distance within the external opening. The second type of spine is the smallest and the most abundant and occurs throughout the greater part of the penis. Each is somewhat spindle-shaped and the free end is slightly hooked (fig. 3). Toward the inner end of the eversible portion this type of spine shades into others of similar form, but of a greater length and of a somewhat more slender appearance. At the extreme inner end, the tip of the fully extended organ, these slender spines become larger and more highly cuticularized, and their distal halves assume the brownish yellow tint of the first type. Among these are several larger, toothed spines which are represented in fig. 6.

Lang maintains that each of the spines in *Planocera graffii* is merely a modified epithelial cell, and judging from his figure (fig. 4, Pl. 10) all are of the same character and are similar to the smallest type in the present species. While this view appears plausible at first sight, there are reasons for believing that it does not express the true state of affairs in *Pl. hawaiiensis.* Certainly it cannot be held that the huge spines of the first and third types are each a modified epithelial cell. On the other hand each presents the appearance of being a cuticularized papilla, possibly covered with many epithelial cells, though no cell structure now exists, and penetrated by a connective tissue core which clearly shades basalwards into the unmodified fibrous substance of the penis. Furthermore, while each of the smaller spines may be the product of a single cell, there is little indeed in the adult condition to indicate such an origin. Sections show that they are merely projections on transverse cuticularized ridges which encircle the inner wall of the organ.

As usual the ovaries are dorsally placed, and the tubes leading from them join with the uteri which are well defined a short distance anterior to the mouth. From this point they extend backward, fuse in the midline and form a single duct which passes dorsally into the egg canal. Distal to this last-named union the egg canal extends posteriorly for a short distance and enlarges slightly to form the small accessory sac. On the other hand the egg tube passes backward, enlarges slightly to form the shell chamber, beyond which it becomes continuous with the bursa copulatrix. This is a thick-walled, cone-shaped organ whose inner walls are developed into well-defined rugæ almost cuticular in appearance.

The following brief description will serve to distinguish this species from other known forms.

Planocera hawaiiensis sp. nov.

Body tolerably consistent, broadly elliptical or circular. Length of largest specimen 39 mm., width 33 mm. Color wholly lacking or limited to faint, black blotches and streaks on dorsal surface. Nuchal tentacles at end of first fourth of body length; bases surrounded by eyes about twice the size of those of the intermediate area, which form two groups, the greater number in front of the brain. Five lateral and one anterior intestinal branches which are united by frequent anastomoses. Testes and uniting tubes form an anastomosing system. Penis lined with three species of spines or hooks, several being of large size. Bursa large, accessory sac relatively small.

Auau Channel, Hawaii (Station 3,876), 28–43 fathoms.

EXPLANATION OF PLATE XIV.

Fig. 1.—*Planocera hawaiiensis*, ventral view showing digestive and reproductive systems.

Fig. 2.—Dorsal nervous system.

Fig. 3.—One of the spines of the penis (for position see fig. 5).

Fig. 4.—Tentacles, eyes and brain.

Fig. 5.—Central portion of the reproductive system. B, bursa copulatrix; G, granular gland; P, penis.

Fig. 6.—Large penis spine (for position see fig. 5).

APRIL 2.

ARTHUR ERWIN BROWN, D.Sc., Vice-President, in the Chair.

Twenty-seven persons present.

JOHN W. HARSHBERGER, Ph.D., made a communication on the scientific application of ecology in the wet and dry cultivation of plants. (No abstract.)

APRIL 16.

ARTHUR ERWIN BROWN, D.Sc., Vice-President, in the Chair.

Twenty-three persons present.

HENRY SKINNER, M.D., spoke of the variations in the life-history of insects. (No abstract.)

Richard H. Harte, M.D., was elected a member.

The following were ordered to be printed:

NOTE ON THE GENUS KUHLIA.

BY THEODORE GILL.

The genus *Dules* was first named by Cuvier and Valenciennes in 1829, in the *Histoire Naturelle des Poissons* (III, 111), for fishes resembling *Centropristes*, but distinguished by the presence of only six branchiostegal rays. The genus is divided into two sections, the first with three points to the opercle and an undivided dorsal (as in *Centropristes*) and the second with two points to the opercle and an emarginate dorsal. The name has been restricted to the first section for many years, and for the second section (not related to *Centropristes*) the generic name *Kuhlia*, given by Gill in 1861, has been used. Recently, however, Mr. Henry W. Fowler, in the *Proc. Acad. Nat. Sci. Phila.*, 1906 (p. 510), has contended that *Kuhlia* "is superseded by *Dules* Cuvier, *Règne Animal*, ed. 2, II, 1829, p. 147 (type *Centropomus rupestris* Lacépède by first species)."

Cuvier in the *Règne Animal* especially refers, in a footnote, to the "*Dules auriga* Cuv. et Val., III, li," etc., and that work was published in advance of the *Règne Animal*. In accordance with Mr. Fowler's own principles, then, *Kuhlia* should be retained as well as the family name *Kuhliidæ*, and not *Dules* and *Duleidæ* (or *Dulidæ*).

Mr. Fowler also remarks that "the specific name of the species generally known as *Kuhlia malo* should be "*Dules mato* Lesson, *Voy. aut. Mond. Coquille, Zool.*, III, 1830 (March 22, 1828),[1] p. 223, thus having priority over *Dules malo* Valenciennes, *Hist. Nat. Poiss.*, VII, 1831, p. 360."

Inasmuch, however, as Lesson, at the place cited, especially quotes "*Dules malo* Cuv., *Poiss.*, t. VII, p. 479," it is obvious that the volume in question (VII) must have been set up and published before the description by Lesson was even in print, notwithstanding the dates of the title-pages.

It may be added that the proper indigenous Tahitian name of the *Kuhlia* appears to have been *Mato* and not *Malo*, and Cuvier's name may have resulted from a typographical error, in which case *Kuhlia mato* would be the correct form.

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[1] It is not evident what is meant by the date "March 22, 1828"; certainly the volume of the *Coquille* could not have been published then.

NON-SALTATORIAL AND ACRIDOID ORTHOPTERA FROM SAPUCAY, PARAGUAY.

BY JAMES A. G. REHN.

The following records and descriptions are based on an extensive series of specimens collected by Mr. W. T. Foster and now forming part of the collection of Mr. Morgan Hebard, of Chestnut Hill, Philadelphia.

Considerable work has already been done on the Orthopterous fauna of Sapucay, but an idea of the richness of this region in species may be formed when we consider that in addition to the number already recorded seven new ones are here described.

Four papers have been published bearing wholly or in the greater part on the Orthoptera of Sapucay,[1] all of which have been of great assistance to me in studying this large series of specimens. One of the first of these papers treated of a small collection secured by Mr. Hebard from Sapucay, the results proving of such interest that he immediately endeavored to secure a more representative collection, an effort well repaid by the magnificent series of specimens available for study.

In many cases notes on the variability of series, both in size and coloration, have been given, while comparisons with available material from adjacent regions have frequently furnished information worthy of record. Species which are here recorded from Sapucay for the first time are preceded by an asterisk.

The Tettigonidæ (Locustidæ) and Gryllidæ of this collection will be the subject of a future contribution.

The author wishes to thank Mr. Hebard for the opportunity to study this collection, a considerable representation of which has been generously presented to the Academy.

FORFICULIDÆ.

APTERYGIDA Westwood.

Apterygida linearis (Eschscholtz).

1 ♀. November, 1902.

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[1] *Rehn, J.A.G.* Records of some Paraguayan Orthoptera, with the Description of a New Genus and Species. *Ent. News*, XVI, pp. 37–42.

Caudell, A. N. On a Collection of Non-Saltatorial Orthoptera from Paraguay. *Journ. N. Y. Ent. Soc.*, XII, pp. 179–188.

Bruner, L. Synoptic List of Paraguayan Acrididæ, with Descriptions of New Forms. *Proc. U. S. Nat. Mus.*, XXX, pp. 613–694.

Caudell, A. N. The Locustidæ and Gryllidæ (Katydids and Crickets) collected by W. T. Foster in Paraguay. *Proc. U. S. Nat. Mus.*, XXX, pp. 235–244.

BLATTIDÆ.

PSEUDOMOPINÆ.

ISCHNOPTERA Burmeister.

Ischnoptera vilis Saussure.

1869. *I[schnoptera] vilis* Saussure, Revue et Magasin de Zoologie, 2e ser., XXI, p. 112. [Argentine Pampas.]

9 ♂. February, March and October, 1902; January to March, 1905.

In several of these specimens the reddish lateral margins of the pronotum are less pronounced than in others.

Ischnoptera brasiliensis Brunner.

1865. *I[schnoptera] brasiliensis* Brunner, Nouv. Syst. Blatt., p. 130. [Brazil.]

2 ♂. April and May, 1902.

These individuals are somewhat smaller than the measurements given by Brunner, but in other respects are typical of the species.

NYCTIBORINÆ.

NYCTIBORA Burmeister.

***Nyctibora vestita** Saussure.

1864. *Paratr[opes] vestita* Saussure, Revue et Magasin de Zoologie, 2e ser., XVI, p. 308. [Brazil.]

1 ♂, 1 ♀. December, 1904; March, 1905.

This species was originally synonymized with *N. crassicornis* Burmeister by Brunner, a proceeding which seems to the author not exactly justified by the published descriptions at least. Burmeister's *crassicornis* appears, from the description given by Brunner, to be a larger species without the very distinct single central blotch on the pronotum; Saussure's *vestita*, on the other hand, has the median spot distinct.[2] The size of *crassicornis* given by Brunner shows that the pronotum was larger by at least one millimeter in both directions than in the available material.

The specimens in hand have the median patch on the pronotum solid, without sign of division, and somewhat resembling that of *N. omissa* Brancsik [3] from Catamarca, Argentina, though more rounded and not as transverse. The anal vein of the tegmen is also finely lined with black, in addition to the discoidal vein and sutural margin.

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[2] *Mém. Mex. Blatt.*, p. 64.

[3] *Jahresheft Naturwissen. Ver. Trencsiner Comitates*, Trencsén, XXIV, p. 186, tab. III, fig. 1, 1*a* and *b*.

EPILAMPRINÆ.

PARATROPES Serville.

***Paratropes elegans** (Burmeister).

1838. *Ph[oraspis] elegans* Burmeister, Handb. d. Entom., Bd. II, Abth. II, pt. I, p. 493. [Probably Surinam.]

1. ♂. February, 1905.

This specimen differs from Brunner's interpretation [4] of the species in that the limbs are solid black, the coxæ finely margined with pale yellowish, the face without the transverse line dorsad of the labrum, and the antennæ with a narrow annulus instead of having the terminal portion all yellowish. When compared with the descriptions of other species of the genus the individual in hand agrees closer with that of *elegans*, differing in the color characters here given.

EPILAMPRA Burmeister.

***Epilampra brasiliensis** (Fabricius).

1775. *[Blatta] brasiliensis* Fabricius, Syst. Entom., p. 272. [Brazil.]

1 ♂, 1 ♀. February and March, 1905.

This species has also been recorded from San Pedro Province, Paraguay.

PANCHLORINÆ.

PANCHLORA Burmeister.

***Panchlora hyalina** (Stoll).

1813. *[Blatta] hyalina* Stoll, Natuur. Afbeeld-Besch. Kakkerlakken, p. 5, 14, pl. III d, fig. 12. [No locality.]

1 ♂. March, 1905.

This name appears to be applicable to the species generally known as *Panchlora viridis* Burmeister.

MANTIDÆ.

MANTINÆ.

ACONTISTA Saussure.

Acontista bimaculata Saussure.

1870. *A[contista] bimaculata* Saussure, Mittheil. Schweiz. Entom. Gesell., III, p. 229. [Brazil.]

9 ♂, 4 ♀. February and March, 1905.

As the female of this species has never been described the following diagnosis may prove of service.

Form robust, as is usual in females of this genus. Head with the occipital outline slightly arcuate, almost straight mesad, more arcuate

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[4] *Nouv. Syst. Blatt.*, p. 150.

laterad, the prominent lateral vertical sulci cutting the occipital outline; ocelli disposed as in the male but much smaller; facial scutellum shaped as in the male; antennæ slender, subfiliform, not exceeding the head and pronotum in length. Pronotum shaped very much as in the male, but shorter and consequently with the dilation extending more caudad, and the constricted caudal section shorter. Tegmina short, but very slightly longer than the pronotum, costal margin evenly rounded, apex subrectangulate, sutural margin slightly arcuate in the distal two-thirds, rather abruptly and obliquely curved on the proximal third; stigma distinct. Abdomen strongly depressed, expanded; supra-anal plate broadly and roundly trigonal; cerci slightly surpassing the apex of the plate. Cephalic limbs very robust; coxæ hardly exceeding the pronotum in length, subquadrate in section; femora slightly longer than the coxæ.

General color pale apple green; eyes pale walnut brown. Tegmen with the stigma bistre. Wing brick red, the greater part of the marginal section of the caudal area rich glossy blue black, the transverse veins hyaline and touched with brick red.

Measurements.

Length of body, ...	23	mm.
Length of pronotum, ...	6	"
Greatest width of pronotum, ...	3.5	"
Length of tegmen, ...	5.5	"
Greatest breadth of abdomen, ...	8.5	"
Length of cephalic femur, ...	7	"

Two males and one female are washed more or less strongly with brownish.

This species has also been definitely recorded from the Provinces of Goyaz and Rio Grande do Sul, Brazil.

BRUNNERIA Saussure.

1869. *Brunneria* Saussure, Mittheil. Schweiz. Entom. Gesell., III, pp. 58, 71.

Type.—*B. subaptera* Saussure.

Brunneria brasiliensis Saussure.

1870. *B[runneria] brasiliensis* Saussure, Mittheil. Schweiz. Entom. Gesell., III, p. 240. [Brazil.]

8 ♂, 14 ♀. February and March, 1905.

This series shows that the species is moderately uniform in size and possesses well-marked green and brown phases in the female, the thorax and abdomen varying in accord with the general phase.

***Brunneria subaptera** Saussure.

1869. *B[runneria] subaptera* Saussure, Mittheil. Schweiz. Entom. Gesell., III, p. 71. [Argentine Pampas.]

2 ♂. March, 1905.

These two specimens are larger than the same sex of *brasiliensis*, with the ocelli smaller and the antennæ and cerci longer. One specimen (March 5) has the character of the cerci and antennæ more marked than the other, and measurements of both specimens with those of an average male of *brasiliensis* are here given.

	brasiliensis.	*subaptera.*	
Length of body, ...	73 mm.	90.5 mm.	94 mm.
Length of antenna, ...	33.5 "	29.5+ "	48 "
Length of pronotum, ...	24.5 "	31 "	32.5 "
Length of tegmen, ...	35 "	37.2 "	40.5 "
Length of cephalic femur, . .	15.8 "	18.6 "	19 "
Length of cercus, ...	8 "	12 "	15.5 "

This species has been recorded from the north of Patagonia and the Pampas, and specifically from Bahia Blanca, Argentina. A female individual from Carcaraña, Argentina, determined by Prof. Bruner as *B. brasiliensis*, is clearly referable to *subaptera*, the shape of the supra-anal plate and the length of the cerci being typical of this species.

COPTOPTERYX Saussure.

1869. *Coptopteryx* Saussure, Mittheil. Schweiz. Entom. Gesell., III, pp. 56, 66.

Type, as selected by Kirby, *C. claraziana* Saussure = *C. crenaticollis* (Blanchard).

***Coptopteryx crenaticollis** (Blanchard).

1851. *Mantis crenaticollis* Blanchard, in Gay, Hist. Fis. Polit. de Chile, Zool., VI, p. 22. [Chile.]

2 ♂. February, 1905.

These specimens are clearly referable to this species, of which a female from Carcaraña, Argentina, has also been examined. Giglio-Tos has recorded the species from San Pedro Province, Paraguay.

***Coptopteryx gayi** (Blanchard).

1851. *Mantis Gayi* Blanchard, in Gay, Hist. Fis. Polit. de Chile, Zool., VI, p. 21. [Chile.]

3 ♂, 4 ♀. December, 1904; January, 1905.

This species can easily be recognized in the female by the elongate pronotum, and separated from *C. argentina* by the longer, slenderer median and caudal limbs and weaker cephalic limbs, while *C. crenaticollis* is distinctly smaller and comparatively more robust. The male, on the other hand, bears a very considerable resemblance to that of *C. argentina*, and might easily be considered only a brownish specimen of that species. However, a close examination discloses several very good characters to separate the two species, such as the more compressed shaft of the pronotum, the narrower supra-coxal dilation and weaker cephalic limbs. All the specimens examined are of various shades of brown, one male having the limbs clear green, while one male and one female have the same parts touched with the same color.

A female specimen from Rio Grande do Sul, Brazil, received from Dr. Saussure and determined by him as *C. gayi*, is distinctly smaller than Sapucay females and has the margins of the pronotum with somewhat heavier spines, but does not appear separable otherwise. The measurements of a Sapucay female and of the Rio Grande do Sul individual are as follows:

	Sapucay.	*Rio Grande do Sul.*
Length of body,	80.5 mm.	62 mm.
Length of pronotum,	25.5 "	20 "
Greatest width of pronotum,	7 "	5.5 "
Length of tegmen,	13.2 "	11.5 "
Length of cephalic femur,	19 "	15.5 "

Coptopteryx argentina (Burmeister).

1864. *M*[*antis*] *argentina* Burmeister, Berlin Entom. Zeitsch., VIII, p. 208. [Argentina between Buenos Ayres and Mendoza.]

7 ♂, 10 ♀. December, 1904; January to March, 1905.

This series is rather uniform in size and quite so in coloration.

PHOTINA Burmeister.

1838. *Photina* Burmeister, Handb. d. Entom., Bd. II, Abth. II, pt. I, p. 531.

Type.—*P. vitrea* Burmeister.

Photina brevis n. sp.

Type: ♂; Sapucay, Paraguay. March 5, 1905. (William Foster.) [Hebard Collection.]

Very closely allied to *P. vitrea* Burmeister, but differing in the shorter pronotum and the more numerous rami of the discoidal vein of the wing.

Size medium; form moderately slender. Head broad, trigonal, occipital outline moderately arcuate; ocelli large, placed in a broad triangle, apex ventrad; eyes moderately projecting laterad; facial scutellum strongly transverse, dorsad with a median arcuation, sinuate laterad, ventrad margin slightly concave; antennæ slightly exceeding the head and pronotum in length, sub-moniliform. Pronotum with the cephalic section moderately expanded, not constricted cephalad but rounding narrowly from the greatest expansion to the cephalic margin; shaft slightly exceeding the expanded portion in length, moderately narrowed, slightly expanded caudad; margins unarmed, dorsum without distinct carina. Tegmen large, hyaline except for the semi-opaque costal field, in shape elongate-ovate, the greatest width at the distal third, costal and sutural margins arcuate proximad and distad, apex narrowly rounded; median vein furcate with each arm again furcate; discoidal vein furcate proximad, the caudal arm again furcate; principal axillary veins three in number; stigma very weak, linear, crossing the discoidal vein. Wing about twice as long as broad, costal margin straight in the proximal two-thirds, strongly arcuate in the distal third, apex slightly acute, narrowly rounded, caudal margin of the projecting portion of the anterior field nearly straight, oblique; humeral vein furcate near the base, the rami parallel for the greater part of their length; median vein furcate near the apex; discoidal vein trifurcate, the first being almost at the base, the second nearly mesad, the third about the proximal third; axillary vein bifurcate, the first not far from the base, the other near the apex. Abdomen rather slender; supra-anal plate short, trigonal; subgenital plate moderately produced and provided distad with two small styles; cerci slender, acute, moderately exceeding the subgenital plate. Cephalic coxa about two-thirds the length of the pronotum; cephalic femur somewhat shorter than the pronotum, rather slender, armed with six spines on the external margin (counting the genicular spine) and twelve of two sizes on the internal; tibia slightly more than half the

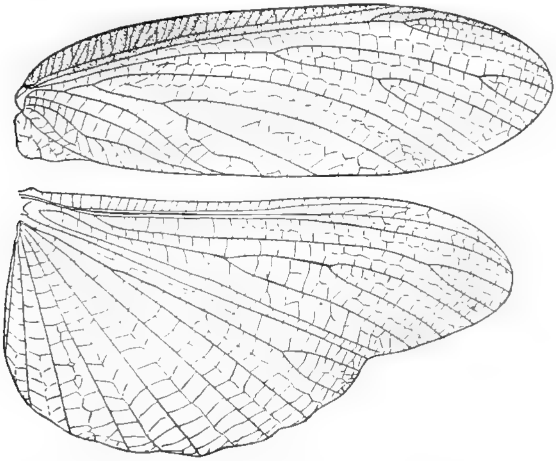

Fig. 1.—*Photina brevis* n. sp. Tegmen and wing of male type. (× 2.)

length of the femur, armed on the external margin with thirteen spines and twelve on the internal. Median and caudal limbs rather slender.

General color pale apple green becoming weak parrot green on the abdomen. Eyes walnut brown; antennæ cinnamon; ocelli glassy crimson, their peduncles rather yellowish. Cephalic femora with the larger spines on their internal margins marked proximad with blackish, the proximal section of the femora also with two circular blackish spots on the ventral portion of the internal face; tibiæ washed with yellowish. Tegmina with the semi-opaque costal area weak apple green, remainder hyaline but the nerves of the same greenish. Wings with the costal margin washed with greenish, the remainder hyaline, the nerves greenish as in the tegmina.

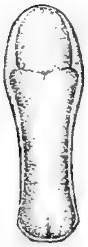

Fig. 2.—*Photina brevis* n. sp. Dorsal view of male pronotum. (× 3.)

Measurements.

Length of body,	41 mm.
Length of pronotum,	10.5 "
Greatest width of pronotum,	3.5 "
Length of tegmen,	35 "
Greatest width of tegmen,	11.2 "
Length of cephalic femur,	9 "
Length of caudal femur,	11.2 "

Two females have also been examined, one taken in February, the other in March, 1905. These individuals differ in no essential particulars from the type.

PARAMUSONIA Rehn.

1894. *Musonia* Saussure and Zehntner, Biol. Cent.-Amer., Orth., I, p. 64. (Not of Stål, 1877.)
1904. *Paramusonia* Rehn, Proc. U. S. Nat. Mus., XXVII, p. 567.

Type.—*Thespis cubensis* Saussure.

Paramusonia livida Serville.

1839. *Thespis livida* Serville, Orthoptères, p. 172. [Brazil.]

Six ♂. April and May, 1902; February and March, 1905.

These specimens are very slightly larger than the measurements given by Serville: "Long 1 pouce au moins, non compris la lame abdominale . . . . prothorax long de trois lignes au moins." Several of the individuals seen about equal the length of body of this species given by Caudell.[5] In all the specimens the tips of the tegmina fall in repose at least a millimeter short of the tips of the wings.

CREOBOTRINÆ.

ACANTHOPS Serville.

1831. *Acanthops* Serville, Ann. Sci. Nat., XXII, p. 52.

Type.—*Mantis fuscifolia* Olivier = *Mantis sinuata* Stoll.

Acanthops sinuata (Stoll).

1813. [*Mantis*] *sinuata* Stoll, Natuur. Afbeeld. Besch. Spooken, pp. 12, 77, pl. IV, fig. 14. [Surinam.]

8 ♂, 10 ♀. November, 1904, to March, 1905.

This series shows some variation in size in both sexes, and also in the shade of the general coloration. Some individuals are decidedly blackish brown and others are practically ferruginous, the average, however, being darker. The tegmina of the females in no case exceed twenty-four millimeters in length.

VATINÆ.

OXYOPSIS Caudell.

1869. *Oxyops* Saussure, Mittheil. Schweiz. Entom. Gesell., III, pp. 56, 66. (Not of Schönherr, 1826.)
1904. *Oxyopsis* Caudell, Journ. N. Y. Ent. Soc., XII, p. 184.

Type.—*O. rubicunda* (Stoll).

***Oxyopsis lobeter**[6] n. sp.

Type: ♀; Sapucay, Paraguay. January 26, 1905. (William Foster.) [Hebard Collection.]

Allied to *O. media* and *obtusa* (Stål) from Brazil, but with the tegmina and wings much longer, the limbs also somewhat longer, while the general size is about the same. The proportions of the exposed section of the wings is as in *obtusa*, and the eyes are rectangulate laterad as in that species. The relationship is apparently closer to *obtusa* than to *media*.

General size rather large. Head depressed, very broadly trigonal, occipital outline straight, cephalic section of the occiput flattened, except for four spaced longitudinal depressions, and forming an obtuse angle with the portion of the head ventrad of the insertion of the antennæ; ocelli very small, well spaced in a broad unequal triangle; facial scutellum transverse, the dorsal margin straight mesad and

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[5] *Journ. N. Y. Ent. Soc.*, XII, p. 184.

[6] Λωβητηρ, *destroyer.*

obliquely emarginate laterad, ventral margin very slightly concave; eyes produced laterad, rectangulate, sub-mammilliform. Pronotum elongate, the collar contained slightly more than three times in the length of the shaft, supra-coxal dilations moderate, the collar hardly constricted cephalad of the expansion; margins serrato-dentate, the serrations becoming fewer and smaller caudad, shaft carinate throughout its length, the carina weak mesad. Abdomen considerably depressed, broad. Tegmen broad, subequal, the width being contained two and a half times in the length; costal margin nearly straight, slightly rounded proximad, obliquely rounded distad, sutural margin nearly straight, apex rather broadly rounded; costal field very broad, in its widest section two-fifths the width of the entire tegmen, costal veins about twelve in number, strongly oblique and curved toward the apex in the distal section; humeral vein furcate near the apex; median vein with two rami; discoidal vein with two rami the caudal of which is furcate; stigma distinct, irregular. Wing with the greatest width contained about twice in the length, the portion extending beyond the tip of the tegmen when in repose being trigonal and broader than long. Cephalic coxa nearly three-fifths as long as the pronotum, all the margins serrato-spinose, the ventral margin with spines of two different sizes; cephalic femur nearly three-fourths the length of the pronotum, slender, armed on the external margin with four spines and seven large and nine small ones on the internal margin,

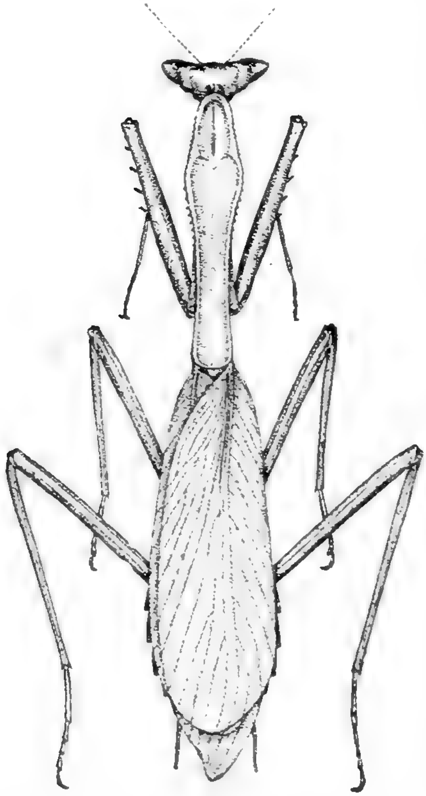

Fig. 3.—*Oxyopsis lobeter* n. sp. Dorsal view of type. (× 1½.)

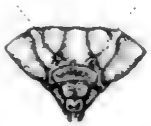

Fig. 4.—*Oxyopsis lobeter* n. sp. Cephalic view of head. (× 2.)

a median line of small tubercles are present on the proximal portion of the ventral surface; cephalic tibia not quite half the length of the femur, armed with ten spines on the external margin and sixteen on the internal. Median limbs rather slender, of moderate length; caudal limbs very considerably longer than the median.

General color dull olive green, touched in many places with bice green and parrot green. Head touched with yellowish, the eyes seal brown. Pronotum with considerable brownish on the shaft. Tegmina passing from nearly bottle green proximad and on a section of the costal area through pea green to apple green in the distal half of the discoidal area and oil green in the costal section; hyaline interstices limited to the pea green area and the apple green section immediately adjoining it in the discoidal field; stigma touched with brown. Wings with the exposed section coriaceous and opaque oil green; remainder of the wings, except a narrow greenish touch along the costal margin, hyaline with the transverse veins rather broadly touched with gamboge yellow. Cephalic femora and tibiæ with the principal spines almost entirely blackish-brown, the others touched with the same color. Median and caudal limbs with the femora mars brown, the tibiæ and tarsi oil green.

Measurements.

Length of body,	61.5	mm.
Length of pronotum,	24.5	"
Greatest width of pronotum,	5	"
Length of tegmen,	32	"
Greatest width of tegmen,	12	"
Greatest width of costal field,	5	"
Length of cephalic femur,	17.2	"
Length of median femur,	15	"
Length of caudal femur,	19	"

A paratypic female, taken December 20, 1904, is essentially similar to the type though slightly larger. The color pattern of the tegmina is not as marked in it as in the type and the hyaline interstices more numerous and extensive.

PHASMIDÆ.

BACTERIINÆ.

CEROYS Serville.

***Ceroys coronatus** (Thunberg).

1815. *P[hasma] coronata* Thunberg, Mém. l'Acad. Imp. Sci. St. Pétérsb., V, p. 299. [No locality.]

1 ♀. December, 1904.

As far as the brief original description goes this specimen appears to represent Thunberg's species. In the absence of any recent information on Thunberg's original specimen of this species, the individual in hand may justly be considered the same as *coronata* until further knowledge disproves or substantiates the association.

Measurements of the Sapucay Specimen.

Length of body,	106	mm.
Length of pronotum,	4.5	"
Length of mesonotum,	27.5	"
Length of metanotum (including median segment),	18	"
Length of abdomen,	49.5	"
Length of cephalic femur,	20.5	"
Length of median femur,	15.5	"
Length of caudal femur,	21	"

CLITUMNINÆ.

STELEOXIPHUS[7] n. gen.

Type.—*S. catastates* n. sp.

A member of the Clitumninæ and related to *Paraleptynia* and *Ceratiscus* Caudell, both described from Sapucay. The genus *Paraleptynia* was based on a male individual, while a female is the only available representative of the new genus. The antennæ are shorter than in *Paraleptynia* and with some of the segments of different proportions, while the general slender form agrees with that genus. The chief character of *Ceratiscus*, which was based on a female, is the elongate opercule which is also present in *Steleoxiphus*, although the form of the latter is by no means as robust, being slender as in *Paraleptynia* with the limbs not lobed or serrate. The character of the antennæ is more similar to that of *Ceratiscus* than of *Paraleptynia*.

Form very elongate; surface glabrous. Head with the eyes very small; antennæ very little longer than the head and pronotum, proximal joint over twice as long as broad, strongly depressed laterad and proximad, second joint more rounded and hardly half the length of the proximal, third joint similar to the second but slightly longer, the fourth to sixth joints similar to the second and from the seventh they evenly increase in length distad. Mesonotum and metanotum (including median segment) subequal in length; median segment longer than broad. Subgenital opercule produced into a compressed, elongate, hastate process. Limbs slender, unarmed.

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[7] Στήλη, *post*; ξίφος, *sword*.

***Steleoxiphus catastates**[8] n. sp.

Type: ♀; Sapucay, Paraguay. March 5, 1905. (William Foster.) [Hebard Collection.]

Size medium. Head slender, subparallel, the caudal width contained about two and a half times in the length; occiput with a very fine median longitudinal impressed line and a lateral one extending caudad from each eye; eyes subcircular, strongly flattened when viewed dorsad; ocelli distinct but small and placed in a large triangle between and immediately caudad of the antennæ. Pronotum slender, slightly compressed mesad, a distinct transverse and a less distinct longitudinal impressed line present. Mesonotum nearly five times the length of the pronotum, regularly but slightly expanding caudad. Metanotum about equal to the mesonotum in length, subequal in width except for a very slight caudal expansion; median segment about a third as long as the remainder of the metanotum, and in its own length nearly twice its width. Abdomen with the proximal seven segments distinctly longitudinal and increasing in length from the first to the sixth, the seventh being shorter than the sixth and about equal to the first; eighth and ninth segments subequal, each hardly two-thirds the length of the seventh, fifth to eighth segments tectate, ninth tectate and carinate dorsad; supra-anal plate very small, trigonal; cerci simple, styliform, about two and a half times the length of the supra-anal plate; subgenital opercule strongly compressed, the lateral surfaces con-

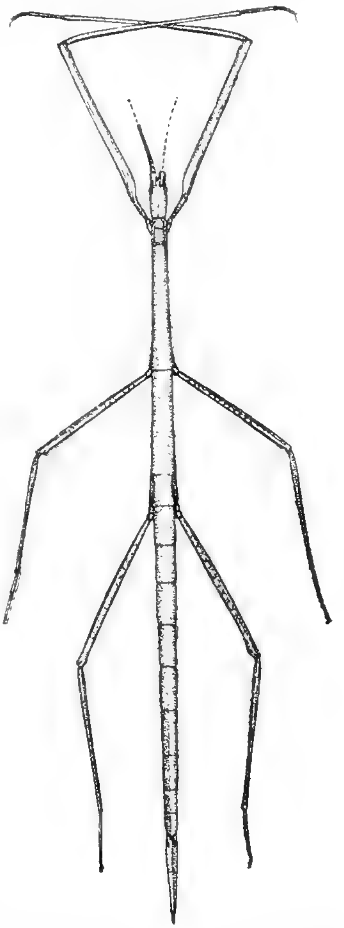

Fig. 5.—*Steleoxiphus catastates* n. gen. and sp. Dorsal view of type. Natural size.

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[8] Καταστατης, *an establisher.*

Fig. 6.—*Steleoxiphus catastates* n. gen. and sp. Lateral view of apex of abdomen of type. (× 2.)

cave, apex acute, surface finely marked with longitudinal linear series of minute punctures. Cephalic femora equal to the length of mesonotum and half of the metanotum, proximal flexure distinct but small, remainder of the femur multicarinate; cephalic tibiæ slightly shorter than the femora; cephalic tarsi with the metatarsus distinctly longer than the remaining joints. Median femora about equal to the metanotum in length; median tibiæ somewhat shorter than the femora; median tarsi with the metatarsus very slightly shorter than the remaining tarsal joints. Caudal femora extending to the middle of the fifth abdominal segment; tibiæ distinctly but not very greatly shorter than the femora; tarsi with the metatarsus about equal to the remaining tarsal joints.

General color apple green, becoming oil green on the limbs and touched with ochraceous on the ventral section of the head, and also on the prosternum, cephalic and caudal sections of the mesosternum and cephalic section of the metasternum and a narrow ventral median line on the abdomen is of the same color. The subgenital opercule and cephalic tarsi are chiefly pale ochraceous, while the ochraceous on the caudal section of the mesosternum is overlaid with a brownish spot. Eyes vinaceous-cinnamon, antennæ ochraceous.

Measurements.

Length of body,	97	mm.
Length of antenna,	+ 8.1	"
Length of pronotum,	3.2	"
Length of mesonotum,	17.2	"
Length of metanotum (including median segment),	18	"
Length of median segment,	4.5	"
Length of abdomen.	42.5	"
Length of subgenital opercule,	24.5	"
Length of cephalic femur,	26	"
Length of median femur,	17.8	"
Length of caudal femur,	22	"

The type is unique.

There is a possibility that this species is the female of *Paraleptynia fosteri* Caudell, known only from the male, but it does not appear right or proper to assume that such strikingly different antennal characters exist in the sexes of the same species. The possibility exists, however, and it remains for further collections and observations to accurately establish the true relationship of the two forms.

PSEUDOPHASMINÆ.

OLCYPHIDES Griffini.

***Olcyphides fasciatus** Gray.

1835. *P[hasma] fasciatum* Gray, Synop. Spec. Ins. Fam. Phasm., p. 24. [Brazil.]

1 ♀. December, 1904.

This specimen answers the description of the species quite well. As no measurements were given in the original description the following may be of interest:

Length of body,	71	mm.
Length of antenna,	68	"
Length of pronotum,	4	"
Length of mesonotum,	7.2	"
Length of tegmen,	5	"
Length of wing,	44.5	"

***Olcyphides hopii** (Gray).

1835. *P[hasma] Hopii* Gray, Synop. Spec. Ins. Fam. Phasm., p. 25. [Brazil.]

1 ♂. February, 1902.

Whether this specimen is the other sex of the species here called *fasciatus* or distinct cannot be positively determined from the material in hand. It agrees quite well with the brief description of *hopii*, and differs from *fasciatus*, as here understood, in having a much smaller tegminal protuberance, lateral lines of yellowish present on the thorax and distinctly though narrowly annulate antennæ. Whether these are specific or sexual characters remains to be determined.

ACRIDIDÆ.

ACRYDIINÆ.

TETTIGIDEA Scudder.

Tettigidea multicostata Bolivar.

1887. *T[ettigidea] multicostata* Bolivar, Ann. Soc. Entom. Belg., XXXI, p. 299. [Brazil.]

9 ♀. February and March, 1905.

This series has been compared with representatives from Caiza, Bolivia, Salta and Tucuman, Argentina.

PROSCOPINÆ.

CEPHALOCŒMA Serville.

Cephalocœma costulata Burmeister.

11 ♂, 13 ♀. November, 1901; February and March, 1905.

The variation in size exhibited by this series, in addition to the slight variation in the comparative length of the rostrum, would at first sight appear to be due to the presence of two or more species. However, no line of demarcation in size or in the number of tibial spines, the latter extremely variable in individuals, can be recognized, and for the present at least all are considered *costulata*. The strength of the abdominal strigæ is another character of variability in this material, and two of the female specimens appear to be what Bruner has provisionally called *burmeisteri*.[9]

ACRIDINÆ.

The material belonging to this subfamily has been studied in two previous papers,[10] the species being merely listed here, with any comments brought out by an examination of determinations in Prof. Bruner's later paper (*vide antea*).

HYALOPTERYX Charpentier.

Hyalopteryx rufipennis Charpentier.

Bruner has described as *H. specularis*[11] the form referred by the author to Charpentier's species.

EUTRYXALIS Bruner.

***Eutryxalis gracilis** (Giglio-Tos).

TRUXALIS Fabricius.

Truxalis brevicornis (Linnæus).

ORPHULA Stål.

Orphula pagana (Stål).

AMBLYTROPIDIA Stål.

Amblytropidia robusta Bruner.

The specimens referred with some little doubt to *A. ferruginosa* Stål by the author belong to Bruner's recently described species.

***Amblytropidia chapadensis** Rehn.

ORPHULINA Giglio-Tos.

Orphulina pulchella Giglio-Tos.

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[9] *Proc. U. S. Nat. Mus.*, XXX, p. 619.

[10] Notes on South American Grasshoppers of the Subfamily Acridinæ (Acrididæ), with Descriptions of New Genera and Species. *Proc. U. S. Nat. Mus.*, XXX, pp. 371-391. May, 1906. Studies in South and Central American Acridinæ (Orthoptera), with the Descriptions of a New Genus and Six New Species. *Proc. Acad. Nat. Sci. Phila.*, 1906, pp. 10-50. May 19, 1906.

[11] Bruner's *H. lamellipes* from Sao Paulo, Brazil, in all probability equals *H. asinus* Rehn.

ORPHULELLA Giglio-Tos.

***Orphulella gracilis** Giglio-Tos.

Orphulella punctata (De Geer).

DICHROMORPHA Morse.

Dichromorpha australis Bruner.

1900. *D[ichromorpha] australis* Bruner, Acc. Gen. Spec. Locusts Argent., p. 28. [Carcaraña, Argentina.]

1 ♂, 1 ♀. February, 1901.

TOXOPTERUS Bolivar.

Toxopterus miniatus Bolivar.

FENESTRA Giglio-Tos.

Fenestra bohlsii Giglio-Tos.

AMBLYSCAPHEUS Bruner.

Amblyscapheus glaucipes (Rehn).

Staurorhectus glaucipes Rehn, Proc. Acad. Nat. Sci. Phila., 1906, p. 34, figs. 9 and 10. May 19, 1906.

Amblyscapheus lineatus Bruner, Proc. U. S. Nat. Mus., XXX, p. 633. June, 1906.[12]

The relationship of these two descriptions is obvious.

STAURORHECTUS Giglio-Tos.

Staurorhectus longicornis Giglio-Tos.

ISONYX Rehn.

***Isonyx paraguayensis** Rehn.

EUPLECTROTETTIX Bruner.

Euplectrotettix ferrugineus Bruner.

SCYLLINA Stål.

***Scyllina brunneri** (Giglio-Tos).

Scyllina brasiliensis (Bruner).

Scyllina conspersa (Bruner).

Scyllina varipes (Bruner).

ŒDIPODINÆ.

CŒLOPTERNA Stål.

1873. *Cœlopterna* Stål, Öfvers. af K. Vetensk.-Akad. Förhandlingar, XXX, No. 4, p. 53.

Type.—*Acrydium acuminatum* De Geer.

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[12] Received in Philadelphia, June 6; probable exact date one or two days previous.

***Cœlopterna acuminata** (De Geer).

1773. *Acrydium acuminatum* De Geer. Mém. l'Hist. Ins., III, p. 501, pl. XLII, fig. 10. [Surinam.]

1 ♂. January, 1903.

This peculiar species has been recorded from several localities in Paraguay. No comparison has been made with Surinam material.

PYRGOMORPHINÆ.

OSSA Giglio-Tos.

1894. *Ossa* Giglio-Tos, Bollett. Mus. Zool. Anat. Comp. Torino, IX, No. 184, p. 15, pl. fig. 2.

Type.—*O. bimaculata* Giglio-Tos.

Ossa bimaculata Giglio-Tos.

1894. *O[ssa] bimaculata* Giglio-Tos, Bollett. Mus. Zool. Anat. Comp. Torino, IX, No. 184, p. 15, pl. fig. 2. [Resistencia nel Chaco, Argentina.]

12 ♂, 12 ♀. December to March.

All of the female specimens are slightly, and some considerably, larger than the measurements of the type given by Giglio-Tos.

OMMEXECHA Serville.

1831. *Ommexecha* Serville, Ann. Sci. Nat., XXII, p. 285.

Type.—*O. virens* Serville.

***Ommexecha virens** Serville.

1831. *Ommexecha virens* Serville, Ann. Sci. Nat., XXII, p. 286. [Buenos Ayres.]

4 ♀. May, 1902.

One of these specimens is distinctly true *virens* as far as color is concerned, the others apparently being Blanchard's *O. servillei*, which probably is only a brown phase of *virens*. The only other conclusion that can be reached from the material before me is, that *servillei* has two color phases represented in this series, distinct, however, from *virens* which should be retained as a poorly understood form. This view does not appear as likely as the synonymy of *servillei* with *virens*. No structural characters separate the two color forms as far as available material goes, the strength of asperities and ridges in this genus being subject to considerable variation.

Bruner has recorded the brown phase from Asuncion and San Bernardino, Paraguay.

***Ommexecha germari** Burmeister.

1838. *O[mmexecha] Germari* Burmeister, Handb. d. Entom., bd. II, abth. II, pt. I, p. 655. [Brazil.]

9 ♂, 10 ♀. February and March, 1905; May, 1902.

This series exhibits some variation in size and length of the tegmina and wings, the two sexes sharing alike in the same.

This species has also been recorded from Porto Allegre (Karsch) and São Leopoldo (Bolivar), Rio Grande do Sul, Brazil

LOCUSTINÆ.

PROCOLPIA Stål.

1873. *Procolpia* Stål, Öfv. K. Vetensk.-Akad. Förhandl., 1873, No. 4, p. 52.

Type.—*Xiphicera emarginata* Serville.

Procolpia minor Giglio-Tos.

1894. *P[rocolpia] minor* Giglio-Tos, Bollett. Mus. Zool. Anat. Comp. Torino, IX, No. 184, p. 17. [Colonia Risso, Rio Apa, Paraguay.]

1906. *Munatia australis* Bruner, Proc. U. S. Nat. Mus., XXX, p. 644. [Sapucay, Paraguay.]

8 ♂, 6 ♀. February and March, 1905.

On comparison of this series with the two descriptions cited above, it is very evident that both refer to the same species. While not absolutely typical *Procolpia* in the form of the apex of the tegmina, the species is certainly nearer *Procolpia emarginata* than *Munatia punctata*, the type of the latter genus. The form of the wing is distinctly that of *Procolpia*, and the apex of the tegmen in every specimen shows a slight oblique sutural truncation.

PRIONOLOPHA Stål.

1873. *Prionolopha* Stål, Recensio Orthopterorum, I, pp. 27, 44.

Type.—*Gryllus (Bulla) serratus* Linnæus.

Prionolopha serrata (Linnæus).

1758. [*Gryllus (Bulla)*] *serratus* Linnæus, Syst. Nat., X ed., p. 427. ["Indiis."]

10 ♂, 12 ♀. January to March, 1905.

These specimens exhibit some slight variation in size, and in the shade of the green base color and of the bars of the sides of the head and pronotum. The latter are in some cases greenish yellow, in others pinkish, and again dull purplish much darker than the base color.

ALCAMENES Stål.[13]

1878. *Alcamenes* Stål, Bihang till K. Svenska Vet.-Akad. Handlingar, V, No. 4, pp. 14, 54.

Type.—*A. granulatus* Stål.

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[13] Giglio-Tos's *Prionolopha brevipennis* (*Bollett. Mus. Zool. Anat. Comp. Torino*, XV, No. 377, p. 3) appears to be a member of this genus.

Alcamenes cristatus Bruner.

1906. *Alcamenes cristatus* Bruner, Proc. U. S. Nat. Mus., XXX, p. 650. [Sapucay, Paraguay.]

2 ♂, 5 ♀. February and March, 1905.

As suggested by Bruner (*supra*, pp. 650–651) the genus *Alcamenes* is closely related to *Prionolopha*, undoubtedly closer than it is to the genus *Tropinotus*.

TROPINOTUS Serville.

1831. *Tropinotus* Serville, Ann. Sci. Nat., XXII, p. 272.

Included *Gryllus serratus* Fabr., *T. discoideus* and *obsoletus* Serville. The first was removed to *Prionolopha* in 1873, the third to *Colpolopha* the same year, and *discoideus* can be considered the type.

Tropinotus discoideus Serville.

1831. *Tropinotus discoideus* Serville, Ann. Sci. Nat., XXII, p. 273. [Brazil.]

11 ♂, 12 ♀. February and March, 1905.

This series contains a few specimens which have the lateral portions of the disk of the pronotum, the dorsum of the head and the anal field of the tegmina bright green. The maculations of the tegmina are subject to a great amount of variation and in a few specimens are almost absent, but in the great majority are distinct though faint.

The presence or absence of the lateral apical spine on the caudal tibiæ appears to be of little or no value to separate genera in this group, as it is not constantly present in the same species, and even may be present on one limb and absent on the other of the same individual. Representatives of this species present this latter condition.

*__Tropinotus guarani__ n. sp.

Types: ♂ and ♀; Sapucay, Paraguay. February 25 (♂), March 9, 1905 (♀). (William Foster.) [Hebard Collection.]

Allied to *T. regularis* Bruner, but differing in the heavier build, the less evenly arched pronotal crest, the broader disk of the pronotum, the slightly heavier limbs, shorter tegmina and the less regularly maculate character of the same.

Size medium; form robust; surface of body rugulose. Head with the occiput distinctly inflated, a distinct median carina continuing cephalad to the angle of the fastigium, this being accompanied by lateral carinæ lower and indefinite in character but constricted at the highest point of the swell of the occiput, and connected with the median carina by numerous low transverse ridges producing a scalariform pattern; interspace between the eyes no narrower than the fastigium; fastigium slightly acute-angulate in the male, rectangulate in the female, the width being nearly that of the eye, between the points of greatest width the fastigium is bounded caudad by a low transverse carina, hardly indicated in the male, cephalad of which the disk is slightly excavate; when viewed laterad the angle of the fastigium is slightly rounded into the facial outline which is distinctly but not greatly retreating; frontal costa very narrow dorsad, much more so comparatively in the female than in the male, from whence it regularly but gradually expands except for a short subequal portion in the vicinity of the ocellus, in the male the costa is punctate but not sulcate, in the female it is sulcate for a moderate distance dorsad and ventrad of the ocellus, punctate elsewhere; eyes subovate, somewhat prominent in the male when viewed dorsad, in length distinctly (♂) or slightly (♀) longer than the infraocular sulcus; antennæ in length slightly exceeding the pronotum in both sexes, slightly depressed proximad. Pronotum with the greatest width contained slightly less than twice (♂) or once and two-thirds (♀) in the length of the same; cephalic margin slightly acute-angulate (♂) or rectangulate (♀), the margins slightly concave laterad; caudal margin acute-angulate in both sexes but sharper in the male than in the female and with the lateral portions concave; dorsal crest moderately high, the greatest height being on the metazona which is arcuate somewhat independent of the prozona and in the male being higher comparatively and more arcuate than in the

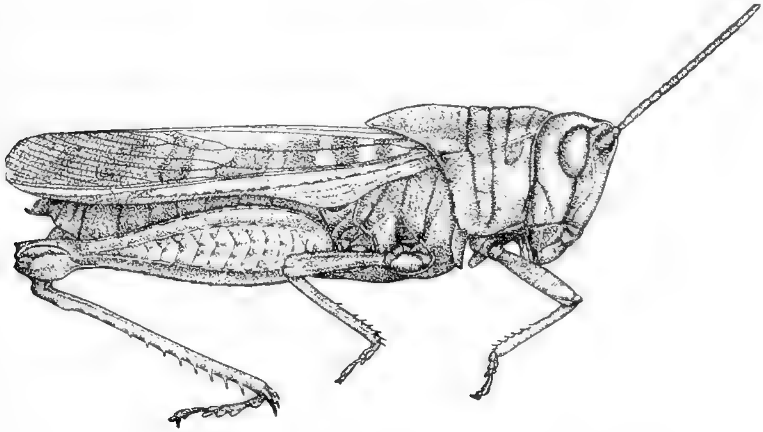

Fig. 7.—*Tropinotus guarani* n. sp. Lateral view of female type. (× 2.)

Figs. 8 and 9.—*Tropinotus guarani* n. sp. Dorsal view of head and pronotum of male and female types. (× 2.)

female, the prozonal portion increasing in height caudad but slightly sinuate in the female, transverse sulci moderately impressed, the caudal one distinctly sunken into the sides of the crest, prozona somewhat shorter than the metazona; lateral carinæ sharp, slightly lamellate caudad, cut by three sulci; lateral lobes with the dorsal length slightly greater than the depth; almost the entire surface of the pronotum is punctate, usually strongly so, and the metazona of the disk, particularly in the male, bears papilliform tubercles. Tegmina slightly over twice the length of the pronotum, rather broad proportionately, costal margin with a very considerable proximal lobe, the proximo-distal length of which is not great in proportion to the depth; apex narrowed somewhat, obliquely rotundato-truncate. Prosternal spine compressed, apex narrowed and directed caudad as usual in the genus; interspace between the mesosternal lobes distinctly longer than broad in the male, subquadrate in the female; interspace between the metasternal lobes small and subquadrate in the male, transverse in the female. Abdomen with the dorsal segments rugoso-punctate. Cephalic and median limbs rather short, the femora of the male, particularly the cephalic, distinctly inflated. Caudal femora robust, the distal portion, however, comparatively slender when the robust proximal two-thirds is considered, the femoral length being about three-fourths that of the tegmina and the greatest width is contained nearly four times in the length, dorsal, ventral and lateral carinæ serrate, particularly the dorsal, paginæ with the pattern very distinctly imbricate, the appearance being that of overlapping plates, the shape being also variable and seldom the usual Acridoid chevron; caudal tibiæ very slightly shorter than the femora, very slightly sinuate, lateral margins with nine to ten spines, internal margins with ten spines.

General color bistre mingled and blended with vinaceous-cinnamon in a pattern which presents but few sharply defined contrasts of the two colors. Dorsum of the pronotum in the female margined laterad by a subequal band of bice green, on the metazona, however, this border becomes fainter caudad until it is not apparent, the median section of the pronotum is almost clove brown. Anal field and a portion of the adjoining discoidal field bice green, absent, however, in the distal fourth; pattern of the tegmina formed by five distinct and two or more faintly indicated transverse bars of bistre, the pale bars distad and none encroaching on the costal field or the green dorsal section. Wings with the disk carmine. Ventro-lateral carinæ of the caudal femora with regularly spaced dark blotches, the dorso-lateral face quite dark; caudal tibiæ wood brown in the male, of the same color but strongly sprinkled with bistre in the female.

Measurements.

	♂	♀
Length of body,	27.5 mm.	38.8 mm.
Length of pronotum,	10.7 "	12.5 "
Greatest dorsal width of pronotum,	5.5 "	7 "
Length of tegmen,	23 "	29 "
Greatest width of tegmen,	4.5 "	6 "
Length of caudal femur,	17.2 "	21.4 "

A series of three topotypic females have been examined in addition to the types. In size these individuals vary somewhat, one being slightly larger than the type, the others of about the same size with slightly shorter tegmina. In color the variation is chiefly in individual variation in shades of brown, the pattern remaining much the same, the green areas being brown as in the male in two of the three specimens. The caudal tibiæ are light in two and dark in one of the paratypic specimens examined.

Tropinotus regularis Bruner.

1905. *Tropinotus regularis* Bruner, Ent. News, XVI, p. 214. [Sapucay, Paraguay.]

7 ♂, 13 ♀. February and March, 1905.

This series exhibits considerable variation in the size and intensity of the tegminal blotches. The phase with green on the lateral portions of the disk of the pronotum and on the anal and contiguous portion of the discoidal field of the tegmina as described by Bruner,[14] is represented by five females.

Tropinotus lævipes Stål.

1878. *T[rapidonotus] lævipes* Stål, Bihang till K. Svenska Vet.-Akad. Handl., V, No. 9, p. 20. [São Leopoldo, Brazil; Argentine Republic.]

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[14] *Proc. U. S. Nat. Mus.*, XXX, p. 647.

10 ♂, 7 ♀. December, 1904, to February, 1905.

This series shows some slight variation in size in the male sex.

Tropinotus lineatus Bruner.

1906. *Tropinotus lineatus* Bruner, Proc. U. S. Nat. Mus., XXX, p. 648. [Sapucay, Paraguay.]

2 ♂, 2 ♀. February and March, 1905.

Three of these specimens are in the brown phase, while one female is colored with green as mentioned in the original description. In the latter specimen the characteristic longitudinal pale bar is light green, and not yellowish as in the other individuals.

ELÆOCHLORA Stål.

1873. *Elæochlora* Stål, Öfv. K. Vetensk.-Akad. Förhandlingar, 1873, No. 4, p. 52.

Type.—*Gryllus scaber* Thunberg.

Elæochlora viridicata (Serville).

1839. *Xiphicera viridicata* Serville, Orthoptères, p. 614. [Buenos Ayres.]

9 ♂, 4 ♀. December, 1904; February and March, 1905.

These specimens are not typical of *viridicata*, but are not strongly enough differentiated to warrant separation. When compared with Buenos Ayres and Carcaraña, Argentina material the Sapucay males are seen to have distinctly shorter tegmina and wings, while the females have these organs slightly shorter. The Sapucay males range from 19.5 to 26 millimeters in the length of the tegmina, while two Argentina males measure 32.5 and 34 millimeters.

CHROMACRIS Walker.

*__Chromacris stolli__ (Pictet and Saussure).

1887. *R[homalea] Stolli* Pictet and Saussure, Mittheil. Schw. Ent. Gesell., VII, p. 351. [Bahia, Brazil.]

9 ♂, 10 ♀. December, 1904; January to March, 1905.

These specimens are clearly *stolli* and show no important differences from Argentina material of the species. When compared with British Guianan specimens of *C. miles* the Sapucay material is seen to be distinct.

ZONIOPODA Stål.

1873. *Zoniopoda* Stål, Recensio Orthopterorum, I, pp. 32, 51.

Included *Z. tarsata* (Serville) and *emarginata* Stål, of which the first may be considered the type.

Zoniopoda iheringi (Pictet and Saussure).

1887. *Z[oniopoda] Iheringi* Pictet and Saussure, Mittheil. Schw. Ent. Gesell., VII, p. 357. [Southern Brazil.]

12 ♂, 10 ♀. December, 1904; February and March, 1905.

This series is quite uniform in size and color, the only appreciable variation being in the color of the antennæ and of the caudal tibiæ. The antennæ are uniform ochraceous in some individuals, of the same color slightly washed proximad with umber, there narrowly annulate with paler in others and also uniform umber annulate through the length but more distinctly so proximad. The color of the eyes vary from ochraceous to deep walnut brown. The caudal tibiæ are strongly purplish-pink in some specimens, in others whitish and numerous specimens are lightly washed with pinkish.

The typical specimen from Rio Grande do Sul mentioned in a previous paper[15] has the median carina of the pronotum more elevated than the Sapucay specimens.

Zoniopoda similis Bruner.

1906. *Zoniopoda similis* Bruner, Proc. U. S. Nat. Mus., XXX, p. 652. [Sapucay, Paraguay.]

9 ♂, 4 ♀. February and March, 1905.

These specimens are quite uniform in size and coloration, in a few the yellowish tint being more pronounced than in others. The carmine caudal tarsi are quite striking.

Zoniopoda cruentata (Blanchard).

1846.[16] *Acridium cruentatum* Blanchard, in D'Orbigny, Voy. dans l'Amer. Merid., VI, pt. II, p. 216, pl. XXVII, fig. 5. [No locality.]

1900. *Z[oniopoda] tarsata* Bruner, Acc. Gen. Spec. Locusts Argent., p. 61, fig. 26. (Not of Serville.)

1906. *Zoniopoda tarsata* Bruner, Proc. U. S. Nat. Mus., XXX, p. 652, pl. XXXVII, fig. 2. (Not of Serville.)

10 ♂, 9 ♀. January to March, 1905.

This species, which has been confused with Serville's *tarsata* from Brazil, differs from the latter in having less red on the head, the entire portion of the latter caudad of the interocular region being red in *tarsata*, in having the clypeus, labrum and mandibles light in color instead of solid black as in *tarsata*, the cephalic and median limbs variegated with yellow, red and olive-green instead of red, orange and black or blackish, and the proximal dark bar on the caudal femora weak and diffuse instead of solid and clearly defined on the dorsal half of the limb.

Two females of this series have the caudal femora with very weak dark maculations and annulations, the actual color of them being oil green, while the blackish genicular maculations are as distinct as in the other specimens. In some individuals the second joint

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[15] *Ent. News*, XVI, p. 38.

[16] *Vide* Sherborn, *Ann. Mag. Nat. Hist.*, 7th ser., VII, p. 389.

of the caudal tarsi is hardly darker than the other tarsal joints, the tarsi then appearing almost uniform carmine. The eyes vary from ochraceous to seal brown in color.

Zoniopoda omnicolor (Blanchard).

1846.[16] *Acridium omnicolor* Blanchard, in D'Orbigny, Voy. dans l'Amer. Merid., VI, pt. II, p. 216, pl. XXVII, fig. 3. [No locality.]

10 ♂, 9 ♀. December, 1904, to March, 1905.

This series exhibits considerable variation in size, the males ranging in length of body from 29 to 37 millimeters, the females from 44 to 52.

Zoniopoda exilipes Bruner.

1906. *Zoniopoda exilipes* Bruner, Proc. U. S. Nat. Mus., XXX, p. 654. [Sapucay, Paraguay.]

10 ♂, 8 ♀. February and March, 1905.

This series is quite constant in size and color. The large yellow lateral sections of the subgenital plate are very conspicuous, the color there being the same as on the head and more yellowish than on the limbs and pronotum.

PRIONACRIS Stål.

1878. *Prionacris* Stål, Bihang till K. Svenska Vet.-Akad. Handlingar, V, No. 4, pp. 19, 55.

Type.—*P. compressa* Stål.

Prionacris erosa* n. sp.

Type: ♂; Sapucay, Paraguay. March 15, 1906. (William Foster.) [Hebard Collection.]

Allied to *P. compressa* from New Grenada, but of different proportions and with the wings colored differently.

Size moderately large; form elongate; surface of thorax ruguloso-punctate, of head smooth or finely punctulate. Head broad, the length distinctly less than the width, the breadth across the eyes being almost twice the length; occiput rounded, but little elevated dorsad of the eyes, gently declivent to the fastigium, smooth, the width between the eyes but little less than the length of the eye; fastigium rectangulate, not broader than the space between the eyes, margins not at all carinate, disk slightly depressed transversely, a longitudinal median depression marked only at the immediate apex, when viewed laterad the frontal costa rounds into the facial outline which is slightly arcuate; frontal costa very broad, defined by distinct lateral margins only in the dorsal half, the ventral section being also somewhat narrower than the dorsal, not

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[16] *Vide* Sherborn, *Ann. Mag. Nat. Hist.*, 7th ser., VII, p. 389.

sulcate, but strongly punctulate as is the whole facial region; eyes ovate, quite prominent when viewed dorsad; antennæ slightly longer than the head and pronotum together, slender. Pronotum with the length about equal to the vertical depth of the head; the caudal width of the disk contained about one and one-half times in the length of the same; cephalic margin obtuse-angulate, caudal margin slightly acute-angulate, the immediate apex sharp; median carina moderately arcuate in general outline, dentato-serrate, particularly on the metazona, the principal sulcus and the prozonal sulci deeply cutting the crest into three parts on the prozona; principal transverse sulci three in number, the disk rounding into the lateral lobes on the prozona, a distinct but well rounded shoulder present on the metazona; lateral lobes with the dorsal length about equal to the depth, the cephalic and caudal margins subparallel for more than half their length, ventral margin truncate caudad, slightly oblique cephalad. Tegmina about two and two-thirds times the length of the head and pronotum together, exceeding the apex of the abdomen by slightly less than the length of the pronotum, the greatest width being two-thirds the distance from the base; costal margin with a slight proximal lobe and arcuate in the distal third, sutural margin

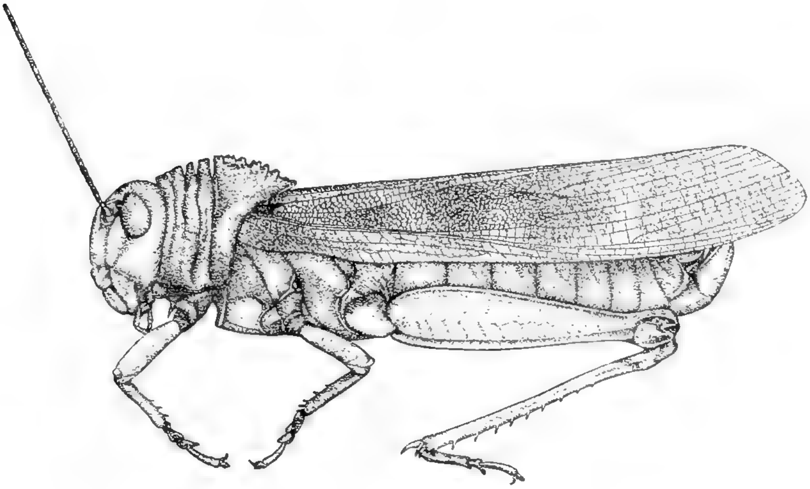

Fig. 10.—*Prionacris erosa* n. sp. Lateral view of type. (× 2.)

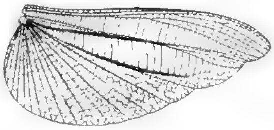

Fig. 11.—*Prionacris erosa* n. sp. Wing of type. Natural size.

nearly straight, apex distinctly oblique truncate, the immediate apex narrowly rounded; mediastine vein strong, nearly straight; anterior ulnar vein sinuate, after bending ventrad from the posterior ulnar vein it recurves and continues closely parallel to the same; intercalary area broad and filled with a network of irregularly meshlike nervures. Wings elongate, narrow, apex rounded acute-angulate; discoidal vein with two rami, the proximal diverging before the middle, the distal separating near the distal third, the proximal furcate; ulnar field occupied by a closely placed scalariform pattern of parallel transverse veins numbering about forty-five, those in the narrow proximal section being very closely placed, while the distal section is occupied by the regular vein pattern; anal vein distinctly sinuate a short distance distad of the middle; anterior axillary field narrow, veined much as the ulnar field and bent under the inflated posterior axillary field, the latter broad, with a scalariform pattern of about thirty veins, as a rule more spaced than in the ulnar field, the vein bounding this area caudad being very much thickened and slightly arcuate. Abdomen subcylindrical, subgenital plate conical, somewhat compressed, slightly carinate ventrad; cerci small, styliform, the apex slightly bent ventrad; supra-anal plate slightly compressed, the median depression subfusiform with margins high, apex acute. Prosternal spine strongly compressed, blunt, directed slightly cephalad; interspace between the mesosternal lobes distinctly longitudinal, narrower than one of the lobes; interspace between the metasternal lobes much smaller, subquadrate; the whole of the sternal region slightly but distinctly concave. Cephalic and median limbs very short, robust; caudal femora slightly more than half the length of the tegmina, thick and with the pregenicular constriction but little marked, greatest width contained nearly five times in the length, carinæ low and hardly marked, paginæ with the pattern very slightly sculptured and with little resemblance to the typical Acridoid chevrons; caudal tibiæ very slightly shorter than the femora, very slightly sinuate, lateral margins with ten spines one of which is apical, internal margins with eleven spines, internal spurs moderately long, subequal, the whole of the dorsal surface of the tibiæ clothed with long white pile; caudal tarsi quite elongate.

General color mummy brown, mingled and sometimes contrasted with wood brown. Head wood brown laterad, washed with russet dorsad and with a narrow median bluish line, face of the general color, eyes burnt umber; antennæ dragon's blood red proximad, brick red distad. Pronotum with the margin of the crest and portions of the ventral section of the lateral lobes touched with bistre. Tegmina with four poorly defined transverse light bars on the proximal two-thirds, distal third hyaline, the longitudinal veins dark and the transverse and adventitious veins pale. Wings with the disk malachite green bordered toward the periphery by an arch of bistre which touches none of the margins; anterior field hyaline with the veins dark. Caudal femora with a touch of clay-color on the dorsal and ventral faces, laterad somewhat hoary, genicular arch blackish, the remainder of the genicular region burnt sienna; caudal tibiæ crimson, faint laterad and touched with blackish on the genicular section, particularly on the internal face, spines and spurs tipped with black; caudal tarsi washed with crimson.

Measurements.

Length of body,	41	mm.
Breadth of head across eyes,	7.8	"
Breadth immediately ventrad of eyes,	6.8	"
Length of pronotum,	9.2	"
Greatest caudal width of disk of pronotum,	5.5	"
Length of tegmen,	37	"
Greatest width of tegmen,	7	"
Length of caudal femur,	19.5	"

The type is unique.

DIPONTHUS Stål.

1860. *Diponthus* Stål, Kongl. Svenska Fregat. Eugenies Resa, Ins., p. 328.

Included *Acridium nigro-conspersum* Stål and *Acridium electum* Serville, of which the first may be considered the type.

Diponthus paraguayensis Bruner.

1906. *Diponthus paraguayensis* Bruner, Proc. U. S. Nat. Mus., XXX, p. 657. [Sapucay, Paraguay.]

9 ♂, 11 ♀. December, 1902 and 1904; January, 1903; February and March, 1905.

This series shows that considerable variation is present in the intensity of the base color of the body and limbs, this being rather warm brown in some and decidedly olive green in others. The femoral bars are less distinct in some specimens than in others, due in the poorly contrasted specimens to a suffusion of the light bars with olive green. One specimen is washed with rosy red, a condition previously noted in species of this genus by Pictet and Saussure.

LEPTYSMA Stål.

1873. *Leptysma* Stål, Recensio Orthopterorum, I, pp. 42, 85.

Included *L. filiformis* (Serv.), *obscura* (Thunberg) and *marginicollis* (Serv.), of which the first may be considered the type.

***Leptysma filiformis** (Serville).

1839. *Opsomala filiformis* Serville, Orthoptères, p. 593. [North of the State of São Paulo, Brazil.]

5 ♀. February and March, 1905.

One of these specimens is decidedly rosy.

Leptysma obscura (Thunberg).

1827. *Tr[uxalis] obscurus* Thunberg, Nova Act. Reg. Soc. Scient. Upsal., IX, p. 79. [Brazil.]

3 ♂, 4 ♀. January, 1903; February and March, 1905.

The comparatively shorter head of this species readily separates it from the preceding species, which also has the caudal section of the head somewhat inflated when viewed laterad.

STENACRIS Walker.

Stenacris coccineipes (Bruner).

1906. *Arnilia coccineipes* Bruner, Proc. U. S. Nat. Mus., XXX, p. 659. [San Bernardino, Asuncion and Sapucay, Paraguay; Victoria, Brazil.]

1 ♂. March, 1905.

This specimen has the caudal tibiæ uniform red as in the type, but rather pale in color.

OXYBLEPTELLA Giglio-Tos.

1894. *Oxybleptella* Giglio-Tos, Boll. Mus. Zool. Anat. Comp. Torino, IX, No. 184, p. 33.

Type.—*O. sagitta* Giglio-Tos.

***Oxybleptella sagitta** Giglio-Tos.

1894. *Oxybleptella sagitta* Giglio-Tos, Boll. Mus. Zool. Anat. Comp. Torino, IX, No. 184, p. 33. [Villa Rica, Paraguay.]

4 ♂, 5 ♀. March, 1905.

These specimens show a slight variation in size in the female sex.

STENOPOLA Stål.

1873. *Stenopola* Stål, Recensio Orthopterorum, I, pp. 42, 83.

Type.—*Stenopola dorsalis* (Thunberg).

Stenopola bohlsii Giglio-Tos.

1895. *S[tenopola] bohlsii* Giglio-Tos, Zoolog. Jahrbücher, Abth. Syst., VIII, p. 813. [Paraguay.]

11 ♂, 7 ♀. February and March, 1905.

This series is quite constant in coloration.

ADIMANTUS Stål.

1878. *Adimantus* Stål, Bihang till K. Svenska Vet.-Akad. Handlingar, V, No. 4, p. 38.

Type.—*Oxya ornatissima* Burmeister.

Adimantus vitticeps (Blanchard).

1846. *Acridium vitticeps* Blanchard, in D'Orbigny, Voy. l'Amer. Merid., VI, pt. II, p. 216, pl. XXVII, fig. 4. [No locality cited.]

3 ♂, 4 ♀. March, 1905.

This series shows considerable variation in the suffusion of vermilion on the cephalic and median limbs, and also in the extent and intensity of the same color on the caudal tibiæ, one specimen having these in the greater part greenish and bluish black. In all the specimens the caudal tibiæ bear two median, more or less complete, annuli of bluish or bluish black.

Burmeister's *Oxya ornatissima* is probably distinct from this species, having, according to the original description, blue wings.

ZYGOCLISTRON Rehn.

1905. *Zygoclistron* Rehn, Entom. News, XVI, p. 39.

Type.—*Z. trachystictum* Rehn.

Zygoclistron trachystictum Rehn.

1905. *Zygoclistron trachystictum* Rehn, Entom. News, XVI, p. 39, figs. 1, 2 and 3. [Sapucay, Paraguay.]

12 ♂, 9 ♀. January to March, 1905.

This series shows that while color variation in the species is slight, the female sex exhibits a considerable amount of individual variation in size, the smallest measuring 10.2, 19 and 20.5 millimeters in the length of the pronotum, tegmen and caudal femur respectively, the largest having these parts 12.5, 21.5 and 24.5.

***Zygoclistron superbum** n. sp.

Types: ♂ and ♀; Sapucay, Paraguay. December 16, 1904 (♀), March 5, 1905 (♂). (William Foster.) [Hebard Collection.]

Allied to *Z. trachystictum* but differing in the more produced, more acute and more excavate fastigium, the less regularly divergent margins of the frontal costa, the more ovate eyes, the longer tegmina and wings (particularly in the female) and in the presence of maculations on the dorsum of the pronotum.

Size rather large; form moderately elongate; surface of head and abdomen smooth, of thorax rugulose. Head with the occiput not elevated to the level of the disk of the pronotum, slightly rounded and gently declivent to the fastigium, interocular region slightly narrower than the width of the eye in the male and equal to two-thirds the length of the eye in the female; fastigium with the apical margin slightly acute-angulate in both sexes, the immediate apex sharply defined, disk of the fastigium broader proportionately and less defined in the female than in the male, distinctly but not greatly excavate in the male, hardly so in the female; position of the lateral foveolæ filled with irregularly vertical rugæ in both sexes; frontal costa represented for a short distance dorsad merely by a high carinate ridge, which, however, distinctly expands with distinct lateral carinæ and a distinctly depressed median area, between them the margins in the male are regularly but not strongly expanded to the ocellus, immediately ventrad of which they are sharply constricted but return to their regular trend, in the female they expand more broadly dorsad and in continuing ventrad they separate but little more and have no appreciable constriction; eyes ovoid, slightly narrower dorsad, in the male the eyes are moderately prominent when viewed dorsad and in length they are distinctly longer (♂) or subequal to (♀) the infraocular sulcus; antennæ subequal to (♀) or slightly more than half as long again as (♂) the head and pronotum together, slightly depressed proximad. Pronotum moderately tectate and slightly inflated on the prozona, flattened except for the median carina on the metazona; cephalic margin broadly obtuse-angulate, the immediate apex blunt; caudal margin obtuse-angulate, the apex blunt and the margins slightly sinuate laterad; greatest caudal width of the disk contained one and a half times in the length; median carina prominent, slightly arcuate on the prozona and divided into three parts by transverse sulci, the cephalic part longer than the others, on the metazona the carina is slightly elevated cephalad decreasing in height caudad; prozona without distinct lateral shoulders, metazona with definite but well-rounded shoulders; lateral lobes considerably longer dorsad than deep, ventral margin obtuse-angulate, the angle slightly caudad of the middle. Tegmina somewhat exceeding the apex of the abdomen in the male, subequal in the female; costal

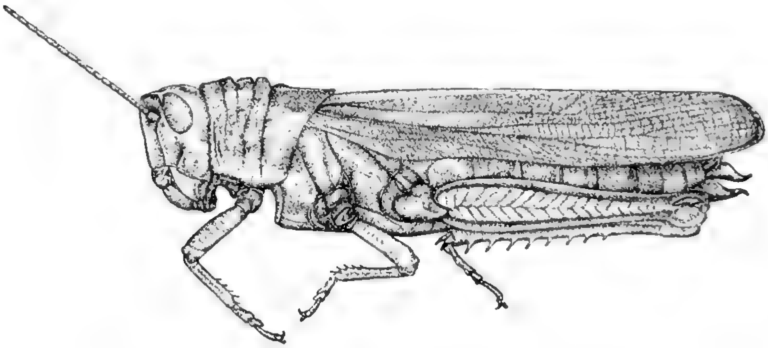

Fig. 12.—*Zygoclistron superbum* n. sp. Lateral view of female type. (× 1½.)

margin with a very slight proximal dilation, the distal third slightly rounded off, apex oblique rotundato-truncate; area between the median and discoidal veins in the middle of the tegmen supplied with ten to twelve transverse regularly placed veins arranged in a scalariform pattern, this feature being present in both sexes but larger and stronger in the male. Prosternal process slightly bent caudad, slightly inflated distad, rounded, slightly compressed; interspace between the mesosternal lobes extremely narrow, the lobes almost attingent in the male, in shape clepsydral; interspace between the metasternal lobes as wide as the mesosternal interspace in the male, considerably wider and sub-cuneiform in the female. Abdomen slightly compressed; furcula of the male present as very short and broad rounded lobes; supra-anal plate of the male broad and subequal in the proximal two-thirds, distad of this the margins are roundly incurved and then produced into the acute apex, median portion elevated, the proximal section with an enclosed longitudinal rectangulate area, the distal section with a pair of converging carinæ; cerci elongate, slender, bent falciform in a horizontal plane, the distal half moderately tapering, the median section slender, apex slightly depressed and with the tip sharp and slightly outcurved; subgenital plate compressed, the apex hooked, elevated and lamellate. Cephalic and median limbs short and robust, particularly in the male. Caudal femora hardly robust, the greatest width contained five times in the length which is equal to twice (♀) or slightly more than twice (♂) the length of the pronotum, the outline of the femora tapering slightly but regularly from the proximal third to the moderately inflated genicular region, carinæ distinct but not high, smooth, paginæ with the pattern distinct, chevrons moderately regular; caudal tibiæ about equal to the femora in length, lateral margins with eight to ten spines, internal margins with eleven to twelve spines.

General colors chromium green, bay and saffron yellow. Head with a broad irregular median longitudinal bar of dull yellow, margined laterad by bay; postocular regions green, genæ ventrad of the eyes obliquely yellow, the ventral margin touched with bay; face of the female bay, of the male faintly washed with the same and with a trace of a transverse yellowish bar; eyes cinnamon; antennæ wine purple. Pronotum bay with broad lateral yellow bars on the disk, these bars converging on the middle of the prozona and regularly diverging cephalad and caudad, the ventral margin of the lateral lobes also with a bar of yellow. Pleura greenish, the two pronotal bars on each side continued on them, the dorsal to the insertion of the caudal femur, the ventral to the insertion of the median femur. Abdomen yellowish. Tegmina greenish, the anal area yellow, this color as is also that of the pronotal and pleural bars brighter in the male than in the female. Wings washed with orange red proximad. Limbs greenish brown, the carinæ and paginæ marked but not conspicuously with purplish, genicular arches of the caudal femora bay; caudal tibiæ pale vinaceous, in the female the internal face and the internal faces of the internal spines marked with purplish black, in the male the internal faces of the spines alone are marked, tips of all the spines of the same color.

Measurements.

	♂	♀
Length of body,	36.5 mm.	54 mm.
Length of pronotum,	7.5 "	11.2 "
Length of tegmen,	30.5 "	38.5 "
Length of caudal femur,	17.5 "	22.8 "

A paratypic series of three males and four females, taken on dates in December, 1904, January, February and March, 1905, have also been examined. One of the females possesses slightly longer tegmina and wings than the others, and in several of the females the frontal costa is slightly constricted ventrad of the sulcus, but otherwise no important structural variation is noticed. In color the variation noticed is chiefly in the depth of the bay color and the brilliancy of the yellow, the blackish on the internal face of the caudal tibiæ also varying slightly in extent and intensity, being weak in some females and distinctly marked in two of the males.

ALEUAS Stål.

1878. *Aleuas* Stål, Bihang till K. Svenska Vet.-Akad. Handlingar, V, No. 4, pp. 25, 69.

Included *A. vitticollis, gracilis* and *lineatus* Stål, of which the first may be considered the type.

Aleuas brachypterus Bruner.

1906. *Aleuas brachypterus* Bruner, Proc. U. S. Nat. Mus., XXX, p. 667. [Sapucay, Paraguay.]

3 ♀. March, 1905.

Aleuas gracilis Stål.

1878. *A[leuas] gracilis* Stål, Bihang till K. Svenska Vet.-Akad. Handlingar, V, No. 4, p. 70. [Brazil.]

10 ♂, 4 ♀. February and March, 1905.

The individuals I have considered as representing the females of this species are short-winged as in *A. brachypterus,* but smaller than that species, with the fastigium more acute and the margins carinate, being in this respect a modified form of the structure of this portion in the male. The measurements of an average female are as follows: length of body, 45 mm.; length of pronotum, 10; length of tegmen, 10; length of caudal femur, 18.

PARALEUAS Giglio-Tos.

1898. *Paraleuas* Giglio-Tos, Bollett, Mus. Zool. Anat. Comp. Torino, XIII, No. 311, pp. 47, 57.

Type.—*P. bohlsii* Giglio-Tos.

Paraleuas fosteri Bruner.

1906. *Paraleuas fosteri* Bruner, Proc. U. S. Nat. Mus., XXX, p. 669. [Sapucay, Paraguay.]

1 ♂, 8 ♀. February and March, 1905.

These specimens vary considerably in color, the males being light yellow in the paler areas, the majority of the females dull gamboge on the same sections, while one has a very slight rather general pinkish-red suffusion.

JODACRIS Giglio-Tos.

1897. *Jodacris* Giglio-Tos, Bollett. Mus. Zool. Anat. Comp. Torino, XII, No. 302, p. 32.

Type.—*Anniceris ferrugineus* Giglio-Tos.

Jodacris ferruginea (Giglio-Tos).

1894. *A[nniceris] ferrugineus* Giglio-Tos, Bollett. Mus. Zool. Anat. Comp. Torino, IX, No. 184, p. 30. [Province of San Pedro, Villa Rica, Asuncion, Paraguay.]

3 ♀. March, 1905.

One of these specimens is slightly smaller than the others.

OMALOTETTIX Bruner.

1906. *Omalotettix* Bruner, Proc. U. S. Nat. Mus., XXX, pp. 642, 672.

Type.—*Jodacris*(?) *nebulosa* Bruner.

Omalotettix nebulosa (Bruner).

1900. *Jodacris*(?) *nebulosa* Bruner, Acc. Gen. Spec. Locusts Argentina, p. 67. [Asuncion, Paraguay; Province of Tucuman, Argentina.]

1 ♂, 3 ♀. February and March, 1905.

These specimens appear to be fully typical. One female individual is rather faintly suffused with rosy.

Omalotettix signatipes Bruner.

1906. *Omalotettix signatipes* Bruner, Proc. U. S. Nat. Mus., XXX, p. 673. [Sapucay, Paraguay.]

5 ♂, 9 ♀. February and March, 1905.

This series is readily separable from *nebulosa* by the blunter fastigium, as mentioned by Bruner, and also by the more robust caudal femora. It is apparent from this material that the lower external face of the caudal femora is not always black, specimens indistinguishable otherwise varying in this respect. In the cases where this is not black, it is of the color of the external femoral face. The maculation on the external face also varies in size and intensity.

VILERNA Stål.

1873. *Vilerna* Stål, Recensio Orthopterorum, I, pp. 38, 71.

Type.—*V. æneo-oculata* (De Geer).

Vilerna rugulosa Stål.

1878. *Vilerna rugulosa* Stål, Bihang till K. Svenska Veten.-Akad. Handlingar, V, No. 4, p. 61. [Peru; Rio Janeiro.]

1 ♀. April, 1902.

XIPHIOLA Bolivar.

1896. *Xiphiola* Bolivar, Actas Soc. Españ. Hist. Nat., XXV, p. 17.

Type.—*X. cyanoptera* Bolivar.

Xiphiola borellii Giglio-Tos.

1900. *X[iphiola] Borellii* Giglio-Tos, Boll. Mus. Zool. Anat. Comp., XV, No. 377, p. 5. [Urucum, Brazil.]

1 ♀. May, 1902.

This individual is slightly smaller than the specimen measured by the describer.

SCHISTOCERCA Stål.

Schistocerca infumata Scudder.

1899. *Schistocerca infumata* Scudder, Proc. Amer. Acad. Arts and Sci., XXXIV, p. 457. [Montevideo, Uruguay; Brazil.]

8 ♂, 10 ♀. February and March, 1905.

When compared with the closely allied *S. flavofasciata* (De Geer), the form of the male cerci is found to be a good diagnostic character, these being broadly truncate in *flavofasciata* and distinctly, but not greatly, tapering in *infumata*.

ATRACHELACRIS Giglio-Tos.

1894. *Atrachelacris* Giglio-Tos, Bollett. Mus. Zool. Anat. Comp. Torino, IX, No. 184, pp. 19, 20.

Type.—*A. unicolor* Giglio-Tos.

Atrachelacris unicolor Giglio-Tos.

1894. *Atrachelacris unicolor* Giglio-Tos, Bollett. Mus. Zool. Anat. Comp. Torino, IX, No. 184, p. 21. [Resistencia nel Chaco, Argentina; Asuncion, Paraguay.]

6 ♂, 10 ♀. January to March, 1905.

This is unquestionably true *A. unicolor*, as comparison with the original measurements demonstrates, the individuals recorded by Bruner as *A. unicolor* from Cordoba and Carcaraña, Argentina being distinct.

DICHROPLUS Stål.

1873. *Dichroplus* Stål, Recensio Orthopterorum, I, p. 78.

Included *D. arrogans patruelis, cliens* and *lemniscatus* (Stål), of which the first can be considered the type.

Dichroplus robustus Bruner.

1906. *Dichroplus robustus* Bruner, Proc. U. S. Nat. Mus., XXX, p. 679. [Sapucay, Paraguay.]

2 ♂, 2 ♀. February and March, 1905.

As the male of this species is at present undescribed, a few notes on the appendages of this sex may be of service.

Furcula present as very minute short fingers lying close together. Supra-anal plate broad with the apex obtuse-angulate and the median ridges approaching to about the middle of the plate, from which caudad they are subparallel. Cerci slender, long, distinctly tapering in the proximal half from a rather broad base to a slender rounded shaft, beyond which they have a slight ventral falcation, being also slightly compressed distad and with the apex acute. Subgenital plate rather short, conical, horizontal, margins straight and with a small apical indentation.

The females are slightly smaller than the measurements given by Bruner, but appear without doubt to be this species. All the specimens are darker than those described by Bruner.

Dichroplus paraguayensis Bruner.

1906. *Dichroplus paraguayensis* Bruner, Proc. U. S. Nat. Mus., XXX, p. 680. [Sapucay, Paraguay.]

7 ♂, 2 ♀. February and March, 1905.

These specimens appear to fully represent this species, which, without other material, would be hard in the female sex to distinguish from *robustus*. One female specimen measures, length of body, 31.5 mm.; length of pronotum, 7.5; length of tegmen, 24; length of caudal femur, 17.5.

Dichroplus exilis Giglio-Tos.

1894. *D[ichroplus] exilis* Giglio-Tos, Boll. Mus. Zool. Anat. Comp., IX, No. 184, pp. 23. [Resistencia nel Chaco, Argentina.]

1 ♂, 3 ♀. February and March, 1905.

Superficially this species bears some resemblance to *D. bergii*, but is, of course, a very different insect, the apparent similarity being chiefly in color pattern.

Dichroplus punctulatus (Thunberg).

1824. *Gr[yllus] punctulatus* Thunberg, Mém. l'Acad. Imp. Sci. St. Pétérsb., IX, p. 408. [Brazil.]

9 ♂, 14 ♀. September, 1901; January to March, 1905.

This series presents considerable variation in the intensity and shade of the pronotal markings, as well as in the depth of coloration of the dorsal face of the caudal femora.

Dichroplus dubius Bruner.

1906. *Dichroplus dubius* Bruner, Proc. U. S. Nat. Mus., XXX, p. 682. [Sapucay, Paraguay.]

1 ♂, 7 ♀. February and March, 1905.

These specimens are quite uniform in size, and in coloration vary but slightly in the intensity of the broken dorsal bars on the caudal femora. The very slender cerci of this species are quite peculiar.

Dichroplus bergii (Stål).

1878. *P[ezotettix] Bergii* Stål, Bihang till K. Svenska Vet.-Akad. Handlingar, V, No. 9, p. 6. [Buenos Ayres, Parana, Corrientes.]

15 ♂, 11 ♀. December, 1904; February and March, 1905; May, 1902.

This series varies considerably in the suffusion of the dorsum of the pronotum, and in the depth of color of the tegmina and dorsal face of the caudal femora as well as of the caudal tibiæ.

Dichroplus cinctipes Bruner.

1906. *Dichroplus cinctipes* Bruner, Proc. U. S. Nat. Mus., XXX, p. 683. [Sapucay, Paraguay.]

6 ♂, 12 ♀. February and March, 1905.

This series shows that considerable variation exists in the general size of the females and in the length of the tegmina and wings in the same sex.

LEIOTETTIX Bruner.

1906. *Leiotettix* Bruner, Proc. U. S. Nat. Mus., XXX, pp. 643, 684.

Type.—*L. viridis* Bruner.

Leiotettix viridis Bruner.

1906. *Leiotettix viridis* Bruner, Proc. U. S. Nat. Mus., XXX, p. 685. [Sapucay, Paraguay.]

12 ♂, 11 ♀. January to March, 1905.

This series is quite uniform in size and coloration.

Leiotettix punctipes Bruner.

1906. *Leiotettix punctipes* Bruner, Proc. U. S. Nat. Mus., XXX, p. 686. [Sapucay, Paraguay.]

12 ♀. February and March, 1905.

This species varies somewhat in size, specimens distinctly larger and smaller than the original measurements being in the series. The dorsal section of the external pagina is strongly purplish in the majority of specimens.

Leiotettix sanguineus Bruner.

1906. *Leiotettix sanguineus* Bruner, Proc. U. S. Nat. Mus., XXX, p. 687. [Sapucay, Paraguay.]

3 ♂, 1 ♀. January and March, 1905.

The pale portions of the genæ and pronotum in one specimen are more greenish than flavous.

Leiotettix flavipes Bruner.

1906. *Leiotettix flavipes* Bruner, Proc. U. S. Nat. Mus., XXX, p. 687. [Sapucay, Paraguay.]

5 ♂, 8 ♀. February and March, 1905.

This beautiful species appears to be quite uniform in coloration.

***Leiotettix hastatus** n. sp.

Type: ♂; Sapucay, Paraguay. February 3, 1905. (W. T. Foster.) [Hebard Collection.]

Closely allied to *L. flavipes* Bruner, but differing in the straight cerci, reddish caudal tibiæ, the non-emarginate cephalic margin of the pronotum and the more pronounced angle of the caudal margin of the same.

Size medium; form as usual in the genus. Head with the occiput hardly elevated above the level of the pronotal disk; vertex gently declivent to the fastigium, interspace between the eyes about two-thirds the width of one of the eyes; fastigium slightly broader than long, slightly depressed within the margins but not excavate; frontal costa rounded dorsad, rather broad, subequal in width, slightly constricted ventrad of the ocellus, sulcate for a considerable distance ventrad of the ocellus and around the dorsum of the same; eyes hardly prominent when viewed dorsad, ovate in outline, slightly flattened cephalad, in length slightly less than half that of the infraocular sulcus; antennæ somewhat shorter than the caudal femora, slightly flattened at the apex. Pronotum very slightly depressed mesad, disk slightly narrowed mesad, greatest width of the disk (caudal) contained about once and a half in the length; cephalic margin slightly arcuate, caudal margin obtuse-angulate with the immediate angle slightly flattened; median carina distinct but slight on the prozona, more apparent but low on the metazona, principal sulcus dividing the carinæ decidedly caudad of the middle; lateral angles

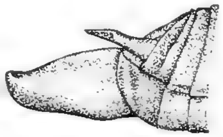

Fig. 13. — *Leiotettix hastatus* n. sp. Lateral view of apex of male abdomen. (× 6.)

rounded on the prozona, developing slight but apparent shoulders on the metazona; lateral lobes distinctly longer than deep, regularly narrowing ventrad, the ventral margin obtuse-angulate. Tegmina slightly exceeding the apex of the abdomen. Prosternal spine pyramidical, moderately acute, directed slightly caudad; interspace between the mesosternal lobes longitudinal, the length distinctly but not greatly exceeding the width; metasternal lobes attingent. Furcula developed as a pair of very short, slight separated fingers; supra-anal plate with the margins converging, a median lanceolate depression in the proximal half very marked; cerci rather short, tapering in the proximal half, the median width no more than half the proximal, distal half slightly compressed, the ventral margin rather straight, the dorsal with a slight expanded shoulder distad of the middle then continuing straight to the acute apex, external face of the distal half slightly excavate; subgenital plate considerably produced, scoop-like, the margin semi-elliptical when viewed dorsad, when viewed laterad straight in the proximal portion but slightly emarginate and depressed distad, the apex on a plane with the base. Cephalic and median limbs with the femora moderately inflated. Caudal femora robust, the length about two and one-half times that of the pronotum and the breadth contained about three and a half times in the length, paginæ distinctly but not very deeply sculptured; caudal tibiæ with nine spines on each margin.

General colors russet, olive-green and gamboge yellow; the russet coloring the tegmina, strongly proximad, weakly toward the apex; the olive-green present in rather broad lateral bars extending from caudad of the eyes across the pronotum and weakly coloring the dorsal exposed portion of the pleura, the dorsal face and the dorsal half of the lateral face of the caudal femora as well as the median and cephalic limbs of the same color; the gamboge yellow colors the genæ, the ventral portion of the lateral lobes of the pronotum, the greater portion of the pleura and the ventral half of the lateral face of the caudal femora. Face very dull olive-green, the dorsum of the head much the same color, separated from the postocular bars by a faint bar of yellow; eyes walnut brown; antennæ cinnamon, darker distad. Pronotum with the dorsum burnt umber with the faintest possible traces of longitudinal lateral bars. Abdomen clay-color. Caudal femora with the genicular arches clove brown, internal face and ventral face and sulcus except for a narrow yellow pregenicular area poppy red; caudal tibiæ washed with dilute orange-vermilion, the spines buffy tipped with black.

Measurements.

Length of body,	24.5	mm.
Length of pronotum,	5	"
Length of tegmen,	18.2	"
Length of caudal femur,	13	"

The type is unique.

SCOTUSSA Giglio-Tos.

1894. *Scotussa* Giglio-Tos, Bollett. Mus. Zool. Anat. Comp. Torino, IX, No. 184, pp. 20, 24.

Type.—*S. impudica* Giglio-Tos.

Scotussa rubripes Bruner.

1906. *Scotussa rubripes* Bruner, Proc. U. S. Nat. Mus., XXX, p. 688. [Sapucay, Paraguay.]

3 ♂, 3 ♀. January to March, 1905.

As stated by Bruner the superficial resemblance of this species to *Leiotettix flavipes* is very great. The male being hitherto unknown some remarks on the appendages may be pertinent.

Furcula very short, minute, placed close together. Supra-anal plate evenly depressed distad. Cerci slender, elongate, tapering in the proximal half, distad of this slightly compressed, slightly falcate, acute and with a distinct sigmoid curve toward the median line. Subgenital plate slightly produced, broad, rather shallow, the apex rectangulate.

The measurements of a male specimen are as follows:

Length of body,	21	mm.
Length of pronotum,	4.5	"
Length of tegmen,	17	"
Length of caudal femur,	10.5	"

PARASCOPAS Bruner.

1894. *Scopas* Giglio-Tos, Bollett. Mus. Zool. Anat. Comp. Torino, IX, No. 184, pp. 20, 28. (Not of Bonaparte.)
1906. *Parascopas* Bruner, Proc. U. S. Nat. Mus., XXX, p. 689.

Type.—*Scopas obesus* Giglio-Tos.

Parascopas obesus (Giglio-Tos).

1894. *S[copas] obesus* Giglio-Tos, Bollett. Mus. Zool. Anat. Comp. Torino, IX, No. 184, p. 29, pl. figs. 5 and 6. [Province of San Pedro, Asuncion, Paraguay.]

10 ♂, 11 ♀. February, 1903 and 1905.

CHLORUS Giglio-Tos.

1898. *Chlorus* Giglio-Tos, Boll. Mus. Zool. Anat. Comp., XIII, No. 311, p. 50, footnote.

Type.—*Paradichroplus borellii* Giglio-Tos.

Chlorus vittatus Bruner.

1906. *Chlorus vittatus* Bruner, Proc. U. S. Nat. Mus., XXX, p. 690. [Sapucay, Paraguay.]

1 ♀. February, 1905.

This specimen fully answers the original description, except that the median carina of the pronotum is hardly perceptible.

OSMILIA Stål.

1873. *Osmilia* Stål, Recensio Orthopterorum, I, p. 68.

Included *Acrydium flavolineatum* De Geer, *Gryllus violaceum, rufipes* and *obliquum* Thunberg, of which *flavolineatum* may be considered the type.

Osmilia violacea (Thunberg).

1824. *Gr[yllus] violaceus* Thunberg, Mém. l'Acad. Imp. Sci. St. Pétérsb., IX, p. 413. [Brazil.]

11 ♂, 9 ♀. January to March, 1905.

This series presents some variation in the depth of the ground color and also in the presence or absence of weak tegminal maculations.

MAY 7.

ARTHUR ERWIN BROWN, D.Sc., Vice-President, in the Chair.

Twenty-one persons present.

The Chair announced the death of William K. Shryock, a member, April 28, 1907.

The Publication Committee reported that papers under the following titles had been presented for publication:

"Description of New Species of Spioniform Annelids," by J. Percy Moore (April 26).

"A Contribution to the Morphology of Pyrula," by Burnett Smith (April 29).

"The Hymenopterous Family Evaniidæ," by J. Chester Bradley (April 3).

Origin of the Tropical Forms of the Land Molluscan Fauna of Southern Florida.—DR. H. A. PILSBRY remarked that former writers on this fauna have treated the tropical area in Florida as an outlier of the Antillean zoological province. The speaker recognized two groups of genera, of diverse origin: (1) Antillean genera, consisting chiefly of species also West Indian, such as *Chondropoma, Liguus, Cepolis, Varicella,* etc., concentrated southward, and unknown in the Floridian Pliocene, and (2) Mexican genera, chiefly composed of species confined to Florida, such as *Euglandina, Praticolella, Drymœus* of the *dormani* type, and apparently *Polygyra,* some of which are represented in the Floridian (Caloosahatchie) Pliocene. The first group he regarded as recent additions to the fauna, which had reached Florida from Cuba and the Bahamas by the agency of hurricanes, drifting trees and the like. The second group probably emigrated from the Southwest during the mild Miocene climate, and entered peninsular Florida on the elevation marking the close of the Miocene. The Oligocene fauna of the Tampa Silex beds, the speaker thought, had left no descendants. Its snails were of wholly Antillean type, the leading Antillean genera of Helices, *Cepolis* and *Pleurodonte* both being represented.

Dr. Pilsbry alluded also to Prof. Alexander Agassiz's conclusion, that the Florida Keys are in process of diminution by solution of the limestone composing them. The former unity of keys now separated accounts for the homogeneity of their land-shell faunas.

Note on the Value of the Gastropod Apex as a Means of Classification.—Dr. **Burnett Smith** remarked that studies recently made among Tertiary and recent Gastropods tend to show that the importance of the "protoconch" as a means of generic discrimination has been greatly exaggerated. An examination of the species of *Pyrula* with rounded whorls (*P. ficus, P. papyratia, P. mississippiensis, P. condita,* etc.) has shown that with slight exceptions *the chief specific modifications have been introduced not into the later adult whorls, but into the early whorls.* On tracing the genus back in time it is seen that on the whole the apices become smaller and the smooth whorls are more numerous. Nevertheless we find that at the present day both the small (generalized) and the large (specialized) apices are found. The Panamic form (*P. decussata*) is furnished with the primitive type of apex, while the Gulf and Caribbean representative (*P. papyratia*) has the large specialized apex with but one smooth whorl.

The Texas and Louisiana Lower Claiborne races of the species commonly known as *Volutilithes petrosus* constitute still another monophyletic assemblage, though in this case a more restricted one. Here it has been observed that again the chief modifications are exhibited by the apical smooth stage, while the later ontogenetic stages remain relatively unchanged.

John W. Harshberger, Ph.D., spoke of the influence of chemicals on the development of the bud. (No abstract.)

May 21.

Arthur Erwin Brown, D.Sc., Vice-President, in the Chair.

Thirty-eight persons present.

The Publication Committee reported that papers under the following titles had been presented for publication:

"The Polycystid Gregarines of the United States" (third contribution), by Howard Crawley (May 13).

"A New Species of Athleta and a Note on the Morphology of Athleta petrosa," by Burnett Smith (May 15).

"New and Little-known Whelks from Northern Japan and the Kuril Islands," by H. A. Pilsbry (May 16).

"The Distribution of the North American Gordiacea, with Description of a New Species," by Thomas H. Montgomery Jr. (May 21).

P. Chalmers Mitchell, of London, was elected a correspondent.

The following were ordered to be printed:

DESCRIPTIONS OF NEW SPECIES OF SPIONIFORM ANNELIDS.

BY J. PERCY MOORE.

The following descriptions of four species of Spionidæ and one of Magelonidæ are based upon material mostly included in the collection of Polychæta belonging to this Academy, and which, with one exception, was secured by the writer in the region about Wood's Hole, Massachusetts.

Prionospio heterobranchia sp. nov.

This very interesting and distinct species is based upon a single imperfect specimen lacking the posterior end, and having a length for the first 65 segments of 12 mm., and a maximum width at somite VIII of less than ½ mm. Form very slender, widest and depressed in the branchial region, thence tapering very gently into the very slender and subterete posterior region.

Prostomium (Plate XV, fig. 1) elongated cuneiform, tapering behind to a slender point which overlaps somite II and reaches to its posterior margin; lateral margins with slight concavities opposite the eyes for the accommodation of the bases of the tentacular cirri; anterior margin entire and broadly rounded; a conspicuous median ridge begins just anterior to the eyes and, becoming more prominent, reaches to the posterior end of the prostomium, where it forms a slightly free and elevated process. Eyes one pair, very large and conspicuous, elongated, black, situated close together at the sides of the median ridge and between the bases of the tentacular cirri. No cephalic appendages. Peristomium closely united to prostomium, relatively small, somewhat pushed forward below as an oral papilla in the form of a truncated cone; at the sides and above embracing the prostomium laterally as slender, curved, lateral cephalic lobes much shorter than the prostomium and ending in rounded enlargements anterior to the attachment of the tentacular cirri, which have unfortunately been lost. Proboscis protruded in the form of a short inverted cone with a somewhat crenulated border extending slightly beyond the prostomium.

Somites II to VI wider and much depressed; VII to X of the same width but becoming deeper; after X the segments become gradually more slender and terete and taper gently caudad. Branchial segments very short, the others about ⅔ as long as wide and feebly marked.

Parapodia of branchiate segments II to V large and conspicuous (figs. 2 and 3); both notopodia and neuropodia provided with large, foliaceous, postsetal laminæ, usually overlapping or at least touching across the sinus; the former rising as a long dorsal process external to but quite free from the gill; the latter nearly circular, and in the case of the first one (II) apparently bearing a slender cirrus-like process on the ventral border. Behind V the parapodia are much smaller and soon become reduced to the form shown in fig. 4, in which the notopodial and neuropodial postsetal lamellæ have a similar form, but the former is twice the size of the latter. Posteriorly they become still smaller.

Branchiæ 5 pairs, on somites II to VI inclusive. All large, exceeding the diameter of the body even in contraction, erect, and arising from the dorsum close to the notopodia. The first pair (fig. 2) have a central stem containing a large vascular loop and ending in a slender, free filament. The basal $\frac{2}{3}$ of the stem is crowded, chiefly on the posterior and medial surface, with numerous slender, finger-like processes, each with a small vascular loop connected with the two limbs of the stem loop; free surfaces ciliated. The last pair are similar, but the papillæ are longer toward the base and distributed on all sides of the proximal $\frac{2}{3}$ of the stem (fig. 5). The 2d and 3d (fig. 3) are simply flattened and ligulate, marked across the posterior face by numerous very fine transverse ridges which correspond with delicate branches uniting the two sides of the vascular loop. The 4th is intermediate, resembling the last in form, but bearing a few filaments along its inner and posterior margin.

Anterior parapodia bear capillary setæ exclusively, arranged in shaggy, fan-shaped, vertical tufts in both rami, and curving outward and upward, the dorsal members of bundles on the branchial notopodia being especially long, and those of the first two exceeding the width of their respective somites. They are all simple, with very narrow wings or none, and very acute. Behind the branchial region the notopodials become gradually, and the neuropodials quickly, smaller and fewer. At about XL 1 or 2 crochets appear in the notopodium along with several very long, thread-like, flexible setæ. Little further change occurs within the length of the specimen. In the neuropodium crochets appear at XV; at XXV there are 6 or 7 crochets alternating with as many very small, straight, delicate setæ; at L there are about 10 crochets and a few still smaller setæ. Crochets (fig. 6) colorless, slender, terminated by 1 large and 3 or 4 small teeth, all enclosed in a spacious hood of two halves.

Body walls generally colorless and translucent, allowing the red blood in the anterior part and the olive-green intestine in the posterior part to show through; tentacular cirri with a red central vessel and gills red throughout.

The type and only specimen (Coll. A. N. S. P., No. 850) was dredged from the soft ooze at the bottom of the deepest part of the Eel Pond at Wood's Hole on August 4, 1902. Several subsequent searches have failed to reveal any others.

Prionospio tenuis Verrill, the only species definitely described from our shores, has four minute eyes and four pairs of gills, of which the first only is branched, the others being foliaceous. A larger specimen, probably representing a distinct species, is recorded as having all of the 4(?) pairs of branchiæ lanceolate and pectinate posteriorly, with slender papillæ. Webster and Benedict record an undetermined species at Provincetown, Massachusetts. The four or five European species are all easily distinguished by the characters of the prostomium, gills and crochets.

Numerous species of *Polydora* have been described from both sides of the Atlantic. Eight species occur in the region about Wood's Hole, the following two of which are new and rather closely related.

Polydora anoculata sp. nov.

Form very slender and elongated, anterior half depressed and of nearly uniform width; posterior half gently tapered, nearly terete. Length up to 20 mm., breadth at VI 35 mm. Number of segments about 98.

Prostomium (Plate XV, figs. 7, 8 and 9) about 3 or 4 times as long as broad, not prolonged caudally beyond somite II, but truncate or broadly rounded; anterior half abruptly bent downward, with a steep front; sides straight or slightly concave in anterior half; anterior end cleft medially, the halves diverging as a pair of rather prominent, short, rounded lobes, which may be drawn together or separated. Eyes totally absent and no nuchal ridge nor nuchal cirrus.

Peristomium (figs. 7, 8 and 9) bounding mouth by a small simple posterior lip; lateral cephalic lobes nearly meeting below, compressing the ventral portion of prostomium between them and extending as far forward as the base of anterior prostomial lobes. Tentacular cirri arising from posterior dorsal region of peristomium, in contact with sides of prostomium, rather stout, length three or four times width of body, reaching to XIII or XV, constricted at base, then widened, then tapered to blunt tip, channeled for entire length, and much wrinkled transversely.

Segments all well marked, uniannulate, those of the anterior $\frac{1}{3}$

depressed, the remainder terete or subterete, strongly convex below, more or less flattened above; the first 4 very short, about five times as wide as long, nearly straight laterally; the next (VI) enlarged, nearly twice as long as the preceding, strongly convex laterally, and widest in front. The others gradually increase in length until the middle ones are ½ to ¾ as long as wide. Posteriorly they again become very short and close to the pygidium minute. Pygidium (figs. 10 and 11) bearing a small, scarcely expanded, somewhat funnelform caudal disk as wide as the small posterior segments and less than one-half the greatest width of the body, the margin even, with only a very faint ventral emargination and a deep dorsal cleft which passes into the slight fecal groove. Anus dorsal of the center, on a small papilla.

Parapodia of II with rami widely separated, the notopodium (fig. 7) immediately behind the base of the tentacular cirrus, and consisting of a minute setigerous tubercle and a short papilliform cirrus or postsetal lobe; the neuropodium at the level of the notopodia of succeeding somites, but otherwise of normal form. Succeeding parapodia are strictly lateral, with well separated rami; the notopodia at first with rather large foliaceous, postsetal lamellæ projecting dorsal, and after the gills appear gradually diminishing (fig. 12); neuropodia with longer lower postsetal lamellæ which practically disappear after somite VII. Branchiæ (fig. 12) appear on X on all specimens studied, the first very small, and continue to LIII at least. When best developed they are short, thick, digitiform and extend over the dorsum, meeting or nearly meeting in the middle line. They have the usual structure.

Somites II–V and VII bear capillary setæ only. Notopodials of II 5 or 6, very slender, delicate, and wingless; the others bear 4–6 longer, slender, slightly curved, and narrowly bilimbate dorsal setæ, and about as many shorter, coarser, often twice-bent, bilimbate ventral setæ. Neuropodia bear 12 or 14 setæ in 2 rows; they are similar to the notopodials, but, except on II, distinctly shorter and more strongly curved. Behind VII the notopodal setæ (figs. 13) are at first similar, but after the gills appear their number is reduced and they gradually become longer, more slender and straighter, those of posterior segments exceeding the diameter of the body. No notopodial crochets. Crochets appears in the neuropodia at VIII, which, like the next 3 or 4 segments, contains 2 or 3 accompanied by 1, or rarely 2, very delicate setæ at the ventral end of the series; for the remainder of the length there are 3 or 4 crochets and no setæ. Crochets (fig. 17) are delicate, colorless, strongly bent near the end and provided with a stout tooth arising at a wide angle (about 110 degrees), and above it an accessory tooth; both enclosed in a delicate hood. On VI from 4 to 6 sessile spines are arranged in a slightly oblique series, diminishing in size from above downward. They (figs. 16 and 23) are pale yellow, rather slender, the blunt tips rather strongly hooked, a prominent subterminal spur on one side, and a smaller one often on the other. Guard setæ (fig. 15) form a row anterior to and alternating with the spines; when unworn they are broadly bilimbate at the end with a delicate and elongated mucron. Overlapping the anterior-most spine from the dorsal side are 2 or 3 much larger bilimbate setæ (fig. 14), abruptly bent and either truncate or mucronate at the tip. A ventral posterior tuft beneath the last spine contains 4 or 5 much more delicate, nearly straight setæ, closely resembling the guard setæ.

Color of intestine usually pale yellow; body walls translucent, without pigment; blood red, coloring the gills and other parts.

Known from the region about Wood's Hole only. Uncommon. Usually taken in association with colonies of *Amaræcium pellucidum* in 7–17 fathoms in Vineyard Sound. Less often on piles among *Cynthia* in Little Harbor and with *Polydora colonia* at Vineyard Haven.

Type Coll. Acad. Nat. Sci. Phila., No. 2,338.

A specimen taken on July 14th contained nearly mature eggs.

Polydora colonia sp. nov.

Form elongated and very slender, resembling *P. anoculata* and of about the same size or rather smaller. Number of somites unknown. Length of head and 38 somites 6 mm., width at VI 3 mm. Depressed anteriorly, subterete farther back.

Prostomium (Plate XV, fig. 18) elongated; anterior half with straight sides and of nearly uniform width, posterior half tapering into a nuchal ridge which ends in a blunt point at the posterior margin of IV; anterior margin broadly rounded, entire or slightly emarginate. Eyes usually totally absent, but occasionally a small collection, or two, of pigment, as in the specimen figured.

Peristomium united with prostomium and somite II, forming a simple posterior lip and a pair of prominent lateral cephalic lobes much shorter than prostomium. Tentacular cirri attached to dorsum of lateral cephalic lobes, not constricting prostomium. The basal half has the usual structure and proportions, but the distal half, probably owing to maceration, is very slender and elongated, the total length being about 7 times the width of VI (fig. 18). The next four segments are very short and much depressed; VI is nearly as long as the three preceding segments, strongly convex and furrowed laterally, widest anteriorly. Succeeding segments rapidly increase in length until by XIII they are $\frac{2}{3}$ as long as wide, becoming also subterete, strongly convex below and somewhat flattened above. Pygidium unknown.

Except the first (on II) the parapodia are larger than usual. That of II consists of a minute notopodial setigerous tubercle and papilliform postsetal lobe immediately behind the base of the tentacular cirrus, and a small neuropodium situated at the level of the notopodia of succeeding segments. Succeeding parapodia have prominent foliaceous postsetal lamellæ on both rami, but with the appearance of crochets on VIII the neuropodium becomes much reduced.

Gills begin on VIII or sometimes IX and continue to XXVIII, at least, arising from the dorsum in contact with the base of the notopodium; form subcylindrical, rather short, apparently never long enough to meet across the back, but their bases connected or nearly connected by a low, ciliated, delicate, transverse fold.

Setæ of II few and very small, the notopodials only 3 or 4, very slender and delicate, the neuropodials 6 or 8, short, slightly curved and narrowly bilimbate. Succeeding notopodial setæ rather conspicuous and numerous for the genus, anteriorly about 18–20, arranged in 2 rows, the dorsalmost (fig. 19*a*) longest and rising prominently over the back, narrowly bilimbate, very slender and little curved, the ventralmost (fig. 19*b*) much shorter, often doubly curved, with much broader wings and acute awn-like tips. Toward the middle of the body the number decreases and all the setæ become more slender and elongated. Anterior neuropodials also in two vertical rows of usually 6 or 7 each, all smaller and more strongly curved than the notopodials. Crochets appear abruptly in the neuropodium of VIII and never, so far as observed, are accompanied by capillary setæ. Anteriorly there are 3, farther back 5 or rarely even 6. They are colorless, slender, with a long acute beak and slender erect accessory tooth and are enclosed distally in a delicate hood, composed of a pair of well separated guards (fig. 22). On somite VI there are almost invariably three (in only one case out of many four) pale yellow spines in a strictly vertical row (figs. 20, 21). They are straight, slightly enlarged at the end where they bear a principal and an accessory blunt, straight, conical tooth, below which, on the posterior face, is a half-round sheath ending in a free border on the side of the small tooth and forming a flange encircling the base of the large tooth on the opposite side (figs. 20*a* and 21). On the anterior side of these spines and alternating with them are a corresponding number of broadly bilimbate setæ, and a group of 3 or 4 similar and perfectly straight setæ lies just dorsad of the spines. Ventral and slightly anterior to the lowermost is a second group of similar but much smaller setæ (fig. 20).

Lives abundantly in colonies formed of soft mucoid tubes covered with fine silt in the interstices of tunicates and sponges on wharf piles in the harbor of Vineyard Haven, Massachusetts. Individual tubes are less than 1 mm. in diameter and from 20–30 mm. long. Hundreds of them are inextricably intertwined and cemented together with mucous, forming masses 1 or 2 inches in diameter. Specimens taken at the end of July contain large eggs which begin at somite XVI or XVII.

The type is No. 2324 (Coll. Acad. Nat. Sci. Phila.).

Unfortunately all of the numerous specimens were preserved in the tubes and are more or less macerated and the posterior ends lost. The setæ, however, and especially the spines and associated setæ on VI, are perfectly characteristic and serve to distinguish the species completely from any European or American species.

Magelona rosea sp. nov.

Form very slender, body slightly depressed anteriorly, tapering very gradually and subquadrate posteriorly. Length 40 mm., greatest width 1 mm. Number of segments about 95.

Prostomium and peristomium completely coalesced to form a head (Plate XVI, fig. 24) of a broad ovoid form, about $\frac{1}{4}$ long erthan broad but capable of much greater elongation during life. A pair of dorsal cephalic ridges, in contact medially, extend for nearly the entire length of the head, tapering to acute points anteriorly, and near the end suddenly diverging, leaving a thin triangular area between. Anterior and lateral portions of prostomium formed by a thin but rigid shovel-like expansion marked on the dorsal surface by a number of delicate raised sub-parallel lines. No prostomial appendages and no eyes.

Peristomium dorsally consisting of the posterior portion of the cephalic ridges and a pair of prominent lateral lobes, again subdivided by a groove extending from the posterior margin; ventrally a simple ring bounding the mouth behind. Tentacular cirri (fig. 24) arising from the sides of the peristomium above the mouth and beneath the margins of the prostomial plate. They are 8 mm. long, reaching somite XX, delicate, and tapering, the lateral surface covered with very fine and close transverse ridges, the medial with somewhat coarser but still very small papillæ which increase in length to the distal half where they are as long as the diameter of the cirrus. Proboscis soft, bulbous, protruded to half the length of the head and marked with numerous fine longitudinal parallel ridges.

Metastomium slender and of nearly equal diameter throughout, only the anterior 8 segments and the tapered caudal end being distinctly narrower; margins of body even and regular, the parapodia being small and inconspicuous and arising from small, slightly depressed rings; segments more or less distinctly divided into dorsal, ventral and lateral fields by longitudinal furrows above and below the parapodia, the latter forming interpodal wrinkled glandular areas, and the ventral field divided by a median neural groove, which becomes obscure posteriorly. Anterior region, consisting of peristomium and nine podous segments, separated from the posterior region by a deep annular groove in which the ninth pair of parapodia lie (fig. 24); its segments somewhat narrower than those of the posterior region and without distinct intersegmental furrows, the distance between successive parapodia about ¾ the width. Ventral median field occupied by a series of slightly overlapping, segmental ventral plates, which become smaller from in front caudad and are divided into halves by the neural groove; lateral fields distinctly bounded and much furrowed transversely. Distinct glandular bands or half-rings extend across the dorsum between the parapodia, and several small and irregular transverse furrows mark the dorsum and sides of each segment, dividing it imperfectly into about 3 incomplete rings. Posterior region slightly wider than the anterior and consisting of 84 or 85 segments; first segment very short, but the others increasing in length until they are about half as long as wide; ventral field distinctly wider than dorsal, without ventral plates and divided by a deep ventral groove. Throughout most of this region the parapodia lie in the deeper furrows, and a shallower furrow is only obscurely indicated a short distance caudad to each pair. Farther back it becomes clear that the segments are biannulate and that the parapodia lie between the larger anterior and smaller posterior annulus.

Pygidium very small, oblique, with the anus dorsal and covered by a broad flat papilla; below and behind the anus a pair of small, slender cirri, often replaced by a pair of minute papillæ.

Parapodia all biramous and more or less foliaceous, the first 9 pairs with capillary setæ only, the others with crochets only in both rami. The first 8 pairs consist of winglike, foliaceous, postsetal laminæ, the notopodial being somewhat broader and strongly curved ventrad to meet the neuropodial, which is longer and projects more directly laterad; both somewhat contracted at the base to form a stem, which bears the spreading, fan-shaped tufts of setæ, the neuropodial being somewhat the larger. The ninth parapodium (fig. 26) is similar but rather larger and has a more extensive series of setæ. In the posterior region the neuropodia and notopodia consist of vertical ridges, each bearing a series of 18–20 crochets and ending in minute notopodial and neuropodial cirri, while from their contiguous ends arise foliaceous expansions borne on short stems (figs. 27–29). These expansions increase somewhat in size to the middle of the body and bending toward each other overlap broadly, but farther back they become much reduced in size and the cirri disappear, simultaneously with an increase in the number of crochets.

Setæ of both rami of the first nine pairs of parapodia (II–X) all capillary, colorless, moderately slender, not greatly elongated, with curved and tapered stems very delicately bordered by margins which are broad on the concave and narrow on the convex side; arranged in one regularly spaced series of from 15 to 30 and spreading in a broad fan-shaped figure. Except that they are slightly longer, the notopodials differ in no noticeable respect from the neuropodials, and except that they are rather longer, more numerous and in part arranged in double series, those of the tenth somite are exactly like the preceding ones. Posterior to somite X both rami bear hooded crochets only, in simple series facing each other; anteriorly each series contains 15 to 20, posteriorly as many as 30. They (fig. 30) are little exposed, colorless, slightly tapered distally, where they terminate in an abruptly hooked blunt beak, surmounted by a smaller tooth and enclosed in a pair of wide guards.

Color translucent white, the intestine varying from buff to greenish-brown, pharynx salmon pink, both showing through body walls; blood madder pink, especially conspicuous in the tentacular cirri which contain a large vascular loop.

Specimens taken during the latter part of August contain nearly ripe eggs in the middle segments of the body.

Type No. 1677, Coll. Academy of Natural Sciences of Philadelphia.

Lives in sand at and below low water, forming soft sand tubes under stones, etc. As the worm crawls the pharynx is everted as a tumid fold or bulb reaching half the length of the head, the ventral median part being most prominent and marked by delicate longitudinal furrows.

This species has been found only on a sandy beach, chiefly below low water, in a little shallow bay on the Buzzard's Bay side of Wood's Hole. Prof. E. A. Andrews found it at the same place about ten years before it came to my notice, and has described a specimen under the name of *M. papillicornis* Müller. The remarkable larvæ have been described by Fewkes (as *Prionospio tenuis*) from Newport, and by Andrews from Beaufort, N. C., and Wood's Hole.

Magelona papillicornis was originally described by Fritz Müller in 1858 from specimens taken off the coast of Brazil. Since then it has been repeatedly recorded from various parts of Europe, and because of its remarkable characters has been much studied. As mentioned above, Andrews was the first to recognize *Magelona* on the coast of North America. More recently Johnson has described a very distinct species from Puget Sound.

Hitherto the North Atlantic species has always been considered identical with the Brazilian species, the very noteworthy difference in the color of the blood of the two having been curiously overlooked. Müller describes his species as having pale violet blood, whereas all specimens from the North Atlantic have madder pink blood. Müller's description is very brief, and the other characters mentioned are generic only. It is quite probable that when the Brazilian species is better known other characters than the color of the blood will be found to distinguish it from ours. Comparison of Wood's Hole specimens with the excellent figures of parapodia given by McIntosh and Mesnil make it clear that the European species again is quite distinct from ours and will require to be named. The most obvious difference is that the setæ of the tenth somite of the former are provided with a bulbous terminal enlargement and small process, while those of *M. rosea* are unmodified.

Spionides japonicus sp. nov.

Known from the anterior end only. Size large, probably not less than 4 or 5 inches long, moderately slender. The type, consisting of the head and 44 setigerous somites, is 25 mm. long and 2.5 mm. wide. A fragment from the postbranchial region indicates a still larger worm, having a width of nearly 4 mm.

Prostomium (Plate XVI, fig. 31) flattened, subtriangular, nearly as broad as long, the base anterior; anterior margin very broad, divided into a low, wide, median lobe and a pair of narrow, bluntly rounded lateral lobes directed toward the sides; lateral margins concave, meeting in the blunt, rounded apex which is slightly elevated and bears a slender, suberect nuchal cirrus, behind which a low, narrow ridge continues along the dorsum. Eyes 1 pair, large, conspicuous, reddish-brown, crescentic, situated at a slight widening behind the middle of the prostomium; just anterior to each of them is a curved series of small reddish-brown pigment specks.

Peristomium forming lower lips and lateral cephalic lobes; the latter small, rounded laterally and becoming very narrow posteriorly, where they disappear beneath the prostomium just behind the level of the eyes. Tentacular cirri missing, their faint scars of attachment on the dorsum of the lateral lobes just anterior to the level of the eyes. Body segments short and rather indistinctly defined; much concealed by the foliaceous parts of the parapodia; body rather strongly depressed, gently convex above and below.

Parapodia very conspicuous, so large that they completely envelop the body and give somewhat the appearance of a series of thin disks strong upon an excentric band. They are very broadly attached and the two rami nearly continuous, with extended setigerous tubercles, low presetal lobes, and very large and foliaceous postsetal lamellæ. The first (fig. 31) is relatively small and lies by the side of the prostomium, the posterior part of which is crossed by the notopodial setæ. On the next few both postsetal lamellæ increase rapidly in size, the notopodial soon predominating over the neuropodial and extending dorsally and ventrally. In this region the neuropodial lamella (fig. 32) is formed much like the quadrant of a circular disk, and the notopodial lamella like a narrow palette, broadly rounded above and with an auricular process below which is absent or little developed in the most anterior parapodia. The notopodial lamellæ meet or overlap medially and touch the neuropodial lamellæ below. After somite XXX the notopodium gradually becomes smaller and withdraws from the dorsum. By XXXVIII it is strictly lateral and its postsetal lamellæ is no larger than that of the neuropodium, and leaves the dorsum entirely exposed. Simultaneously with this change a delicate transverse integumental fold appears on the dorsum, connecting the bases of the notopodial lamellæ of the two sides. At first quite insignificant, these increase in height as the branchiæ diminish and by XLII their lateral parts are nearly half as high as the lamellæ which they connect, but the medial part is much lower.

The first 3 pairs of parapodia are free, but all others are united continuously along each side by a thin lateral fold of integument, which is attached to the sides of the body ventrally and whose dorsal border is free between the parapodia but attached to each neuropodium for the full height of its base and for a short distance above it. Thus is formed a series of deep interpodal pockets widely open above.

Branchiæ arise from the dorsum just above the base of the notopodial lamella from III to XLII inclusive, largely concealed behind the medial ends of the lamellæ. The first 2 or 3 are rather small, but they soon increase in size and rise erect far above the notopodial lamellæ. The last 10 gradually diminish before they finally disappear. Typical branchiæ (fig. 32) are more or less flattened, ligulate, tapered and unbranched. They contain large axial bloodvessels, from which pinnate loops branch on either side, corresponding with slight surface plications.

Capillary setæ alone are found on both rami of parapodia of the branchial region. They form broad spreading fan-shaped tufts and are very numerous (40 or more notopodials and even more neuropodials) and arranged in two vertical rows, a long seta of the posterior being always paired with a shorter one of the anterior row; much the longest and most slender in dorsal part of notopodium, stouter in ventral part of both rami. All setæ are pale yellow with tapering, longitudinally striated stems finely granulated on the surface, with more or less prolonged and delicate tips and the more or less well developed wings or margins directed toward the middle part of the foot on both rami (fig. 33). Wings best developed on dorsal neuropodial and ventral notopodial setæ, the marginal setæ of both bundles nearly lacking them. Notopodial setæ of II very small and delicate, those of the two sides crossing over the prostomium. As the foliaceous structures and gills become smaller the setæ also become smaller and fewer. Crochets appear in the ventral portion of the series on neuropodia of the postbranchial region. There are 2 on XLI and 6 on XLIII. They (fig. 24) are nearly colorless, rather slender, delicately striated longitudinally, the tips gracefully hooked, with a stout beak surmounted by an accessory process, both enclosed in a delicate hood conforming to their contour.

The type is No. 1, 055, Coll. Acad. Nat. Sci. Phila.; found with *Aricia fimbriata*, taken at Albatross Station, No. 5,771, off Honshu, Japan, on June 5, 1900; 61 fathoms; bottoms of green sandy mud.

From the type of the genus, *S. cirratus* Webster and Benedict, known only from Eastport, Maine, this species differs in having numerous pairs of gills beginning on III, instead of 13 pairs only beginning on IV, in having 1 pair of large eyes instead of 2 pairs of small ones, and in the much larger size.

EXPLANATION OF PLATES XV, XVI.

PLATE XV.—*Prionospio heterobranchia*—figs. 1 to 6.

Fig. 1.—Dorsal aspect of head and somite II, showing scars of attachment for tentacular cirri and gills. × 40.

Fig. 2.—Anterior aspect of parapodium II with setæ and detached gill of other side. × 98.

Fig. 3.—Similar view of parapodium and gill of IV, without setæ, × 98. Only a few of the transverse bloodvessels and external ridges are shown.

Fig. 4.—Anterior aspect of parapodium X. × 98.

Fig. 5.—Posterior aspect of detached gill of VI. × 98.

Fig. 6.—A crochet from neuropodium of L. × 600.

Polydora anoculata—figs. 7 to 17.

Fig. 7.—Dorsal aspect of head and first 6 setigerous somites, one tentacular cirrus in place. × 56.

Fig. 8.—Dorsal aspect of head and 2 setigerous somites of another specimen. × 56.

Fig. 9.—Ventral aspect of same. × 56.

Fig. 10.—Dorsal aspect of pygidium and posterior somites. × 56.

Fig. 11.—Ventral aspect of pygidium. × 56.

Fig. 12.—Parapodium XV. × 83.

Fig. 13.—Dorsal (*a*) and ventral (*b*) notopodial setæ from XV. × 440.

Fig. 14.—Strongly bent seta from dorsal tuft of VI. × 440.

Fig. 15.—Guard seta from VI. × 440.

Fig. 16.—Three spines from VI, *a* and *b* from young, *c* from adult (type) specimen. × 440.

Fig. 17.—Profile and face views of neuropodial crochet from XV. × 600.

Polydora colonia—figs. 18 to 23.

Fig. 18.—Dorsal aspect of head and first 6 setigerous somites, one tentacular cirrus in place. × 56.

Fig. 19.—Dorsal (*a*) and ventral (*b*) notopodial setæ from XV. × 440.

Fig. 20.—Anterior and ventral view, showing all of the spines and setæ of one side of VI under slight pressure, *a* the reverse or postero-dorsal aspect of the end of one of the spines. × 440.

Fig. 21.—Profile of one of the spines from somite VI of a larger specimen. × 440.

Fig. 22.—Profile and face views of a crochet from XV. × 600.

Fig. 23.—Variations in the form of the spines on somite VI of *Polydora anoculata*. × 440.

PLATE XVI.—*Magelona rosea*—figs. 24 to 30.

Fig. 24.—Dorsal aspect of head and anterior region, showing the right tentacular cirrus in outline and the left complete. × 9.

Fig. 25.—Ventral aspect of anterior end, showing bases of tentacular cirri, partly everted proboscis and ventral plates. × 24.

Figs. 26–29.—Outlines of parapodia X from the anterior side, all except fig. 27 with setæ or crochets. × 56.

Fig. 30.—Two crochets from somite L, striations omitted from one. × 440.

Spionides japonicus—figs. 31 to 34.

Fig. 31.—Dorsal aspect of head, lacking tentacular cirri, and first two setigerous somites with setæ. × 24.

Fig. 32.—Anterior aspect of parapodium XV, with setæ, the concealed portion of the gill shown in dotted outline. × 24.

Fig. 33.—A pair of middle notopodial setæ from XV. × 98; *a*, a small portion, × 440.

Fig. 34.—An entire crochet from the neuropodium of XL, × 250; and distal end of the same, × 440.

A CONTRIBUTION TO THE MORPHOLOGY OF PYRULA.

BY BURNETT SMITH.

Introduction.

At the present day the genus *Pyrula*[1] is made up of a small number of species and these, though differing from one another somewhat, are nevertheless all very much alike. The thin shell, cancellated sculpture, low spire and long anterior siphon are common to them all. There is no exaggeration in saying that nowhere among the marine gastropods do we find a set of species which are with better reason arranged in one generic group. They are indeed distinctly monophyletic. On examining the fossil Pyrulas we find that the genus gives us a homogeneous series of species ranging back in time well into the Eocene. It is true that *Pyrula* is seldom a common fossil in any formation, and likewise it does not furnish us with great series of closely related races which follow one another in the rocks of any continuous geological section. Nevertheless the very homogeneity of the scattered fossil species comes to our aid. Their distinctly peculiar shell characters are always present, just as in the widely distributed living forms.

The desire to deal with a group whose monophyletic nature is above suspicion has led the author to exclude from the present paper many Eocene and earlier species which are usually assigned to the genus. Not a few of these may be indeed very close to *Pyrula*, but the present paper has for its object the recording of the changes which a monophyletic assemblage of species actually exhibits when we trace its members through the different episodes of the time range and from one geographical province to another. Still other early species appear to be referable to *Pyrula*, but the preservation of the specimens is not good, and this is an essential for a proper understanding of the shell sculpture and apical characters. These forms also must be omitted.

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[1] This paper is intended merely as a study of some of the morphologic changes in a monophyletic group and makes no pretense of being a systematic revision of the genus. Most of the specific types are either undesignated, lost or unavailable, and the author has learned by experience that the average published figure of a species of *Pyrula* is extremely unreliable. For these reasons the propriety of using the generic name *Pyrula* is not here considered, and the classification in Tryon's *Manual of Conchology* has been followed in discussing the recent forms. In dealing with the fossil species references are given in each case.

MORPHOLOGY.

Among the species of *Pyrula* (as here restricted) the similarity of their grosser morphologic features is evident at a glance. The shell is always light and thin, the whorls are as a rule very evenly rounded and always increase rapidly in size, the spire is low and each whorl rises high on its predecessor. This latter feature often makes the top of the shell appear quite flat. Contrasted with the low spire, the branchial siphon is much produced anteriorly and often slightly curved. The shell is, in fact, roughly pear-shaped.

It is, however, only when the finer features of the ornamentation are studied that we realize the unusual constancy of the genus. The early whorls are smooth, and this smooth stage may occupy from one (or even less than one) to two and three-quarters or even three whorls.[2]

The smooth stage is followed rather sharply by the fine ribs and spirals of the cancellated stage. Perhaps, on the whole, the spirals appear a little earlier in life than do the ribs, but this is not a marked feature. The cancellated stage persists in all the species to the end of shell growth. At first there is but one set of spirals, but later secondary sets appear between the primary spirals. Still finer sets of spirals are introduced with the course of the ontogeny. Sometimes by the end of the last whorl the secondary and later spirals may have acquired about the same strength as the original primary spirals, though it is more common for the primary spirals to be strongest, with the other sets fainter and fainter according to the order in which they are introduced into the ontogeny, the last sets introduced being faintest. On their first appearance the ribs and the primary spirals are of about equal strength, but in the later whorls the primary spirals are as a rule considerably stronger than the ribs. Exceptionally the ribs on the later whorls may be as strong as the primary spirals.

To give any idea of the morphologic features which now serve, and have in the past served, to differentiate the species we must employ unusual methods. Ordinary descriptions fail to convey the meaning. It has therefore been thought best to use tables for the purpose. In these tables the two major ontogenetic stages are represented by the letter A for the smooth stage and B for the cancellated stage. These stages are marked off on the line of the ontogeny as they appear in the different whorls. The numbers stand for the whorls.

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[2] Sections of the apex in *P. papyratia* Say, show that it is filled with a secondary limy deposit.

P. papyratia.
Recent. Florida, etc.

P. decussata.
Recent. Western Central America.

P. dussumieri.
Recent. China.

P. ficus.
Recent. East Indies.

P. reticulata.
Recent. East Indies.

P. reticulata.
Recent. Cargados Islands.

P. tessellata.
Recent. Rosemary Islands, Australia.

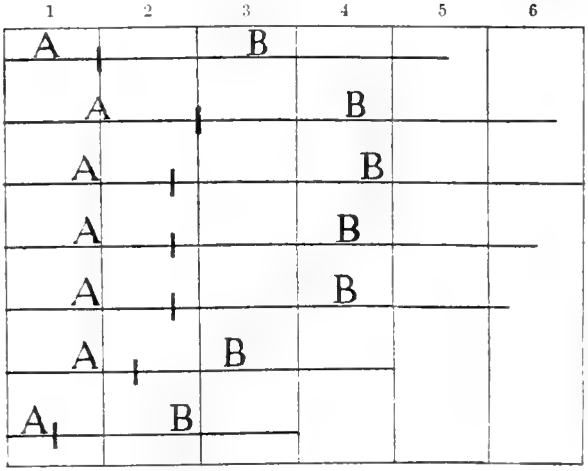

TABLE I.

P. papyratia.
Recent. Florida, etc.

P. papyratia caloosahatchiensis.
Pliocene. Florida.

P. papyratia.
Waccamaw Pliocene. South Carolina.

P. pilsbryi duplinensis.
Miocene. North Carolina.

P. pilsbryi.
Oligocene (or Miocene). Jamaica.

P. mississippiensis.
Oligocene. Vicksburg, Miss.

P. filia.
Eocene. Jackson, Miss.

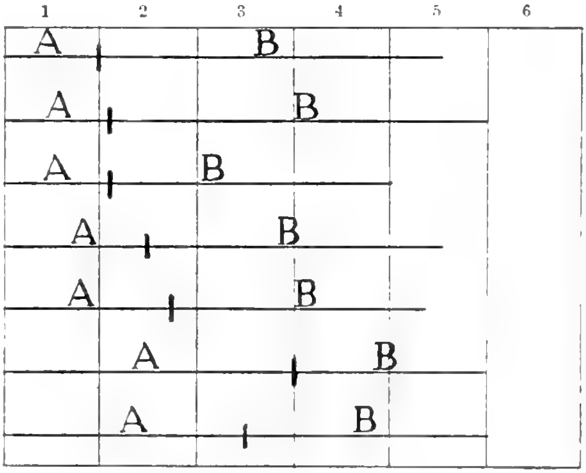

TABLE II.

P. condita.
Miocene. Dax, France.

P. pilsbryi.
Oligocene (or Miocene). Jamaica.

P. carbasea(?).
Oligocene (or Miocene). S. Domingo.

P. mississippiensis.
Oligocene. Vicksburg, Miss.

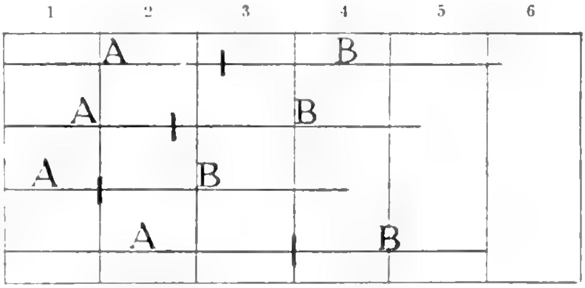

TABLE III.

Table I gives a representation of the ontogenetic features of the recent species. *Pyrula decussata* Wood and *Pyrula ficus* Linn. are the most clear-cut and distinctive species as regards the ornamentation in the cancellated stage. *Pyrula decussata* is distinguished by its strong primary spirals, while *P. ficus* has flat, weak spirals and very faint ribs. *Pyrula dussumieri* Valenc. is marked by its long slender form and the relatively high spire. In their apical features *Pyrula decussata, P. ficus* and *P. dussumieri* are all very much alike. The smooth stage occupies about 1.6–2 whorls and these early whorls are small.

Among the forms commonly grouped as *Pyrula reticulata* Lam. there is much variation. How much of this is individual and how much racial or specific it is impossible to say with the present data. They all have relatively strong ribbing, and this together with spirals of about the same strength gives them a much more conspicuously cancellated appearance than is seen in any other recent species. In this *Pyrula reticulata* assemblage the smooth stage occupies from 1.3 to 1.75 whorls and the first whorl varies not a little in size. These forms strongly recall *Pyrula condita* Brongniart[3] of the European Miocene in the sculpture of the cancellated stage. It is probable that more accurate collections will necessitate the division of *P. reticulata* into separate geographical races or species.

Pyrula tessellata Kobelt is a small type which differs from all others in the peculiar character of its apex. The cancellated stage has been thrown so far back in the ontogeny that little more than the globular beginning of the first whorl is smooth. This smooth portion is large and swollen. In fact *P. tessellata* is, in its apical characters, the most abnormal of any of the Pyrulas.

On comparing *Pyrula papyratia* Say with the other species we find that it is essentially similar to them as regards its cancellated stage. When, however, the apex is examined it is seen to be sharply distinguishable from all other recent forms. The smooth stage is restricted to about one whorl and this whorl is large and swollen. In this respect *P. papyratia* is only surpassed by *P. tessellata.*

Table I demonstrates clearly that we may have living at one time on the earth's surface a number of very closely related forms which show markedly different degrees of acceleration and much variation in the apex.

Table II illustrates the changes shown by some of the American

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[3] See Cossmann, *Essais de Paléoconchologie Comparée*, pt. V, pl. VI, fig. 7.

species when they are traced from the Jackson Eocene down to the present time. To obtain a good idea of this series it is perhaps best to consider first the more recent forms. As stated above, the living *Pyrula papyratia* is chiefly notable for its large and swollen apex, the smooth stage being confined to one whorl. The cancellated stage is in no way unusual.

To find an ancestor for the *Pyrula papyratia* of Florida seas we naturally look in the Pliocene of the Gulf and other Southern States. A form which has been referred to *P. papyratia*[4] is furnished by the Floridian Pliocene, and another shell from the Pliocene Waccamaw beds of South Carolina has been likewise regarded as specifically identical with it. A critical study of the Florida Pliocene form demonstrates that it is extremely close to the recent species. In fact its cancellated stage is similar in every respect. The apex is likewise almost the same, but differs in having the cancellated stage begin a little later in the ontogeny. The first whorl is also perhaps a trifle smaller in the fossil form. Altogether this Florida Pliocene type is specifically identical with the recent *P. papyratia.* Nevertheless the author believes that it may with propriety be designated as the subspecies *Pyrula papyratia caloosahatchiensis.* The Waccamaw Pliocene forms have an apex similar to that of *P. papyratia caloosahatchiensis.* The individuals examined are, however, all immature, and it is therefore impossible to note the sculpture of the later cancellated stage. It is probable that a better series of specimens will establish the identity of this race with the one from the Florida Pliocene.

In the Miocene beds of the United States *Pyrula* appears to be a rather uncommon fossil. From the Calvert Miocene of Maryland Martin has described *Pyrula harrisi.*[5] He says that good examples are rare. I have had no opportunity to examine specimens of this species, but it appears from the figure to be well removed from the *P. papyratia* stock. In the very full collection of the Wagner Free Institute of Science (Philadelphia) is a specimen collected in Duplin County, North Carolina, by Mr. Charles W. Johnson. It has been referred to *P. papyratia.* On a close examination of this form, however, it is evident that we must assign to it a separate specific name: It is also plainly distinct from the Maryland *P. harrisi.* It is by its apical characters that this North Carolina species is distinguished from the Pliocene and recent *P. papyratia.* The smooth stage occupies about 1.5

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[4] See Dall, *Trans. Wag. Inst.*, III, p. 163.

[5] *Md. Geol. Surv. Miocene*, p. 226, pl. LV, fig. 3.

whorls and the first whorl is small, and not large and swollen as in *P. papyratia.* In these respects it is more closely allied to most other Miocene forms and to some of the recent species of the Indo-Pacific region. It is especially near to the form from the Oligocene (or Miocene) beds of Santo Domingo which Gabb[6] refers to *P. papyratia.* I have examined Gabb's specimens and find them to be identical with the better preserved forms from the Oligocene (or Miocene) beds of Bowden, Jamaica. In their apical characters they are all clearly distinct from *P. papyratia.* I have selected the Bowden race as typical of this new species; the type specimen for the following description being one of the lot numbered 11,144 in the collection of the Academy of Natural Sciences of Philadelphia.

Pyrula pilsbryi n. s.

Locality.—Bowden, Jamaica, W. I.

Horizon.—Bowden beds, Oligocene (or Miocene).

Whorl 1.—Smooth and rounded.

Whorl 2.—Smooth and rounded for about one-half or three-quarters of a whorl, and then the cancellated stage with its fine ribs and spirals sets in.

Whorl 3.—Cancellated stage. Fine ribs and spirals.

Whorls 4, 5.—Cancellated stage, with secondary sets of spirals

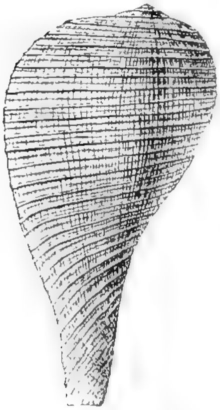

Fig. 1.—*Pyrula pilsbryi* n. s. Bowden beds. Bowden, Jamaica. Length = 42 mm.

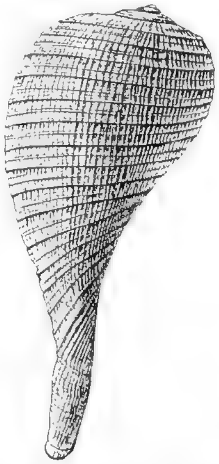

Fig. 2.—*Pyrula pilsbryi duplinensis.* Miocene. Duplin County, North Carolina.

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[6] "Topography and Geology of Santo Domingo," *Trans. Am. Phil. Soc.*, Vol. 15, p. 223, 1881.

introduced between the primary spirals. Other, still finer spirals are introduced with the progress of the ontogeny. The primary spirals are the strongest, while those sets of spirals introduced latest are weakest.

Remarks.—*P. pilsbryi* is much like the Duplin form in its apical features, but differs from it in the relatively weaker primary spirals which do not dominate the later intercalated spirals to any great extent. For the North Carolina form the name *Pyrula pilsbryi duplinensis* is here proposed.

The Vicksburg species *Pyrula mississippiensis* Conrad,[7] it will be noticed, has the first three whorls occupied by the smooth stage. The first whorl is also smaller than in *P. pilsbryi.*

In the Jackson Eocene a species, probably *Pyrula filia* Meyer,[8] has, like the Vicksburg form, a small first whorl and the smooth stage takes up at least 2.5 whorls. It is a little more accelerated than the later Vicksburg species. This emphasizes the fact that a less accelerated and specialized race does not always underlie the more specialized race.

Nevertheless we can say that on the whole Table II shows us a gradual acceleration of the features of the cancellated stage as we trace the different types from the Eocene to the present day. This acceleration is accompanied by a gradual enlargement of the first whorl until we reach the culmination of this feature in the recent *Pyrula papyratia.*

Another exception to this gradual development is furnished by the form from the Santo Domingo Oligocene (or Miocene) which Gabb referred to *Pyrula mississippiensis.* This reference[9] is entirely incorrect, for Gabb's specimen has a very large swollen apex with not more than one smooth whorl. It is fully as accelerated as *P. papyratia* in this respect, but it cannot be ancestral to the recent species on account

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[7] See *Ficus mississippiensis* Con., *J. Acad. Nat. Sci. Phila.*, 2d ser., Vol. 1, p. 117.

[8] *Bericht über Senckenbergische naturforschende Gesellschaft in Frankfurt a. M.*, 1887, *Ficula filia* Meyer, p. 8, Taf. I, fig. 10. I make this reference with some doubt.

[9] See Gabb, in *Trans. Am. Phil. Soc.*, Vol. 15, p. 223. Gabb considered Guppy's *Ficula carbasea* as a synonym for Conrad's *Ficus mississippiensis.* He says: "I have compared Mr. Guppy's shell with Mr. Conrad's original specimens from Vicksburg, Mississippi, and find them identical in form and sculpture. I am by no means sure that this should not be considered the same as *F. decussatus* (*F. ventricosus*), the common west coast Mexican form."

It can, of course, be neither *P. mississippiensis* nor *P. decussata*, and as it resembles Guppy's figure I have referred it to *P. carbasea.* Guppy's type I have not seen.

of the great strengthening of its primary spirals. In this respect it resembles the Panamic *P. decussata.* The unspecialized apex of *P. decussata* is, however, sufficient to preclude a derivation from this fossil Santo Domingan form. Altogether this latter appears to be an early departure from the stock of the generalized Pyrulas of the Oligocene and Miocene. It probably has no descendants in later beds. I have referred it with some doubt to *Pyrula carbasea* Guppy.[10]

Table III shows that the apex was as variable in the Eocene, Oligocene, and Miocene as at the present day. The great length of the smooth stage and slight acceleration of the cancellated stage are noteworthy features of this group of species. It is only in *P. carbasea*(?) that the smooth stage is short and restricted.

Range and Distribution.

The genus *Pyrula* as restricted in this paper ranges from the late Eocene to the present day. Earlier in the Eocene we encounter an abundance of forms which appear to be closely related to the species here considered. Their inclusion in the present study would, it is believed, throw some doubt on the monophyletic nature of the group. Their consideration is therefore delayed, so that we may be able to observe the changes in a series which obviously can be referred to only one generic stock.

In the Jackson Eocene and in the later Vicksburg beds the species are remarkable for the great length of the smooth stage and for the small size of the early whorls. The same characteristics are also to be observed in the European Miocene *Pyrula condita.* The three species *P. filia* of the Jackson Eocene, *P. mississippiensis* of the Vicksburg beds, and *P. condita* of the Miocene of Europe all exhibit similar apical features. They represent the most primitive expression of the *Pyrula* assemblage which the geological record furnishes.

In the Oligocene (or Miocene) deposits of Bowden, Jamaica, we find *Pyrula pilsbryi,* and in the Miocene of North Carolina occurs *P. pilsbryi duplinensis.* Both are very much alike as to the characters of the smooth stage. In them it is more restricted than in *P. condita* or in the American Vicksburg and Jackson types. In other words, the cancellated stage is thrown farther back into the ontogeny. In addition, the early whorls have now become larger in size. Altogether *P. pilsbryi* is very similar in its early whorls to *P. decussata, P. dussumieri, P. ficus,* and some specimens of *P. reticulata.* These three latter species

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[10] *Ficula carbasea Q. J. Geol. Soc. Lond.,* 1866, Vol. 22, p. 580.

are living to-day in the Indo-Pacific region. In its apical features, then, *P. pilsbryi* has attained about the same evolutional grade as several of the recent forms.

Nevertheless there is in the Oligocene or Miocene at least one exception to the general prevalence of the primitive apex. This is furnished by the *Pyrula carbasea*(?), which in addition to the feature already mentioned has a specialized adult sculpture that marks it as an early offshoot from the main stock, and it is probably also a terminal member of such an offshoot.

Passing over this aberrant form, we find that in the Pilocene rocks of North America the smooth stage is still further restricted and the apex yet larger, for there is at least one subspecies of *Pyrula papyratia*. It is more primitive than the recent *P. papyratia*, for the first whorl is hardly as large and the cancellated stage is not quite so accelerated as in the recent form. It is very close and must be regarded as ancestral to *P. papyratia* of the modern Florida seas.

In American rocks, then, we have an excellent series showing the gradual acceleration of the sculpture and the increase in size of the early whorls. With the exception of *P. mississippiensis* and *P. carbasea* this American series represents a good morphological succession, and from *P. pilsbryi* to the living *P. papyratia* we can reasonably assume a phylogenetic succession as well.

The solution of the ancestry for the present day species of the Indian and Pacific Oceans can hardly be attempted with the meager data at our command. *Pyrula decussata*, *P. dussumieri*, and *P. ficus* probably owe their origin to some such generalized types as we have seen in the American Eocene and the European Miocene. Just how long their separate specific stocks have been distinct it is impossible to say. The forms described as *P. reticulata* probably represent a group of geographical races which have arrived at different stages of evolution. Some of them are very like *Pyrula condita* of the Miocene, for the ribs are strong and, equalling the primary spirals, impart a markedly cancellated appearance to the shell. *Pyrula tessellata* of Australian seas represents an offshoot from the primitive stock. It has become distinctive by its large swollen apex and the encroachment upward of each whorl high on its predecessor; but its ribbing is relatively strong, the sculpture of its cancellated stage being primitive.

A point of great interest is the succession of morphological features which has taken place in the Gulf and Caribbean region with the progress of the Tertiary. *Pyrula pilsbryi* is more specialized than the Eocene forms, but less specialized than the later races which are grouped together as *P. papyratia.* When we compare *P. pilsbryi* with *P. decussata* of the Panamic geographical province we find that the Pacific form is distinct in its later whorls, but very similar to the fossils in the characters of its apex.

Altogether this evidence points to free communication between the Atlantic and Pacific basins during Miocene time, a time when most Pyrulas possessed the primitive type of apex. With the end of the Miocene this strait between the two oceans was closed by the elevation of the land bridge which has ever since connected the continents of North and South America. From the time when this barrier was interposed down to the present the forms of the Caribbean and Gulf regions have undergone a striking evolution, marked by the accleration of the cancellated stage and the enlargement of the initial whorl. On the other hand, the forms inhabiting the waters on the Pacific side of the isthmus have retained the ancient apical features of the Miocene.

SUMMARY.

The assemblage of forms treated in this paper is particularly well adapted for showing the mutations and variations of a gastropod stock. In order that the results may be of value it is essential that the group be a restricted one. *Pyrula*, or at least that part of the genus here considered, fulfills the above conditions. The distinctions between its species are so slight, and they are all so unlike the examples of other genera, that we may well feel that they constitute a single genetic stock.

In addition to the slight but more apparent specific differences furnished by the cancellated stage we have the differences exhibited by the apices. If we trace the members of the genus back into the Tertiary, we find every gradation between the two extremes of apical modification.

The more important changes which have taken place since the late Eocene are found not so much in the adult sculpture as in the features of the apex. We have, especially in America, a regular series, beginning with forms having a smooth stage of two or three whorls, followed by species in which the smooth stage is more restricted, and finally terminating in *Pyrula papyratia* of Gulf and Caribbean waters, whose smooth stage does not persist beyond the close of the first whorl. This change from the two- or three-whorled smooth stage to the one-whorled smooth stage is accompanied throughout by the gradual enlargement of the early whorls. The more restricted the smooth stage becomes the larger grows the initial whorl.

If we examine the recent species of *Pyrula*, we find here again different apical characters which can usually be duplicated in the fossil forms of the American rocks. For instance, though their adult sculptures may differ, the recent species *P. decussata* and *P. dussumieri* and the Oligocene (or Miocene) *P. pilsbryi* all possess a very similar style of apex.

At the present day the genus is widely distributed in the shallow waters of the tropical seas. Though these seas are now separated by land barriers, it is probable that in Eocene, Oligocene and Miocene times the marine connections between the different provinces were much more prominent features of the geography. Then, in all likelihood, the genus had a continuous distribution around the world; and even where land barriers were interposed near the equator, it is probable that a more generally moderate climate enabled its representatives to pass through latitudes where now their existence would be impossible.

The differences between *Pyrula dussumieri* of China and *P. decussata* of the west coast of Central America were probably produced by some change which forbade the intermingling of the inhabitants of the two provinces. At present the deep water of the tropical Pacific and the colder climate in the shallower parts of that ocean are both sufficient barriers to keep the species apart. Whether their separation was originally caused by a change of climate in higher latitudes, or by a depression in some part of the bottom of the tropical Pacific, or by the working of both of these factors, it is, of course, impossible to say.

The relations of *Pyrula decussata* with *P. papyratia* are probably more certain. In the Oligocene and Miocene the Pyrulas with the generalized apex had a free passage between the Atlantic and Pacific basins, and there was no differentiation into two geographical provinces. With the close of the Miocene the land barrier of the Isthmus of Panama was thrown up, the two oceans were separated and two geographical provinces created. After this the forms of the eastern waters, for some unknown reason, followed out a line of evolution which was chiefly marked by apical modifications, while the Pacific forms changed slightly in the cancellated stage but retained the old Miocene type of apex.

Perhaps the most important points emphasized by this study are the following: (1) We may have living at any one time on the earth's surface an assemblage of closely related gastropod species which differ to a marked degree in the evolutional grades which they have attained.

(2) *In a group of closely related gastropod species the chief modifications which are introduced with the passage of time may occur mainly in the features of the early whorls, while the later adult whorls may remain relatively unchanged.*

(3) In this particular group of species the differences in the apical characters cannot be used for the division of the assemblage into separate genera,[11] but are of use only as aids to specific discrimination, and then only when the characters of the later whorls are considered together with those of the apex.

EXPLANATION OF PLATE XVII.

Fig. 1.—Apex of *Pyrula papyratia* Say. Recent. Lee County, Fla. Shows the smooth stage restricted to the large and swollen first whorl. The cancellated stage starts with the beginning of the second whorl. Greatest diameter = 3.2 mm.

Fig. 2.—Apex of *Pyrula papyratia caloosahatchiensis*. Pliocene. Caloosahatchie River, Fla. Here the cancellated stage is hardly as accelerated as in fig. 1. Greatest diameter = 3.2 mm.

Fig. 3.—Apex of *Pyrula pilsbryi duplinensis*. Miocene. Duplin County, N. C. The smooth stage occupies about 1.5 whorls. Here the initial whorl is smaller than in figs. 1 and 2.

Fig. 4.—Apex of *Pyrula pilsbryi* n. s. Oligocene (or Miocene). Bowden, Jamaica. Smooth stage occupying about 1.75 whorls. Greatest diameter = 3 mm.

Fig. 5.—Apex of *Pyrula mississippiensis* Con. Oligocene. Vicksburg Beds, Vicksburg, Miss. Here the initial whorl is much smaller than in *P. pilsbryi* and the smooth stage extends over three whorls. Greatest diameter = 3.5 mm.

Fig. 6.—Apex of *Pyrula filia* Meyer. Eocene. Jackson Beds, Jackson, Miss. Smooth stage of about 2.5 whorls. Greatest diameter = 3.5 mm.

Fig. 7.—Apex of *Pyrula decussata* Wood. Recent. Acapulco. Smooth stage of about 2 whorls. Greatest diameter = 2.8 mm.

Fig. 8.—Apex of *Pyrula dussumieri* Valenc. Recent. China. Smooth stage of about 1.6 whorls. Greatest diameter = 3 mm.

Fig. 9.—Apex of *Pyrula ficus* Linn. Recent. East Indies. Smooth stage of about 1.7 whorls. Greatest diameter = 2.6 mm.

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[11] See *Proc. Linn. Soc. New South Wales*, 1905, Pt. II, p. 325, "Notes on Prosobranchiata. No. IV—The Ontogenetic Stages represented by the Gastropod Protoconch," by H. Leighton Kesteven. On p. 334 he says: "The protoconch is to be used in conjunction with other features, and that only where the other features, anatomic or conchological, are negative or unknown is it to be used in deciding a systematic position or generic segregation."

THE POLYCYSTID GREGARINES OF THE UNITED STATES (Third Contribution).

BY HOWARD CRAWLEY.

In 1853 Leidy described a gregarine parasite of the common cricket. To this animal he gave the name of *Gregarina achetæ-abbreviatæ,* the host being at that time known as *Acheta abbreviata.* The parasite was illustrated by figs. 32–34 of Leidy's plate 11. In my first communication on our gregarines (Crawley, 1903) I reproduced two of Leidy's figures, and based my description partly upon these and partly upon his text. A glance at these figures, Nos. 34 and 35 of my paper, will suggest at once that they portray different species of gregarines, and studies which I made during the summer of 1906 show that this is so. For the animal shown in Leidy's fig. 34, copied in my fig. 35, I have retained the name given by Leidy, while the other is tentatively placed in the genus *Stenophora.* I have also considered it advisable to redescribe *Gregarina achetæ-abbreviatæ,* and have given a new figure, a camera outline from a living solitary gregarine.

Gregarina achetæ-abbreviatæ Leidy. (Pl. XVIII, fig. 1.)

Gregarina achetæ-abbreviatæ Leidy (1853), p. 238, pl. 11, fig. 34.
Gregarina achetæ-abbreviatæ Crawley (1903), p. 45, pl. 3, fig. 35.
Gregarina achetæ abbreviatæ Crawley (1903*a*), pp. 639, 641.

Protomerite.—Hemispherical to globular, broader than long. Shape modified in the associations.

Deutomerite.—Ellipsoidal to oval.

Epicyte.—Thin, delicately striated.

Sarcocyte.—Thin, but present all over the animal.

Myocyte.—Easily demonstrated by the use of reagents.

Entocyte.—Dense, but, following the usual rule, less dense in the protomerite than in the deutomerite. In most of the specimens which I encountered, the peripheral part of the entocyte was almost free of granules; this phenomenon being much more conspicuous in the deutomerite than in the protomerite.

Nucleus.—Not seen.

Size.—The largest solitary animal I saw was 500 microns long.

Habit.—Solitary or associated in pairs.

Cysts.—Spherical, provided with a thick gelatinous envelope Diameter of cyst mass, 225–275 microns. Thickness of gelatinous envelope, 30–300 microns. Dehiscence by sporoducts, 2–5 in number, reaching a length of 1,000 microns. Prior to evagination, the situation of the sporoducts is plainly indicated by the appearance around the periphery of the cyst of dense discoid masses. These are yellowish in color, owing to the presence of oil. Time required for maturation, 1–4 days.

Spores.—Cylindrical, with rounded ends to dolifirm. Dimensions, 4.5 by 2.25 microns.

Host.—*Gryllus abbreviatus* Serv.

Locality.—Beach Haven, New Jersey, and Wyncote, Pennsylvania.

Stenophora erratica sp. n. (Pl. XVIII, fig. 5.)

Gregarina achetæ abbreviatæ Leidy (1853), p. 238, pl. 11, fig. 33.
Gregarina achetæ abbreviatæ Crawley (1903), p. 45, pl. 3, fig. 34.

The general form of this gregarine is shown in fig. 5, which was drawn from a young individual, 150 microns long. In the older animals, while the protomerite is much as here shown, although at times relatively shorter, the deutomerite varies considerably in shape. In some its outline is an elongated ellipse, while in others it is broadest near the posterior end, tapering slowly and gradually forward to the septum. The largest animal seen was 500 microns long.

The epicyte shows distinctly a double contour, and is 1.5 microns thick. The sarcocyte is present all over the animal, and reaches a thickness of 2.5 microns. At the anterior tip of the protomerite, the ectosarc is often thickened to form a low papilla, within which are traces of a pore. It is this character which led me to place the gregarine in the genus *Stenophora.* The entocyte is dense, except in the anterior third of the protomerite, where it is almost free of granules.

These gregarines are not at all polymorphic, but almost constantly display the progressive movement. They are by no means infrequent in crickets, but always present in small numbers. The suggestion is permissible that this form is actually the common *Stenophora julipusilli* Leidy, somewhat altered in appearance from being in the wrong host. Crickets and Julidæ frequently occur in the same environment, and the former might readily swallow spores derived from the feces of the latter. This done, the spores might readily develop, although producing slightly atypical gregarines. There is an excellent field here for experimental work.

In addition to the two forms considered above, the cricket harbors a third, a true *Gregarina,* which is herewith described.

Gregarina kingi[1] sp. n. (Pl. XVIII, figs. 10–12.)

Protomerite.—In the primites, the protomerite, as seen in fig. 10,

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[1] To Dr. H. D. King.

is sometimes saddle-shaped. While this peculiarity of contour is not always so striking as here shown, the protomerite is always broad and swollen in front, and much narrower behind. This serves to separate this species from *Gregarina achetæ-abbreviatæ.* In the satellites, the protomerite is subspherical to compressed.

Deutomerite.—Cylindrical, generally somewhat broader in front. Outlines often irregular.

Epicyte.—Very delicate.

Sarcocyte.—Feebly developed, except in the anterior part of the protomerite, where there is a conspicuous crescentic thickening. According to my observations, this character was more marked in the younger than in the older animals.

Entocyte.—Not dense.

Nucleus.—Moderate in size.

Size.—Largest pair seen, 350 microns long.

Habit.—Nearly always associated in pairs. Satellite generally slightly and sometimes considerably smaller than the primite. When the connection between a pair is broken, the anterior surface of the protomerite of the satellite shows a slightly raised ring. Thus the posterior end of the primite fits into a very shallow saucer on the anterior end of the satellite.

Movements.—The gregarines seen were more or less constantly bending and contracting, but showed little or no disposition to progress.

Cysts.—Round, occasionally oval. The cyst mass varies from 90–110 microns in diameter. There is a cuticular wall 6–7 microns thick, outside of which a gelatinous envelope develops. In newly formed cysts, taken from the mid-gut of the host, the gelatinous envelope is so diaphanous as to appear merely as a halo round the dense central mass. But in cysts taken from the feces in the hind-gut, the gelatinous envelope is much more evident. This change in appearance is doubtless merely due to the accumulation of detritus.

Of the cysts found in the host intestine, some are uniformly opaque, with a clear space just inside the cuticle. Others are less opaque, sometimes mottled; sometimes with an irregular dense central mass and a clear periphery. These different aspects represent different developmental stages, and indicate that maturation is rapid in this species. This was confirmed by the behavior of cysts placed on slides in a moist chamber. A considerable number, many of which had just formed, were so isolated on July 2, and all were found to have dehisced on July 4, no observation having been taken on July 3. The period is thus 1–2 days, which is in close agreement with that of *Gregarina achetæ-abbreviatæ.*

Dehiscence is by a single sporoduct, which may reach a length of 750 microns. A discharged cyst is shown in fig. 12. The residuum is a loose mass of granules and débris which nearly fills the cavity within. The duct is limited externally by a cuticular wall. Within it is filled by a soft substance, through the center of which can be seen the lumen along which the spores had passed. This lumen, however, shows no definitive membrane, being merely a channel through this soft substance, which is probably of the same nature as the residuum.

In one case observed, the spores still lay *in situ* as they had been projected from the duct. The duct was 600 microns long; the file of spores 2,400. Hence the leading spore had reached a distance of 3 millimeters from the cyst. In consideration, however, of the size and activity of the host, it is not easy to see how the scattering of the spores over such an infinitesimal area can cut much of a figure in their dissemination.

Spores.—Rounded cylinders or barrel-shaped. Dimensions, 5 by 2.75 microns.

Host.—Gryllus abbreviatus Serv. The gregarines occurred in perhaps 25 per cent. of the crickets opened. But when present, they are present in countless numbers, compact masses of gregarines as large as peas being found. It does not seem likely that such extensive infections can be due merely to the chance picking up of stray spores. More probably we have here to do either with cannibalism or the devouring of dead comrades.

Gregarina melanopli sp. n. (Pl. XVIII, figs. 6–9.)

Protomerite.—In the young solitary animals, the protomerite is cubical, with rounded corners, to mammaliform, and often shows in front a low, broad projection. In the associated gregarines, it has the form of a greatly compressed hemisphere.

Deutomerite.—In the young, cylindrical to flask-shaped. There is generally a slight constriction in the middle. In the pairs, cylindrical, but with a very variable ratio of length to breadth. Two cases are shown in figs. 8 and 9, which are camera outlines of living gregarines.

Epicyte.—Longitudinally striated. The following measurements of its thickness are taken from a large pair:

Primite.—

Anterior tip of protomerite	5	microns.
Sides of protomerite	5	"
Sides of deutomerite	1–2	"

Satellite.—

Anterior corners of protomerite	3 microns.
Sides of deutomerite	1–2 "
Posterior end of deutomerite	4 "

Sarcocyte.—Differentiated into an outer hyaline and an inner granular layer. Its thickness in the various parts of the same large pair from which the above measurements of the epicyte were taken is given in the following table:

Primite.—

Front of protomerite	15 microns.
Sides of protomerite	5 "
Sides of deutomerite	10 "

Satellite.—

Anterior corners of protomerite	16 microns.
Sides of deutomerite	10–12 "
Posterior end of deutomerite	6 "

It may be noted here that in those parts where the epicyte thickens, the sarcocyte thins. A like condition has been noted by Léger for *Amphoroides polydesmi.*

Entocyte.—Very dense. Tinged with brownish yellow. The nucleus shows merely as a lighter area.

Size.—The solitary animals ranged in length from 200–370 microns. The lengths of a number of pairs, in microns, are given in the appended list:

Primite.	*Satellite.*	*Total.*
675	750	1425
640	710	1350
600	750	1350
600	710	1310
600	700	1300
525	500	1025
420	450	870

The first was the largest pair seen. In nearly all cases, the primite was the shorter and broader animal.

Habit.—The gregarines, according to the particular host examined, were either nearly all solitary or nearly all associated. I examined, however, but very few locusts; so cannot say if this be the rule. In one, in which I found some fifty pairs, they occurred in an almost solid mass in the host's intestine, gradually separating when placed upon the slide.

Movements.—The animals are somewhat polymorphic, undergoing fairly extensive changes of shape. Such changes, however, were always effected very slowly. They also progressed in curves and straight lines, but in a most leisurely manner.

Host.—*Melanoplus femoratus* (Burm.).

Locality.—Wyncote, Pennsylvania.

As with his *G. achetæ-abbreviatæ*, so with his *G. locustæ-carolinæ*, Leidy (1853) seems to have described two species under one name. My observations of the summer of 1906 show that the host in question, *Dissosteira carolina* (L.), then known as *Locusta carolina*, is infected by two gregarines. One of these is in all probability a true *Gregarina*, and I believe Leidy's figs. 35 and 36 to be representations of it. On the other hand, his fig. 37 is probably a Stephanophora, and it has been placed in that genus by me (Crawley, 1903). The confusion seems best cleared up by retaining Leidy's name for the true *Gregarina*, and creating a new one for the *Stephanophora*. The two species are defined below.

Gregarina locustæ-carolinæ Leidy. (Pl. XVIII, fig. 13.)

Gregarina locustæ-carolinæ Leidy (1853), p. 239, pl. 11, figs. 35, 36.
Gregarina locustæ-carolinæ Leidy (1856), p. 47.
Gregarina fimbriata Diessing (1859), p. 730.
Gregarina locustæ-carolinæ Labbé (1899), p. 35.
Stephanophora locustæ-carolinæ Crawley (1903), p. 54.

Epimerite.—A small rounded knob, cut off from the protomerite by a very short neck. The epicyte of the epimerite is continuous with that of the protomerite, and does not intervene between the two segments, the boundary between which is formed by the sarcocyte of the protomerite. A small quantity of entocyte is present.

Protomerite.—Globular in the cephalonts, and nearly so in the sporonts. Posterior boundary plane.

Deutomerite.—Globular to oval or even cylindrical in the cephalonts. Oval to cylindrical in the sporonts.

Epicyte.—Shows a double contour.

Sarcocyte.—In the cephalonts and very small sporonts, well developed, especially in the anterior part of the protomerite.

Entocyte.—Pale. This applies to the young animals; my notes being silent as to its condition in the adults.

Nucleus.—Large, with one large karyosome.

Size.—The largest animal seen was 350 microns long. The appearance of this individual, however, did not suggest full maturity. The cephalonts were 100–110 microns long. Decapitation takes place early. Quite a number of small gregarines were seen, all about 100 microns long, the youthfulness of which was plainly indicated by their transparency, and fully half had lost their epimerites.

Host.—*Dissosteira carolina* (L.).

Locality.—Wyncote, Pennsylvania.

Stephanophora pachyderma sp. n. (Pl. XVIII, figs. 2, 3.)

Gregarina locustæ-carolinæ Leidy (1853), p. 239, pl. 11, figs. 37, 38.
Gregarina locustæ-carolinæ Leidy (1856), p. 47.
Gregarina fimbriata Diessing (1859), p. 730.
Gregarina locustæ-carolinæ Labbé (1899), p. 35.
Stephanophora locustæ-carolinæ Crawley (1903), p. 54.

Epimerite.—Consists of a cylindrical piece, bearing in front a number of forwardly directed digitiform processes. Separated from the protomerite by a mere constriction, no definitive neck being formed.

Protomerite.—In the cephalonts, consisting of a cylindrical basal portion, narrowing regularly in front to the base of the epimerite. This anterior conical part, which makes up one-half the length of the protomerite, is composed entirely of ectosarc. In the sporonts, almost perfectly hemispherical, with its contour continuous with that of the deutomerite.

Deutomerite.—In the cephalonts, lanceolate, with a blunt posterior end. Broader than the protomerite, and broadest just behind the septum. There is scarcely a constriction between the two. In the sporonts, heart-shaped.

Epicyte.—Thickness 2–3 microns. The thickness is essentially uniform over the entire gregarine, except for a small region at the anterior tip of the protomerite. Here the epicyte thickens on its inner surface, making a small indentation into the sarcocyte.

Sarcocyte.—Always very thick. In the cephalonts, making up one-half the length of the protomerite. On account of the change of shape which follows decapitation, the sarcocyte is more conspicuous in the protomerite of the cephalonts than in that of the sporonts. Yet even in the latter, it here measures 30 microns, which is reduced to 12 microns elsewhere.

Entocyte.—In the sporonts, black in transmitted light in the deutomerite. Not quite so dense in the protomerite, and here showing a relatively clear space, as indicated in fig. 3.

Nucleus.—Fairly large, with a number of karyosomes.

Size.—The largest sporont seen was 500 microns long.

Host.—*Dissosteira carolina* (L.).

Locality.—Wyncote, Pennsylvania.

The perfectly oval shape of this last species, sometimes disguised by their habit of holding the long axis bent, is probably normal. Yet one balloon-shaped specimen was seen.

The animals are present only sparingly in the infected locusts, and occur in both the mid-gut and pyloric cæca.

One specimen was observed which showed behind it a gelatinous stalk, such as described by Schewiakoff (1894), and considered by him to furnish the means for the progressive movement. This stalk, although differing but very slightly in refractive index from the water, could plainly be seen. Since, however, the stalk was carried about by the gregarine as a mammal carries its tail, the sole influence it could have possibly had upon progression would have been that of a hindrance.

The actual extrusion of the substance of this stalk was not witnessed, but that the gregarines were liberally provided with some kind of a gelatinous matter was demonstrated by killing them with iodine. Animals so killed showed, on their surfaces, great numbers of small globules.

I have finally to describe a *Geniorhynchus*, probably distinct from the European form.

Geniorhynchus æshnæ sp. n. (Pl. XVIII, fig. 4.)

Epimerite.—Consists of an ellipsoidal or globular head, borne on a short neck which may be considerably swollen. The head is liberally provided with short spines, directed backward.

Protomerite.—Large, having the form of a truncated cone with slightly curved contours. Broader than the deutomerite.

Deutomerite.—Conical to cylindrical, terminating bluntly. The posterior fourth generally showed, in the cases observed, one or more deep constrictions, which underwent slow changes.

Epicyte.—Thin, longitudinally striated.

Sarcocyte.—Well developed. In the protomerite, it is enormously thickened, occupying the anterior third of the segment as a solid mass, which rapidly thins out behind. It here contains a few small granules.

Entocyte.—Not especially dense, and usually thinning out considerably toward the surface.

Nucleus.—Shows several irregularly shaped karyosomes.

Size.—420 microns long.

Host.—Nymph of *Æshna constricta* Say.

Locality.—Southeastern Pennsylvania.

Bibliography.

Crawley, Howard. 1903. List of the Polycystid Gregarines of the United States. *Proc. Acad. Nat. Sci. of Phila.*, January, 1903, pp. 41–58, pls. 1–3.

Crawley, Howard. 1903*a*. The Polycystid Gregarines of the United Sates. (Second Contribution.) *Proc. Acad. Nat. Sci. of Phila.*, October, 1903, pp. 632–644, pl. 30.

Diessing, C. M. 1859. Revision der Rhyngodeen. *Sitz. Wien Akad.*, Bd. 37, pp. 719–782.

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

Leidy, Joseph. 1853. On the Organization of the genus *Gregarina* of Dufour. *Trans. Amer. Phil. Society*, Vol. 10, N. S., pp. 233–241, pls. 11, 12.

Leidy, Joseph. 1856. *Proc. Acad. Nat. Sci. of Phila.*, Vol. 8, p. 47 (verbal communication).

Schewiakoff, V. 1894. Ueber die Ursache der fortschreitenden Bewegung der Gregarinen. *Zeitschr. f. wiss. zool.*, Bd. 58, pp. 340–354, Taf. 20, 21.

Explanation of Plate XVIII.

Fig. 1.—*Gregarina achetæ-abbreviatæ* (p. 220). Camera outline of sporont.
Fig. 2.—*Stephanophora pachyderma* (p. 226). Cephalont.
Fig. 3.—*Stephanophora pachyderma* (p. 226). Sporont.
Fig. 4.—*Geniorhynchus æschnæ* (p. 227). Cephalont.
Fig. 5.—*Stenophora erratica* (p. 221). Young sporont.
Figs. 6, 7.—*Gregarina melanopli* (p. 223). Young solitary sporonts.
Figs. 8, 9.—*Gregarina melanopli* (p. 223). Camera outlines of two pairs.
Figs. 10, 11.—*Gregarina kingi* (p. 223). Paired individuals.
Fig. 12.—*Gregarina kingi* (p. 221). Discharged cyst. Only the basal portion of the sporoduct is shown.
Fig. 13.—*Gregarina locustæ-carolina* (p. 225). Cephalont

A NEW SPECIES OF ATHLETA AND A NOTE ON THE MORPHOLOGY OF ATHLETA PETROSA.

BY BURNETT SMITH.

Introduction.

Though the present paper is intended primarily to show some of the variations and mutations exhibited by one of our Eocene Volutoid stocks, recent work in nomenclature has necessitated certain changes of generic names, and therefore a brief explanation of these changes is essential to a proper understanding of the forms here considered.

In April, 1906, Dr. Dall[1] called attention to the fact that the type of Swainson's genus *Volutilithes* is not *Voluta spinosa* (which had been previously accepted by most authors), but *Voluta muricina* Lam. A similar observation was made by Mr. R. Bullen Newton[2] in June, 1906. Taking *Voluta muricina* as the type for the genus *Volutilithes*, it is plainly evident that such forms as *Voluta spinosa* of Lamarck and *Voluta petrosa* of Conrad must be furnished with a separate generic designation and not included in the genus *Volutilithes*. In selecting a name for these forms the writer has followed the suggestions of M. Cossmann[3] and revived Conrad's *Athleta*.[4] The type of *Athleta* is the European *Athleta rarispina*.

The forms studied in the present paper are all either specifically identical with or else closely related to Conrad's *Voluta petrosa*, which for so many years has been familiar to American palæontologists as *Volutilithes petrosus*. As the author has recently stated,[5] the study of large and carefully collected series from the Gulf States has convinced him that the forms described as *Athleta tuomeyi* by Conrad are nothing but races of his *Voluta petrosa* which have been subjected to an unfavorable environment. "They are of one genetic stock, and the differences can in no sense be regarded as generic; in fact they are not even specific."

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[1] *The Nautilus*, "Note on some Names in the Volutidæ," p. 143.

[2] "Note on Swainson's Genus *Volutilithes*," *Proc. Malac. Soc. Lond.*, June, 1906, p. 100.

[3] *Revue Critique de Paléozoologie*, p. 222, Oct., 1906.

[4] "Synopsis of the Genus Cassidula and of a proposed new genus Athleta," *Proc. Acad. Nat. Sci. Phila.*, Vol. VI, 1852-3.

[5] *The Nautilus*, March, 1907, p. 131.

Now *Athleta rarispina* certainly has generic affinity with both Conrad's *Athleta tuomeyi* and Lamarck's *Voluta spinosa.* When we compare Lamarck's *Voluta spinosa* and Conrad's *Voluta petrosa,* no differences which can be regarded as other than specific are observed. We have therefore at least four species of *Athleta,* two American and two European. The two American are connected by every gradation of intermediate and cannot be considered as specifically distinct. The European forms are separate species.[6] In spite, therefore, of minor morphologic differences, and of discrepancies in the time range and in the geographical distribution, we must regard these forms as belonging to one generic group and apply the name *Athleta* to them all. *Athleta petrosa* would then include both *Voluta petrosa* and *Athleta tuomeyi;* the value of the designation *tuomeyi* should, however, in no case be more than subspecific.

The assemblages which may be grouped under the specific name *Athleta petrosa* are widely distributed in our Gulf Eocene. The race from any particular locality or bed usually differs from other races, but nevertheless all of them possess so many characters in common that further specific division would be inadvisable. Every individual gradation and not a few racial gradations may be found to connect the normal *Athleta petrosa* with the abnormal *Athleta petrosa tuomeyi.* As far as the author knows, it is only at two localities that we find forms associated with *Athleta petrosa* which, though closely related, must be considered as distinct species.[7] The cases in question are at Claiborne, Alabama, where the closely related associate species is *Athleta sayana,* and at St. Maurice, Louisiana, where the closely related associate is here designated as the new species *Athleta clayi.*

The races of *Athleta petrosa* and their allies from the Alabama-Mississippi region have been considered in a previous paper.[8] In their case, thanks to the work of Prof. Eugene A. Smith and Mr. Lawrence C. Johnson,[9] it is possible to arrange the races in chronologic order. In the present study the races discussed are mostly from the Eocene beds west of the Mississippi River, and unfortunately the

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[6] Dr. Dall (*Trans. Wag. Inst.,* Vol. 3, p. 75) says: "In America, however, the deposition of callus never became normal and regular, though in Europe *A. rarispina* and *A. ficulina* Lam. exhibit a normal, *Cassis*-like expansion around the aperture of what, without it, is a typical *Volutilithes.*" At this time Dr. Dall regarded *Voluta spinosa* as the type of *Volutilithes.*

[7] *Volutilithes precursor* of Dall and *Volutilithes dalli* of Harris, though in the same genus with *Athleta petrosa,* are not very nearly related to it.

[8] "Phylogeny of the Races of Volutilithes petrosus," *Proc. Acad. Nat. Sci. Phila.,* May, 1906, p. 52.

[9] Bull. 43, *U. S. G. S.,* "Tertiary and Cretaceous Starta of the Tuscaloosa, Tombigbee, and Alabama Rivers," Eugene A. Smith and Lawrence C. Johnson.

stratigraphy of the minor divisions is there only poorly understood. The researches of Prof. Gilbert D. Harris have, it is true, done much to make clear the succession in Louisiana and Texas; but it is still impossible to ascertain the relations of the less important beds with each other or with their time equivalents in the standard sections of Alabama. In this western Gulf region we have three well defined formations in which *Athleta petrosa* and its allies occur. These are the Lignitic, Lower Claiborne and Jackson.

MORPHOLOGY.

As with the races from the Alabama sections, we find that the *Athleta petrosa* assemblage from any one locality or horizon is apt to differ more or less from that found at another locality or horizon. Not infrequently certain individuals of a race will depart to some extent from the racial norm, but these make usually but a small minority of the assemblage. "In other words, the majority of specimens from any one locality or horizon show a certain stage of evolution."

Throughout the present paper the author has used the same terms which were employed in dealing with the Alabama forms. As before we have the smooth stage, curved rib stage, cancellated stage, spiny stage and senile stage. The senile and spiny stages may be separate or associated together in the same whorl. Rib, spiral, tubercle, spine, etc., are all used in the same sense, and the end of the first whorl is again placed (arbitrarily, of course) in the same position.

Athleta petrosa tuomeyi.

Sabinetown Race.

Locality.—Sabinetown, Texas.

Horizon.—Lignitic beds.

This series is small and the individuals are poorly preserved. There are no very young ones, and the shelly overgrowth produced by the protruded mantle is very extreme in the old individuals. This, together with the poor state of preservation, renders detailed morphologic work impossible. These forms are typically senile, the most marked feature being the monstrous shelly overgrowth which results from the protrusion of the mantle onto the preceding whorl. In addition they are very small and dwarfed. They resemble closely the Hatchetigbee forms of Alabama, but are even more extreme and dwarfed. If they are members of the same senile phylogenetic series which we find in Alabama they are indeed descendants of the Hatchetigbee Bluff Race. They may, however, be synchronous with any one of the Alabama senile groups, and be merely the expression of conditions which were much more unfavorable than those influencing the more eastern assemblages during Lignitic time.[10]

Athleta petrosa.

Lower Claiborne Races.

In the Alabama sections we find forms representing in a general way the *Athleta petrosa* main stock at a date as early as the Nanafalia Lignitic. In the western Gulf region no such normal types are known to the author from below the horizon of the Lower Claiborne beds. In other words the Lignitic forms from Texas, etc., are (as far as observed) abnormal, and even these senile representatives are rare. No evidence of the presence of these abnormal members has yet been presented by the sediments found above the Lignitic beds of this region.

The Lower Claiborne races of *Athleta petrosa*, then, may all be grouped as members of the *Athleta petrosa* main stock. As a rule each locality is characterized by a single, comparatively homogeneous race, the great majority of whose individuals differs more or less in certain minor characters from the races of other localities. Exceptionally, however, we find two very slightly different strains in the assemblage from a given place. These insignificant peculiarities may sometimes be important in locating the probable ancestry of later forms. Again, in a few places we find a well-defined race of *Athleta petrosa* accompanied by a very closely allied derived form, which has departed enough from its parent stock to be described as a distinct species.

The Lower Claiborne of Louisiana and Texas furnishes many good collecting grounds which afford excellent material for exhibiting the variations and mutations of *Athleta petrosa*. Nine localities which offer large series of well-preserved specimens have been selected, and the developmental shell stages of their races have been arranged in tabulated form. With the exception of Moseley Ferry all the localities chosen have comparatively homogeneous races of *Athleta petrosa*. At Moseley Ferry there are, however, two well-marked strains of *Athleta petrosa*. These two strains are very close, but one is of interest as foreshadowing the characters of the Jackson and Montgomery races of later time. It is greatly to be regretted that our knowledge of the stratigraphy will not permit us to arrange the Lower Claiborne races in chronologic order.

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[10] The Sabinetown beds have usually been correlated with the Wood's Bluff beds of Alabama. See Gilbert D. Harris and A. C. Veatch, *Geol. Surv. La.*, Rep. V, 1899, p. 67, and also A. C. Veatch, *Geol. Surv. La.*, 1902, p. 125.

In the following tables the figures stand for the whorl, while the letters are used for the different ontogenetic stages as follows:

A—Smooth stage.	D—Spiny stage.
B—Curved rib stage.	E—Senile stage.
C—Cancellated stage.	I—Individual variation.

	1	2	3	4	5	6	7	8	9	10	11	12
Mount Lebanon, La.		A		B		C			D			
Lewis House, two miles east of Alto, Tex.		A		B		C			D			
Nine miles southeast of Jewett, Tex.		A		B		C			D			
Smithville, Tex.		A		B		C			D			
Hurricane Bayou, Houston Co., Tex.		A	B			C			D			
Alabama Bluff, Trinity River, Houston Co., Tex.		A	B			C			D			
Shipp's Ford, Bastrop Co., Tex.		A	B			C			D			
Moseley Ferry, Tex.		A		B		C			D			
Moseley Ferry (Jackson Strain).		A	B			C			D			
St. Maurice, La.		A	B			C			D			

TABLE I.—Showing variability in the length of the smooth stage and relative constancy in the beginning of the spiny stage in the Lower Claiborne races of *A. petrosa*.

Athleta petrosa.

Montgomery Race.

Locality.—Montgomery, Louisiana.

Horizon.—Jackson beds.

The Montgomery race is, from a geological standpoint, cotemporaneous with the Jackson race of Jackson, Mississippi. In its early whorls it is perhaps a little less accelerated than the Jackson race. The following table will serve to illustrate its relations with the Mississippi forms and with the probable Lower Claiborne ancestor.

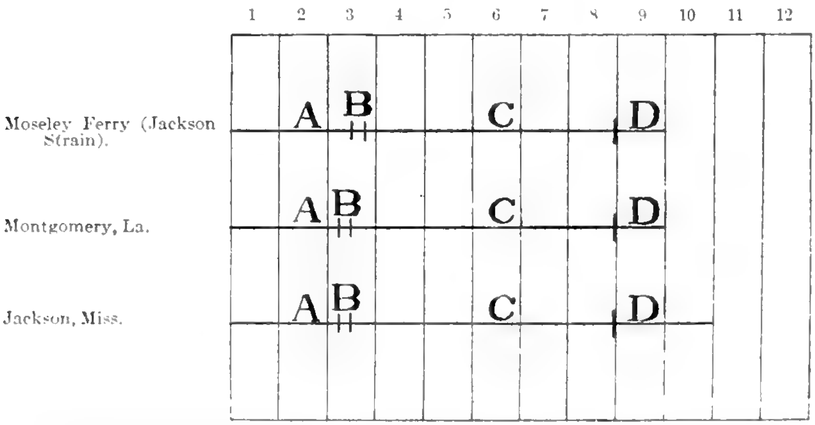

TABLE II.—Showing slight acceleration of the curved rib stage and the beginning of the cancellated stage in the *A. petrosa* races of Jackson time. The Lower Claiborne Moseley Ferry form is introduced as a probable ancestor.

Athleta clayi n. s.[11]

Locality.—St. Maurice, Louisiana.

Horizon.—Lower Claiborne.

The more important morphological features of this species may be summed up as follows:

Whorl 1.—Smooth and rounded.

Whorl 2.—Smooth and rounded at first, but soon a very few untubercled but nearly straight ribs appear. These probably represent a somewhat suppressed and condensed curved rib stage. They are followed by the straight tubercled ribs of the cancellated stage. At first the suture tubercle is the larger, but a shoulder angle soon forms and the shoulder tubercle becomes dominant.

Whorls 3, 4.—Characterized by the cancellated stage. Much as in

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[11] This species has been named in honor of Mr. Randolph Clay, of Philadelphia.

the latter part of whorl 2, but the ribbing above the shoulder grows weaker.

Whorls 5, 6.—Characterized by the cancellated stage, but toward the end of 6 the ribbing above the shoulder is gone and the suture tubercles are weak. The shoulder tubercle strengthens and the ribbing below it is well developed. Whorls covered with fine spirals from the shoulder downward, but they are stronger below on the branchial siphon.

Whorl 7.—Still characterized by the cancellated stage. The suture tubercle and the spirals immediately below the shoulder both disappear. The spirals are well developed, however, on the branchial siphon. Toward the end of the whorl the ribbing below the shoulder disappears and the shoulder tubercles become spine-like, so that the cancellated stage ends with the close of whorl 7.

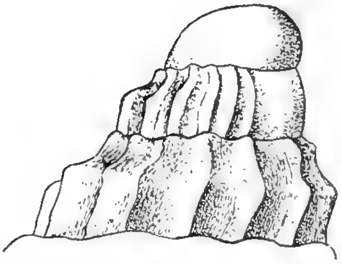


FIG. 1.

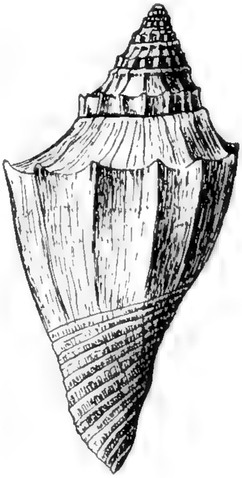


FIG. 2.

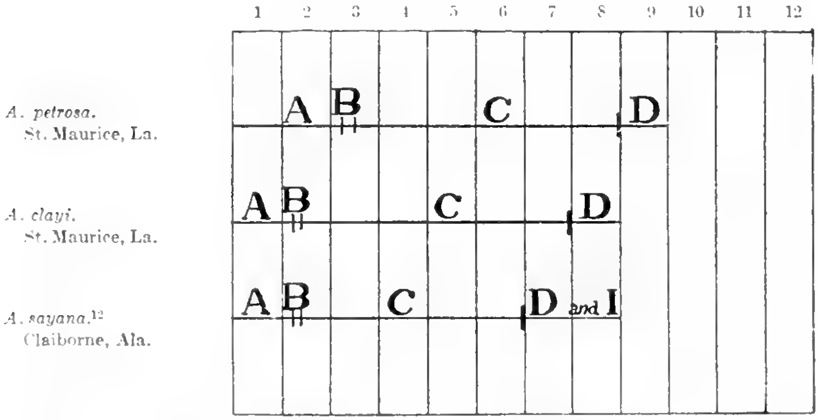
Fig. 1.—Apex of *Athleta clayi.* St. Maurice, Louisiana. In the second whorl the short and almost suppressed curved rib stage is seen passing into the tubercled ribs of the cancellated stage. Length about 1.2 mm.

Fig. 2.—*Athleta clayi.* St. Maurice, Louisiana. Mature individual exhibiting in its last whorl the features of the spiny stage. In the mature sculpture it is practically indistinguishable from the adult specimens of *A. petrosa.* Length = 27.5 mm.

Whorl 8.—Characterized by the spiny stage. Shoulder spines sharp. Spirals on the branchial siphon only. Shelly smoothing of the preceding whorl is slight.

Remarks.—This form is distinguished from the St. Maurice race of

Athleta petrosa by its large and swollen apex; by its smooth stage which occupies little more than one whorl; by its more or less suppressed curved rib stage, and by the earlier decline of the spirals immediately below the shoulder. The following table will serve to compare *Athleta clayi* with its associate, the St. Maurice race of *Athleta petrosa*, and also with a probable descendant, *Athleta sayana*, of Claiborne, Alabama.



	1	2	3	4	5	6	7	8	9	10	11	12
A. petrosa. St. Maurice, La.		A	B			C			D			
A. clayi. St. Maurice, La.	A	B			C			D				
A. sayana.[12] Claiborne, Ala.	A	B		C			D	and I				

TABLE III.—Showing the greater amount of acceleration in *A. clayi* and *A. sayana*. The less accelerated *A. petrosa* is introduced for comparison.

In Table I the compared races of *Athleta petrosa* are all from one geological formation, the Lower Claiborne. As stated before it is not possible, with our present knowledge of the stratigraphy, to arrange them in the order of their geological succession. This is most unfortunate, for it can be seen at a glance that the races differ to a considerable extent in the acceleration of their shell features. These races may and undoubtedly largely do represent certain episodes in the time range of the stock, but we cannot say which ones are mutations and which ones variations. There appears to be no relation between geographical distribution and degree of acceleration, and even if there were it would mean nothing in view of our ignorance of the stratigraphy. Any attempt at a phylogenetic arrangement of these assemblages, having as its basis the degree of acceleration, is very inadvisable. Such an arrangement would be founded on the assumption that an accelerated form must always and invariably occupy a higher horizon in the rock series than an unaccelerated form.

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[12] During 6, 7 and 8 many secondary riblets appear, and these with the spirals produce a secondary cancellation which must not be confused with the primary.

In these ten Lower Claiborne races it is evident that the early stages vary more than do the later stages. The end of the cancellated stage comes very constantly toward the close of whorl 8. The end of this stage is not as distinct as its beginning, and it is true that the table exaggerates slightly the sharpness of this termination of the cancellated stage. Though the change from the cancellated to the spiny stage is gradual it is usually accomplished within half a whorl, and this transformation takes place with great regularity during the latter part of whorl 8. To sum up, the table may slightly exaggerate the sharpness of the change, but it in no way exaggerates the fact that the end of the cancellated stage occupies in this series of forms a much more definite place in the ontogeny than does its beginning.

Table II shows that in the *Athleta petrosa* races of Jackson time the beginning of the cancellated stage is on the whole earlier than in the forms of the Lower Claiborne. In some cases this acceleration is quite marked, as is seen when we compare, for example, the Jackson or Montgomery races with the Mt. Lebanon race of Table I. The Lower Claiborne St. Maurice race of *Athleta petrosa* seems to have attained about the same degree of acceleration as the later races of Table II. The Lower Claiborne Moseley Ferry race, which exhibits the tendencies of the later Jackson time races, has been introduced into Table II as a probable ancestral form.

In Table III the Lower Claiborne race of *Athleta petrosa* from St. Maurice and the *Athleta clayi*, also of St. Maurice, are compared. *Athleta sayana* from the later Claiborne beds is shown as a probable descendant of *A. clayi.*

Taking all three tables into consideration, it is evident that the smooth stage is by far the most variable stage in *Athleta petrosa* and its derivatives, *A. clayi* and *A. sayana*. Still another remarkable fact is brought out by these tables when we examine the changes of the smooth stage in relation with the changes in the later stages. It is only in *Athleta sayana*, a form where the smooth stage has been restricted to a little over one whorl, that we find any marked modification of the characters of the spiny stage. Again, it is only in *A. sayana* that we find the spiny stage beginning at such an early point in the ontogeny as the sixth whorl.

In *Athleta clayi* and *A. sayana* the smooth first whorl is much larger than in any of the assemblages of *A. petrosa*. The apex of *A. sayana* is larger than the apex of *A. clayi*, and in addition the later stages of *A. sayana* are markedly different from those of *A. petrosa*. On the other hand, the later shell characters of *A. clayi* are almost identical (except for acceleration) with those of some of the Texas Lower Claiborne races of *A. petrosa*. In this particular respect *A. clayi* more closely resembles all the races of *A. petrosa* than it does *A. sayana*.

Athleta clayi is similar, then, to *A. petrosa* in its later stages, but similar to *A. sayana* in its smooth and curved rib stages.[13] It may be reasonably regarded as an intermediate between the *Athleta petrosa* main stock and *Athleta sayana*.

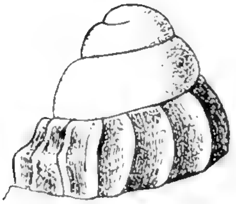

FIG. 3.

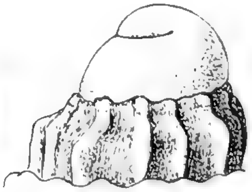

FIG. 4.

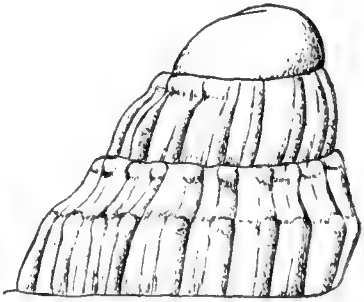

FIG. 5.

Fig. 3.—Apex of *Athleta petrosa* Con. St. Maurice, Louisiana. Showing the small first whorl and the relatively long smooth stage. In whorl 3 the curved ribs are seen passing into the tubercled ribs of the cancellated stage. Length about .75 mm.

Fig. 4.—Apex of *Athleta clayi*. St. Maurice, Louisiana. Shows the large and smooth first whorl. The tubercled ribs of the cancellated stage are displayed in whorl 2. Length about .8 mm.

Fig. 5.—Apex of *Athleta sayana* Con. Claiborne, Alabama. Shows the large smooth whorl and the smooth stage which is restricted to a little over one whorl. In whorl 2 the almost suppressed curved ribs are seen passing into the tubercled ribs of the cancellated stage. Length = 1.8 mm.

One more question is worth considering before we leave the discussion of the morphology. What is the meaning of this restriction of the smooth stage to a little over one whorl? If the size of the apex remained the same it would be best explained as an example of acceleration. The size of the first whorl, however, is not the same as in *Athleta petrosa*, but is larger in *A. clayi* and still larger in *A. sayana*. May not this change then represent only an enlargement of the veliger, rather than a case of true acceleration? The writer feels that with present data he is unable to solve this particular part of the problem. Though

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[13] The author realizes perfectly that the propriety of separating *A. clayi* from *A. petrosa* may be questioned by some workers. Those who object to his arrangement will probably bring up the frequently cited case of Sturany's ***Fusus bifrons*** (Gastropoden des Rothen Meeres). Judging from the figures it would seem, however, that Sturany is dealing with what would be regarded by most systematists as two distinct species.

the cause of this change may be unknown the change itself is unquestionable, and in the probable phylogeny of this particular series of forms it precedes the modification of the later shell stages.

Probable Phylogenetic Relations.

The Lower Claiborne races of *Athleta petrosa* show not a little racial variation especially in the smooth stage. They are nevertheless typical examples of the main stock. The later Claiborne race of Alabama probably owes its origin to some such assemblage as the first strain from the Lower Claiborne of Moseley Ferry. The second strain from Moseley Ferry—that is the one which shows such marked Jackson tendencies—is a probable ancestor which, through acceleration and the multiplication of plaits, passed into the Montgomery and Jackson races of Jackson time.

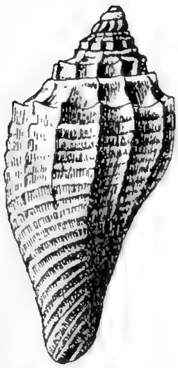


Fig. 6.

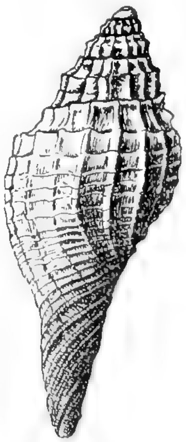


Fig. 7.

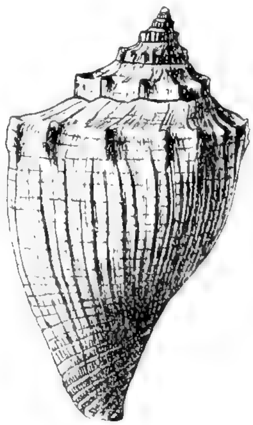


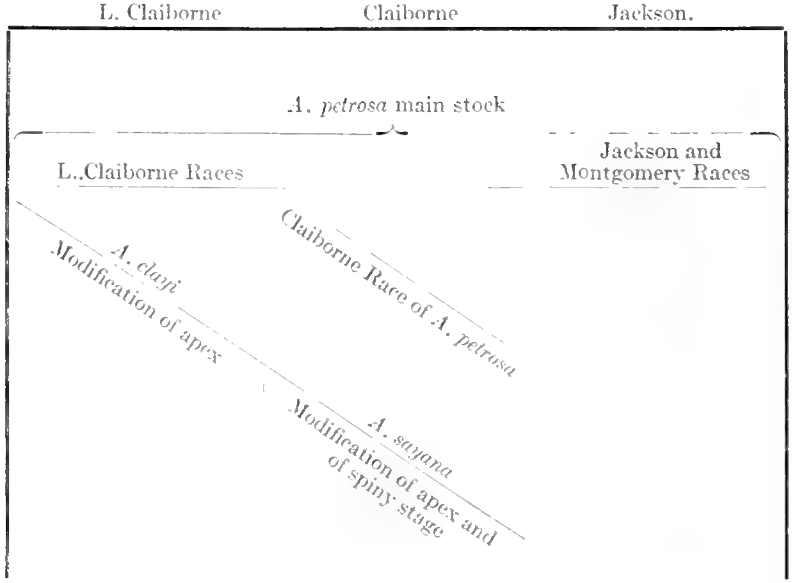
Fig. 8.

Fig. 6.—*Athleta petrosa* Con. St. Maurice, Louisiana. Immature individual exhibiting the sculpture of the cancellated stage. Length = 10 mm.

Fig. 7.—*Athleta clayi*. St. Maurice, Louisiana. Immature individual exhibiting the sculpture of the cancellated stage. Length = 12 mm.

Fig. 8.—*Athleta sayana* Con. Claiborne, Alabama. Mature individual showing in the sculpture of its later whorls marked departures from the *A. petrosa* main stock. The secondary cancellation is shown in the last whorl. Length = 48 mm.

Athleta clayi is almost identical with the examples of *A. petrosa* main stock in everything except its smooth stage. In its smooth stage it approaches *Athleta sayana* of the later Claiborne beds of Alabama. We are reasonably safe in concluding that *A. sayana* was derived from the *A. petrosa* main stock through the Lower Claiborne *A. clayi*. In this case the first change was a modification of the apical characters (*A. clayi*), and the second change was modification in the features of the spiny stage (*A. sayana*). The following table probably comes reasonably close to the phylogeny of these forms.



It will be seen that in the above scheme the Claiborne race of *Athleta petrosa* is placed in a position which indicates a slight divergence from the main stock. This change in its characters is attributed to the local nature of the Claiborne Sands environment.[14] The Claiborne race of *A. petrosa* is the type of the species, and this is just one example of what is frequently encountered in dealing with large series of races or individuals, namely, that the specific type may not be the most typical expression of the actual specific group.[15]

The races of *Athleta petrosa* which are displayed in the Lower Claiborne deposits of Texas and Louisiana appear to constitute a veritable metropolis. In this Lower Claiborne metropolitan assemblage was evolved *Athleta clayi*. The Claiborne race of *A. petrosa* and *A. sayana* of the Alabama Claiborne Sands represent local conditions, and clearly

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[14] See A. C. Veatch, *Geol. Surv. La.*, 1902, p. 140.

[15] Prof. Henry S. Williams has observed that "species are often described for the *extreme form* rather than the *central stock*." He also lays stress on "the necessity of distinguishing the real specific group from the species as understood in literature."

show their origin to have been among the more generalized forms of the Lower Claiborne.

The Jackson and Montgomery races are unquestionably the descendants of the Jackson strain in the Lower Claiborne metropolis and are not derived from the Claiborne forms.

SUMMARY.

In this study of *Athleta petrosa* and its allies from the western Gulf region we find the geological series of the races less complete than in the Eocene beds east of the Mississippi River. The Texas Lignitic yields little material, but that little is quite similar to the senile forms of the later Lignitic of Alabama. Texas, however, gives us no such increasingly abnormal series as we find in the Alabama Lignitic. These abnormal forms are considered as derived (1) by migration and (2) by senile evolution from a theoretical metropolis situated farther seaward in a more typically marine environment than obtained in the waters of the Lignitic Gulf.

With the end of the Lignitic this metropolis is believed to have encroached northward. The *Athleta petrosa* races of the Texas and Louisiana Lower Claiborne represent this metropolitan assemblage. Among these Lower Claiborne forms we find foreshadowed the Jackson, Montgomery and Claiborne races of later time. In addition *Athleta clayi* has in this Lower Claiborne diverged from its parent stock, and illustrates one stage of that evolution which finally results in the Claiborne *Athleta sayana*. The Claiborne forms of Alabama indicate an adjustment to rather local conditions, while the succeeding Jackson is a widespread limestone which bears a clear water facies of the old metropolitan assemblage.

In dealing with the evolution of shell features in fossil gastropods it is necessary to select a group which exhibits change, but at the same time is certainly of one genetic stock. The forms considered in this paper fulfill both of these conditions. No one can doubt the common origin of the races and species in question, while the morphologic changes are evident.

It was shown in another paper that the Lignitic forms diverged from the main stock by an exaggeration and not by an acceleration of the marks of senility. Their peculiar evolution was attributed to uncongenial conditions. It was a violent reaction to an unfavorable environment. The morphologic modifications of the post-Lignitic forms are perhaps still more interesting as casting some light on the laws of gastropod evolution. Taking the normal species and races of Lower

Claiborne, Claiborne and Jackson time, we find that on the whole there is much more variation in the smooth stage than anywhere else in the shell. Among the Lower Claiborne races of *Athleta petrosa* the only changes worthy of notice are in the length of the smooth stage, while *A. clayi* has departed from *A. petrosa* only by a modification of its apical features. The later shell characters of *A. clayi* are almost identical with those of *A. petrosa.*

In the Claiborne Sands we have the Claiborne race of *Athleta petrosa* and *A. sayana.* The writer suggests that in the first case (*A. petrosa*) the local conditions produced a modification in the later stages of a form with a primitive apex—in other words a member of the *A. petrosa* main stock. In the second case (*A. sayana*) it is believed that these similar external conditions acted on a type such as *A. clayi*, and that this form with its already modified apex reacted more readily, so that the characters of its later shell stages departed to a considerable extent from those of *A. petrosa.*

In the more widely extended conditions of Jackson age the apices are not greatly changed in form, but the smooth stage is simply shorter. In other words the curved rib stage and the beginning of the cancellated stage are more accelerated.

From the data furnished by *Athleta clayi* and *A. sayana* it appears that in the normal races of *Athleta petrosa* and its normal allies marked modifications of the later shell stages are preceded by marked modification in the apex. In addition we can say for this restricted normal group at least that the apex is not only a variable feature, but the most variable feature which the shells furnish.[16]

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[16] The author is thoroughly convinced that the features of the apex must be used in classification with great caution. For this group at least Grabau's generalization does not hold. He says: "The smaller the taxonomic group the more nearly identical must be the earlier stages, since in a small group the members have not become widely separated from their common ancestor." (*Am. Nat.*, Vol. 36, p. 922.)

NEW AND LITTLE-KNOWN WHELKS FROM NORTHERN JAPAN AND THE KURIL ISLANDS.

BY H. A. PILSBRY.

Volutopsius hirasei n. sp. (Pl. XIX, fig. 2.)

The shell is fusiform, thick and solid, glossy where unworn, livid under a very thin, smooth transparent cuticle, which however is largely worn from the type. Whorls 6⅓, strongly convex, separated by deep sutures. Surface sculptured with low spiral threads, rather close and fine below the suture, widely spaced in the median part of the last whorl, becoming close on the base, and coarser on the anterior narrow portion. The aperture is livid brownish within, outer lip expanded, white, thin at the edge. The columella is weakly sinuous, covered with a white callus. There is also a small but rather thick callus near the posterior angle of the aperture. A thin transparent callus spreads forward on the parietal wall.

Length 72, diam. 34 mm.; length of aperture 42 mm.

Kisennuma, Rikuzen. Type No. 93,443, A. N. S. P., from No. 1,312 of Mr. Hirase's collection.

This species is related to *V. regularis* Dall, but differs by the longer basal canal and the sculptured surface, *V. regularis* being smooth.

Beringius polynematicus n. sp. (Pl. XIX, fig. 1.)

Shell closely resembling *B. frielei* Dall,[1] large, thin, dirty white under a strong brown cuticle, mainly worn from the type, a "dead" shell. Sculpture of shallow spiral grooves, about 2 mm. apart on the last whorl, not much more than half that on the penultimate; the spaces between these grooves slightly convex, and sculptured with five or six irregular spiral threads on the last whorl (fig. 1), about four on the penultimate. Six and one-half strongly convex whorls remain, the apex being defective. The aperture is wide, the outer lip smooth within, thin; basal canal quite short. Columella very weakly sigmoid; callus on the inner margin thin, not spreading forward.

FIG. 1.

Length 140, diam. 59 mm.; length of the aperture 64 mm.

Kisennuma, Rikuzen. Type No. 93,444, A. N. S. P., from No. 1,760 of Mr. Hirase's collection.

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[1] *Proc. U. S. Nat. Mus.*, 1894, p. 711, pl. 27, fig. 8, from Bering Sea.

Only two specimens of this fine species were found. It is closely related to *B. frielei* Dall, but differs in the finer sculpture, that species having spiral threads in pairs, while in this there are invariably several threads grouped on the convex intervals between deeper spiral grooves.

Beringius schantaricus (Midd.) is a smaller species, 72–77 mm. long, with stronger external sculpture and spiral sulci within the mouth.

B. turtoni (Bean) is a species with internally smooth outer lip, but it differs notably in the shape of the spire.

The genus *Beringius* has also been known as *Jumala* and *Ukko*, both later generic terms.

Buccinum inclytum Pilsbry. (Pl. XX, fig. 1.)

Buccinum inclitum Pils., Nautilus, XVIII, p. 87.

A species of the *B. glaciale* group, of turrite-conic shape, rather solid and heavy, composed of about 8½ convex and somewhat angular whorls. The shell is white, with a few small brown spots, under a very thin, pale buff cuticle. The apex has been lost, and the first two whorls are somewhat worn. The next two whorls have a strong, cord-like keel below the middle, a smaller spiral rib below it, while above it the surface is flattened and sloping, the whole covered with fine spiral threads. Another spiral rib then gradually arises above the peripheral one, so that all the rest of the whorls of the spire have three strong rounded, cord-like spirals, all rendered irregularly nodose by rather close longitudinal waves which radiate from the suture. The last whorl is very convex, with a group of four strongly raised rounded spiral ribs, two below and one above the slightly larger peripheral spiral. The rest of the surface and the intervals between the ribs are sculptured with much smaller spiral cords; and there is also a very minute sculpture of fine spiral threads over the ribs and cords. The rather small aperture is white in the throat, becoming ochre-tinted near the lip and on the columella. The outer lip is slightly expanded and sulcate within, and it is slightly retracted above. The columella is weakly biplicate.

Length 82, diam. 47 mm.; length of the aperture 40 mm.

Etorō, Chishima. Type No. 88,768, A. N. S. P., from No. 1,704 of Mr. Hirase's collection.

This noble *Buccinum* has some resemblance to *B. carinatum* Dkr. and *B. verkrüzeni* Kob., but differs from both in its more numerous, closer and more emphatic spiral ribs. In the original notice in the *Nautilus* the name was printed "*inclitum*" by oversight.

Buccinum unicum Pils. (Pl. XX, fig. 7.)

Described in these *Proceedings* for 1905, p. 102. This peculiar form from Kisennuma, Rikuzen, is related to *B. viridum* Dall,[2] from off California in deep water, and also known from Bering Sea, but it differs from that in the minute sculpture. It is also a somewhat larger and less inflated shell than *B. viridum.*

Buccinum middendorffi Verkrüzen. (Pl. XIX, fig. 4; pl. XX, fig. 4.)

B. middendorffi Verk., Jahrb. Mal. Ges., IX, p. 213, 1882. Kobelt, Conchyl. Cab., *Buccinum*, p. 76, pl. 89, fig. 2.

A specimen from Akkeshi, Kushiro, is figured. It measures, length 69, diameter 44 mm. The spire is dull reddish brown, fading on the last whorl to rusty cream color. The aperture is brownish yellow within, becoming dull reddish deep in the throat, the columella and inner lip largely pure white, but with some yellow stain in the middle. The sculpture of coarse waves reminds one of *B. undatum.* On the last whorl there is a spiral sculpture of unevenly spaced low spiral threads and shallow grooves at intervals, the whole covered with very close, fine, decurrent wavy spiral lines. On the penultimate whorl the spaced grooves run in pairs, and the finer sculpture is less distinct. The next earlier whorl has low spiral cords, and the preceding two have a sculpture of about 6 spiral cords running over slightly arcuate longitudinal rounded ribs, somewhat as in a *Latirus.* The apex is worn.

While this example has much resemblance to Kobelt's figures of *B. lischkeanum* Löb., yet it seems referable to *B. middendorffi.*

Buccinum mirandum Smith. (Pl. XIX, fig. 5; pl. XX, fig. 5.)

The figures represent an example agreeing well with Kobelt's figure of the type, except that the longitudinal waves are almost obsolete. It is white with a creamy or brownish tint, and somewhat profusely maculate with rusty brown. The last whorl has 5 spiral ribs, the upper one weakly nodose, the others hardly perceptibly so. It is strongly puckered below the suture. The surface is finely and very closely engraved with minute, clear-cut spiral lines mingled with coarser ones. Length 45.5, diameter 28.5 mm.

Another example (pl. 19, fig. 3; pl. 20, fig. 3), from Akkeshi, Kushiro, has the primary spiral ribs much smaller, the secondary threads larger, the same minute engraved lines being present. The whorls are also obliquely waved above the periphery. The lip is white, but the interior of the aperture is brownish ochraceous. Length 48, diameter 30 mm.

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[2] *Proc. U. S. Nat. Mus.*, XII, 1889, p. 320, pl. 6, fig. 9. Also Keep, *West American Shells*, p. 172, fig. 165.

Buccinum mirandum var. **schrenkii** Verkrüzen. (Pl. XIX, fig. 6: pl. XX, fig. 6.)

The example figured occurred with *B. mirandum* (fig. 5). It differs from that chiefly by the total absence of spiral ribs. The minute sculpture is the same. The whole shell is dull reddish brown, the thick lip and the columella white. The surface is puckered below the suture as in *B. mirandum*. Length 48, diameter 30 mm.

Purpura freycineti alabaster n. subsp. (Pl. XX, fig. 2.)

The shell is large, thick and heavy, dull ashy white externally. The spire is very short, the last whorl ample. Sculpture of coarse, wide-spaced ribs, the largest at the shoulder, regularly diminishing downwards, about 8 on the last whorl, one on the penultimate, two on the preceding whorls of the spire. There are also some coarse spaced ridges along growth-lines. The aperture is pure white, the bevelled lip a little grooved at the positions of the external ribs. The wide columella is slightly flattened. Siphonal fasciole prominent. Length 56, diameter 38 mm. Kunajiri (or Kunashiri), Chishima. Type No. 88,304, A. N. S. P., from No. 1,591 of Mr. Hirase's collection.

This large and ponderous *Purpura* is very unlike the typical *P. freycineti*, which is a common species of Kamchatka and the Kuril Islands; but it has some resemblance to certain forms of that species figured by Lischke (J. M. C., pl. 4, figs. 16–19), and I have thought it best to subordinate *alabaster* to the common form of the region until extensive collections can demonstrate its true status.

Explanation of Plates XIX and XX.

Plate XIX.—Fig. 1.—*Beringius polynematicus* n. sp. Type.
  Fig. 2.—*Volutopsius hirasei* n. sp. Type.
  Fig. 3.—*Buccinum mirandum* Smith. Variety from Akkeshi, Kushiro.
  Fig. 4.—*Buccinum middendorffi* Verkrüzen. Variety, " "
  Fig. 5.—*Buccinum mirandum* Smith. Strongly ribbed form.
  Fig. 6.—*Buccinum mirandum schrenkii* Verkrüzen.

Plate XX.—Fig. 1.—*Buccinum inclytum* Pilsbry. Type.
  Fig. 2.—*Purpura freycineti alabaster* n. subsp. Type.
  Fig. 3.—*Buccinum mirandum*. Akkeshi, Kushiro.
  Fig. 4.—*Buccinum middendorffi* Verk. Variety.
  Fig. 5.—*Buccinum mirandum* Smith. Strongly ribbed form.
  Fig. 6.—*Buccinum unicum* Pilsbry. Type.

NOTES ON THE LEAF HAIRS OF LESQUERELLA.[1]

BY E. G. VANATTA.

The hairs of the leaves of *Lesquerella* are usually described in botanical works as "stellate." So far as I know, it has not been noticed that the forms vary in different species. These differences may become an important feature for the determination of the species. The number of rays of these stellate hairs is variable, but the form of the rays and their manner of branching are more constant, although some hairs of the compound forms often have one or more rays simple.

By the shape of the hairs the species of *Lesquerella* which I have examined fall into five groups as follows:

Group I.—Hair a simple few-rayed star.

Pl. XXI, fig. 1 × 60. *L. argyrea* Gray. Flora, Texas, Exsic. 329, Fasc. III, leg. T. Lindheimer, 1846.

Group II. Hair a few-rayed star, each ray normally bifid.

Pl. XXI, fig. 3 × 60. *L. argentea* Wats. Laramie University Campus, Wyoming. Acad. Nat. Sci. Phila. No. 523,700.

Fig. 2 × 60. *L. globosa* Dr. Rising Sun Bluff, Cumberland River, fourteen miles below Nashville, Tenn.

Fig. 4 × 60. *L. gracilis* Hook. Mesa near Tucson, Arizona. E. Pringle, April 12. (B. Smith.)

Fig. 5 × 60. *L. ludoviciana* Wats. Laramie, Wyoming; Flora, Wyoming, 190. C. Nelson, 1894.

Fig. 8 × 60. *L. montana* Gray. Table Mountain, Wyoming; Flora, Wyoming, 88. A. Nelson.

Fig. 9 × 60. *L. recurvata* Engl. Kerrville, Texas. A. Heller, 1657.

Group III. Each ray of star normally twice bifid.

Pl. XXI, fig. 10 × 60. *L. alpina* Wats. New Mexico. A. Fendler, 1847.

Fig. 13 × 60. *L. arctica* Wats. Itibla, Whāle Sound, McCormick Bay, Greenland. A. Heilprin, 1891.

Fig. 11 × 100 and fig. 17 × 60. *L. didymocarpa* Hook. Wagon Wheel Gap, Colorado. B. Smith, July 16, 1882.

Fig. 15 × 60. *L. douglasi* Wats. Klickitat County, Washington. B. Smith (Sukodorf!).

Fig. 6 × 60. *L. lindheimeri* Berl. Texas and Mexico. Herb. Berl., 1439 (Short Herb).

Fig. 7 × 60 and fig. 14 × 100. *L. nuttalli* Gr. Arkansas, Nuttall.

Fig. 18 × 60. *L. occidentalis* Wats. White Bluff, Columbia River, Washington, 635, Brandiger, 1883.

GROUP IV. Hair a many-rayed star, often with a web between the rays.

Pl. XXI, fig. 12 × 60. *L. berlandieri* Gray. Circa Matamoras, Texas. Herb. Berland, Texas and Mexico, April, 1831 (Short Herb).

Fig. 16 × 60. *L. fendleri* Gr. Sierra Madre, forty miles south of Saltillo, Mexico. Dr. E. Palmer.

Fig. 19 × 60 and fig. 20 × 100. *L. lepidata* Rose. Near Tula, 6,800 feet, Mexico. C. Pringle, 6,899. Acad. Nat. Sci. Phila. No. 506,384.

Fig. 22 × 60. *L. purpurea* Gray. Santa Catalina Mountains, Arizona. C. Pringle, 1883.

Fig. 23 × 100 and fig. 25 × 60. *L. schaffneri* Wats. San Luis Potosi, Mexico. Ex. Herb. Gray.

Fig. 21 × 60 and fig. 26 × 60. *L. stenophylla* Gr. (*humilis*). Pecos, Texas. C. Wright, 1881. No. 852.

Fig. 24 × 60. *L. stenophylla* Gray (*procera*). Turkey Creek, Texas. 850. C. Wright.

GROUP V. Hair a few-rayed star, which looks as if one ray was omitted.

Pl. XXI, Fig. 27 × 60. *L. densiflora* Gray. Flora. Texas. Exsic. 328, Fasc. III. F. Lindheimer, 1846 (Short Herb).

Fig. 28 × 60. *L. grandiflora* Hk. Victoria, Texas, Flora. Texas, Exsic. Dr. Engelmann, 1846.

Fig. 24 × 60. *L. engelmanni* Gr. Texas. Fendler, 1846.

All the specimens figured are mounted in Canada balsam in the herbarium of the Academy of Natural Sciences of Philadelphia.

NOTES ON SERRANIDÆ.

BY HENRY W. FOWLER.

The material on which this paper is based is all contained in the collections of the Academy of Natural Sciences of Philadelphia.

PERCICHTHYINÆ.

Percichthys melanops Girard.

No. 22,892, A. N. S. P. Cotype.

Percichthys trucha (Valenciennes).

Argentina. Recently reported by Drs. Evermann and Kendall.

PARALABRACINÆ.

Maxillary with a supplemental bone. Tongue smooth. Gill-rakers long and slender. Scales very small. Dorsals 2, connected at base, XI–XIII, I–II, 12–14. Anal spines III, well developed. Ventrals inserted behind bases of pectorals.

The only genus examined seems to be *Percalabrax* Schlegel, *Fauna Japonica, Poiss.*, I, 1842, p. 2 (type *Labrax japonicus* Cuvier, only species), which has priority over *Lateolabrax* Bleeker, *Verh. Batav. Genoot.* (Nalez. Ich. Jap.), XXVI, 1854, pp. 4, 53 (type *Labrax japonicus* Cuvier, only species).

Percalabrax japonicus (Cuvier).

Tsuruga, Japan (D. S. Jordan and J. O. Snyder).

MORONINÆ.

Roccus chrysops (Rafinesque).

Southern Illinois (R. Kennicott).

Roccus lineatus (Bloch).

Trenton, N. J.; Sing Sing, N. Y. (S. F. Baird); Chestertown, Md. (E. G. Vanatta); Connecticut River (Smiths. Inst.); North Carolina? (E. D. Cope).

Labrax labrax (Linnæus).

Italy (Bonaparte Coll.).

Labrax Klein, in Walbaum, *Pet. Artcd. Gen. Pisc.*, 1792, p. 584 (type

Perca labrax Linnæus, understood by tautonomy) has priority over *Dicentrarchus* Gill, *Proc. Acad. Nat. Sci. Phila.*, 1860, pp. 109, 111 (type *Perca elongata* Geoffroy St. Hilaire = *Perca labrax* Linnæus specified).

CHRYSOPERCA subgen. nov.

Type *Morone interrupta* Gill.

Dorsal fins slightly connected, spines robust and longest somewhat more than half of head. Color brassy-yellow with about 7 distinct longitudinal lines interrupted posteriorly.

Related to subgenus *Morone* Mitchill, which has shorter fins well connected, spines moderate and shorter, and coloration more silvery.

(*Χρυσος*, gold; *πέρκα*, perch.)

Morone interrupta Gill.

Two examples, probably cotypes(?), from the Smiths. Inst. Both would agree with Dr. Gill's statement concerning the anal spines, the second of which is about equal to the third.

Wabash River, Indiana (E. D. Cope).

Morone americana (Gmelin).

Newport, R. I. (Dr. W. Gibson); Bayport, Fla. (E. D. Cope); Mount Desert, Me. (Dr. H. C. Chapman); Boston Harbor, Mass. (Dr. J. H. Slack); Potomac River (Smiths. Inst.); New York Harbor (T. Norris).

LIOPROPOMINÆ.

Labracopsis japonicus Steindachner.

Yokohama, Japan (D. S. Jordan and J. O. Snyder).

CENTROGENIINÆ.

To replace *Myriodontinæ*, *Myriodon* preoccupied.

Centrogenys vaigiensis (Quoy and Gaimard).

Singapore, Malacca (Dr. J. B. McCartee).

POLYPRIONINÆ.

Stereolepis gigas Ayres. Fig. 1.

Proc. Cal. Acad. Nat. Sci., II, 1858, p. 28. ? Type No. 32,753, A. N. S. P. Bay of San Francisco.

Head $3\frac{1}{3}$; depth $3\frac{1}{3}$; D. XI, 9; P. 17; scales in lateral line to base of caudal about 77? (squamation damaged); about 120? scales in a lateral series to base of caudal along lateral line above; about 16? scales between origin of spinous dorsal and lateral line; about 27? scales in a vertical series between origin of anal and lateral line; width of head about 1$\frac{2}{7}$ in its length; snout nearly 3; eye about 9; maxillary 2$\frac{1}{6}$; interorbital space 3$\frac{1}{2}$; second dorsal spine 6$\frac{1}{4}$; third dorsal ray 3; third anal spine 4; second anal ray 3$\frac{1}{8}$; upper caudal lobe 1$\frac{4}{7}$; least depth of caudal peduncle 3$\frac{3}{5}$; pectoral 2; ventral 2$\frac{2}{3}$. A slight median predorsal keel. Snout about half as long as wide. Eye a little longer than deep, and placed near first third in head. Upper jaw slightly protruding. Lips thick. Distal expansion of maxillary about half of orbit. Nostrils close together, similar. Interorbital space broad and somewhat convex. Edges of bones on head entire. About 13 rows of scales on cheek. Lateral line on 1 or more alternate scales in its course, concurrent with dorsal profile, and also extending out on base of caudal. Spinous dorsal inserted a little behind origin of ventral. Rayed dorsal begins well in front of anal or much nearer origin of pectoral than base of caudal. Spinous anal inserted about opposite base of third dorsal ray, spines slender and second longest. Caudal slightly marginate. Pectoral reaches about half way to origin of rayed dorsal. Ventral reaches $\frac{1}{3}$ of space to anal. Color of dried skin more or less uniform brownish. Length 6 feet 2 inches.

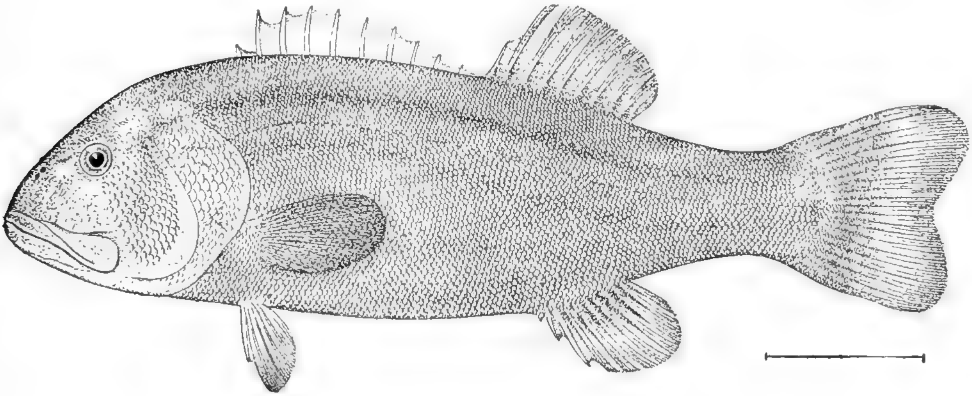

Fig. 1.—*Stereolepis gigas* Ayres. (Cotype?)

In the original account 2 examples are mentioned, one taken in 1857, which measured 5 feet 8 inches, and the other in 1859, which was 7 feet long. Allowing for shrinkage in the above example it is more likely the latter. This was stated to have weighed 360 pounds. Ayres gives D. IX, A. III, 8, P. 19, and other discrepancies, which may possibly be explained by the preparation of the specimen as a dried skin, typographical errors, etc.?

Polyprion americanum (Schneider).

Italy (Bonaparte Coll.).

SERRANINÆ.

To replace *Epinephelinæ.*

Petrometopon cruentatum (Lacépède).

Viequas, Porto Rico (U. S. F. C.).

Petrometopon cruentatum coronatum (Valenciennes).

New Providence, Bahamas (Dr. H. C. Wood).

Cephalopholis argus Schneider.

Recorded by me as *Bodianus guttatus* in *Proc. Acad. Nat. Sci. Phila.*, 1899, p. 485, from Thornton Islands (C. D. Voy).

Apia, Samoan Islands (D. S. Jordan).

Cephalopholis fulvus (Linnæus).

New Providence, Bahamas (Dr. H. C. Wood); San Domingo, West Indies (Prof. W. M. Gabb); Bermuda Islands (Prof. A. Heilprin).

Cephalopholis fulvus ouatalibi (Valenciennes).

New Providence, Bahamas (E. Tatnall, Dr. H. C. Wood); San Domingo (Prof. W. M. Gabb), St. Croix (Capt. T. Davidson, Dr. R. E. Griffith) and St. Kitts (B. H. Lightfoot); Bermuda Islands (Prof. A. Heilprin).

The Sumatran species I recorded in 1904 under *Bodianus* should now stand as *Cephalopholis aurantius indelebilis, C. miniatus* and *C. rogaa.*

Serranus alexandrinus Valenciennes.

Beirut, Syria.

Serranus Cuvier, *Règne Animal,* II, 1817, p. 276 (type *Perca gigas* Brünnich first species = *Labrus guaza* Linnæus), is the first name available for the fishes of this genus, as the first species under *Epinephelus* Bloch, and therefore its type, is an *Alphestes. Daba* Forskål, *Descript. Animal.*, 1775, p. 44 (type *Perca areolata* Forskål understood from the Arabic vernacular) is uncertain.

Serranus maculosus Valenciennes.

New Providence, Bahamas (Dr. H. C. Wood); San Domingo (Prof. W. M. Gabb) ; St. Martin's (Dr. R. E. van Rijgersma) ; St. Thomas (Henry Warrington); St. Kitts (B. H. Lightfoot).

Serranus flavolimbatus (Poey).

San Domingo (Prof. W. M. Gabb).

Serranus niveatus Valenciennes.

Newport, R. I. (Samuel Powell); Katama Bay, Martha's Vineyard, Mass. (Dr. H. M. Smith).

Serranus quernus (Seale).

Honolulu, H. I. (Dr. T. D. Wood).

Serranus guaza (Linnæus).

Italy (Bonaparte Coll.); Beirut, Syria.

Serranus guaza mentzelii (Valenciennes).

Epinephelus brachysoma Cope, Trans. Amer. Philos. Soc. Phila., (2) XIV, 1871, p. 466. Type, No. 13,372, A. N. S. P. Rio Janeiro, Brazil. Dr. W. S. W. Ruschenberger.

Head $2\frac{1}{2}$; depth $2\frac{9}{10}$; scales 103 in lateral line to base of caudal, and about 10 more out on latter; tubes about 64 in lateral line to base of caudal, and 8 more on latter; 15 scales in a vertical series between origin of rayed dorsal and lateral line; 22 scales in a vertical series between origin of spinous anal and lateral line; width of head $2\frac{1}{8}$ in its length; fourth dorsal spine $2\frac{1}{5}$; eleventh dorsal ray $2\frac{1}{2}$; second anal spine $3\frac{1}{8}$; fifth anal ray 2; least depth of caudal peduncle $3\frac{2}{5}$; caudal $1\frac{3}{5}$; pectoral $1\frac{4}{7}$; ventral $1\frac{7}{8}$; snout $4\frac{3}{5}$ in head measured from tip of snout; eye 5; maxillary $2\frac{1}{10}$; interorbital space $7\frac{1}{8}$. Body oblong, compressed. Head elongate, profiles similar. Snout a little broader than long. Eye a little longer than deep, high and near first third of head. Mouth inclined, and mandible protruding. Maxillary reaches nearly opposite posterior margin of eye, and its expansion about $\frac{2}{3}$ of same. Teeth in bands in jaws, sharp, conic and canines $\frac{1-1}{1-1}$. Inner mandibular series and upper inner teeth depressible. Fine teeth on vomer and palatines. Tongue long and free. Nostrils close. Interorbital space a little convex, flattened medianly. Preopercular margin finely serrated posteriorly, serræ increasing in size toward angle. Median opercular spine largest, most posterior, and nearer lower. Gill-rakers vi, 2 + 12, iii, and a trifle less than filaments, which are $\frac{4}{7}$ of eye. About 32 irregular series of scales on cheek. Tubes in lateral line simple. Spinous dorsal inserted about midway between origin of rayed dorsal and tip of snout. Rayed dorsal inserted about midway between base of third dorsal spine and base of caudal, posterior rays longest, and edge of fin rounded. Spinous anal inserted about midway between origin of ventral and base of caudal, second spine robust and longest, and third slender and but little shorter. Rayed anal rounded, and its base about $1\frac{2}{3}$ in its height. Vent near last fifth in space between ventral and anal. Color in alcohol more or less uniform brown generally. Margins of fins more or less dusky-brown, and this color sharply contrasting on rayed dorsal and anal with paler basal color. On dusky area of caudal distally 2 pale or whitish spots about median rays. Pectorals brownish with narrow pale edge. Side of body with obscure whitish flakes of various sizes. A dusky streak back from end of maxillary above, and below this a whitish streak. Iris warm brownish. Length 7⅜ inches. Type.

I retain *Serranus mentzelii* Valenciennes for this fish, as I have not compared any examples of corresponding size of *Labrus guaza* Linnæus. Cope states the length of his type as 8 inches.

Serranus labriformis Jenyns.

Epinephelus ordinatus Cope, Trans. Amer. Philos. Soc. Phila., (2) XIV, 1871, p. 466. Type, No. 13,457, A. N. S. P. Panama. Dr. W. S. W. Ruschenberger.

Head 2½; depth 3⅒; scales about 100? (squamation injured) counted along lateral line to base of caudal, and about 10 more somewhat enlarged on latter; about 46 pores in lateral line to base of caudal; about 12 scales in a vertical series between origin of rayed dorsal and lateral line; 33 scales in a vertical series between origin of spinous anal and lateral line; width of head 2⅗ in its length; third dorsal spine 3⅞; sixth dorsal ray 2⅓; second anal spine 3; third anal ray 2; least depth of caudal peduncle 3⅗; caudal 1⅗; pectoral 1⅗; ventral 2⅙; snout 5 in head measured from tip of upper jaw; eye 4⅙; maxillary 2⅕; interorbital space 9½. Body elongate. Head compressed. Length of snout about 1⅓ in its width. Eye a little longer than deep and placed about first third in its length. Mandible protruding a little in front. Maxillary reaching a trifle behind posterior margin of eye, with narrow supplemental bone, and its distal expansion half of eye horizontally. Narrow bands of teeth in jaws, inner in front of upper a little elongate and depressible. An inner series of rather enlarged depressible mandibular teeth, and at first teeth irregularly triserial and then becoming biserial on posterior portions of rami. Canines small, $\frac{2-1}{1-2}$, a little curved. Small vomerine and palatine teeth. Tongue slender, smooth and free. Nostrils close. Lower preopercular margin entire. Interorbital space narrow, flat, and slightly depressed in front. Median opercular spine most posterior, uppermost anterior, and median about midway between upper and lower. Gill-rakers vi, 2 — 11, vi, larger than filaments and about 2¼ in eye. Scales finely ctenoid, and about 24 series on cheek. Maxillary naked. Tubes in lateral line simple. Spinous dorsal inserted nearly midway between tip of mandible and origin of rayed dorsal, and spines graduated down from third and fourth, which are subequally longest. Rayed dorsal inserted a little nearer base of caudal than origin of spinous fin, rounded. Spinous anal inserted nearer origin of pectoral than base of caudal, second spine longest, and third subequal. Color in alcohol dull pale brown, head and trunk blotched with a number of scattered or grayish-white flakes of uneven size, though all smaller than pupil and with a number of obscure deep brownish mottlings scattered about between. Lower surface of head and body scarcely paler or more grayish. Fins pale brownish like general body-color, margin of spinous dorsal a little deeper brown, and also its base with deep shades about third to seventh and tenth to third dorsal rays. Outer or submarginal portions of other fins deeper brownish than otherwise. Edges of rayed fins narrowly whitish. Pectoral and ventral dusky-brownish, pale basally. A large dusky saddle on caudal peduncle above. Iris slaty-gray. Length 5½ inches. Type of *Epinephelus ordinatus* Cope.

Tower Island, Galapagos (R. E. Snodgrass and E. C. Heller).

Serranus striatus (Bloch).

New Providence, Bahamas (Dr. H. C. Wood); St. Croix (Dr. R. E. Griffith); no locality (Dr. A. L. Heermann); San Antonio Bridge and Puerto Real, Porto Rico (U. S. F. C.).

Serranus morio Valenciennes.

Key West, Fla. (Dr. Murray).

Serranus merra (Bloch).

Thornton Island, south Pacific Ocean (C. D. Voy); Apia, Samoa (D. S. Jordan).

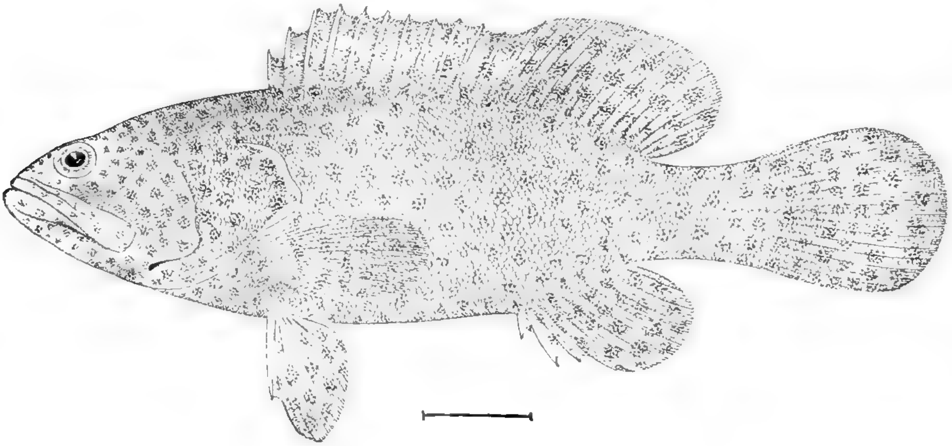

Fig. 2.—*Serranus phæostigmæus* Fowler. (Type.)

Serranus phæostigmæus sp. nov. Fig. 2.

Epinephelus fuscoguttatus Fowler, Proc. Acad. Nat. Sci. Phila., 1900, p. 502. Sandwich Islands. Dr. J. K. Townsend. (Probably not of Forskål.)

Head 2½; depth 3⅛; D. XI, 16, i; A. III, 8, i; P. 18; V. I, 5; scales about 102 in lateral line to base of caudal, and 6 more on latter; tubes 61 in lateral line to base of caudal, and about 5 more on latter; 14 scales in a vertical series between origin of rayed dorsal and lateral line; about 20 scales between origin of spinous dorsal and lateral line in a vertical series; width of head 2 in its length; depth of head $1\frac{2}{3}$; mandible $1\frac{5}{6}$; fourth dorsal spine $3\frac{1}{3}$; eleventh dorsal ray $2\frac{3}{7}$; third anal spine $3\frac{9}{10}$; seventh anal ray $3\frac{1}{5}$; caudal $1\frac{3}{5}$; least depth of caudal peduncle $3\frac{1}{4}$; pectoral $1\frac{5}{7}$; ventral 2; ventral spine $3\frac{1}{2}$; snout $5\frac{1}{5}$ in head measured from tip of snout; eye 7; maxillary $2\frac{1}{10}$; interorbital space 5.

Body robust, elongate, compressed, profiles rather evenly and similarly convex, so that contour is somewhat fusiform, and greatest depth at base of fifth dorsal spine. Edges of body rounded, chest broadly so. Caudal peduncle compressed, and least depth about $\frac{2}{3}$ its length.

Head large, robust, slightly compressed, and with greatest width swollen below. Upper profile more inclined than lower, nearly straight, and but slightly concave over eye. Snout convex, its length about half its width. Eye a little longer than deep, rounded, high, and near first quarter in length of head. Mouth inclined obliquely, and broad mandible protruding a little in front. Lips a little broad and fleshy. Maxillary well exposed, reaching about $\frac{4}{5}$ an eye-diameter beyond eye, and its expansion about $\frac{7}{8}$ of horizontal orbital diameter. Bands of rather small fine teeth in jaws, a few canine-like in front of upper and along rami of lower posteriorly. Rami of mandible not elevated inside of mouth. Bands of minute teeth on vomer and palatines. Buccal membranes broad in mouth. Tongue broad, rounded and a little free. Nostrils close together on side of snout above front of eye, anterior with a tube ending in a cutaneous flap posteriorly. Posterior nostril midway between anterior and upper front of eye. Preorbital narrow, its width about $\frac{3}{7}$ horizontal orbital diameter. Preopercular margin convex posteriorly, that edge finely serrated, and about 3 large denticles at corner. Opercular spines 3, median largest and closer to lower, also a little posterior.

Gill-opening extending forward opposite front of orbit, and uppermost margin horizontal. Gill-rakers vi, 3 + 8, vi, clavate, and longest half of orbit or same of gill-filaments. Gill-filaments $\frac{3}{4}$ of horizontal orbital diameter. Pseudobranchiæ about $\frac{3}{5}$ of filaments. Isthmus broad, bevelled in front, and broadly keeled posteriorly.

Scales all rather finely ctenoid, largest on opercle and middle of side, and very small and reduced along edges of body, especially predorsal region and chest. On predorsal region, and cheek above, scales more or less truncate. Scales disposed over trunk in more or less longitudinal series, and somewhat inclined posteriorly, also extending over lateral line. Minute scales on bases of all fins. Axil of pectoral with a pit, covered by a scaly flap above. About 28 scales on cheek. Head almost scaly everywhere, except on lips and maxillary. Lateral line of slightly arborescent tubes, and concurrent with dorsal profile till out in middle of base of caudal.

Spinous dorsal inserted about midway between front of eye and origin of rayed dorsal, graduated from fourth spine which is longest, and margin of fin deeply notched, so that cutaneous points occur behind tip of each spine. Rayed dorsal inserted midway between origin of spinous fin and base of caudal, fin rounded, and posterior rays a little longest. Spinous anal inserted nearer base of caudal than origin of ventral, and graduated to third spine which is longest. Rayed anal with posterior rays longest, and fin rounded. Caudal rounded. Pectoral broadly expanded, inserted before dorsal, and reaching $\frac{5}{8}$ of space to spinous anal. Ventral inserted just behind base of pectoral, and reaching $\frac{4}{7}$ of space to spinous anal, but not so far posteriorly as tip of pectoral. Ventral spine $\frac{4}{7}$ length of fin. Vent midway between tip of ventral and origin of spinous anal.

Color in alcohol dull drab generally, lower or under regions not paler. Head and body with obscure spots almost everywhere of vandyke-brown, not sharply defined but most intense in color in center, about size of pupil, and disposed over body and all fins alike. Fins brownish like general body-color, not especially pale marginally but with deepest color basally. Iris dull brownish with a narrow golden circle around pupil.

Length 8½ inches.

Type, No. 13,463, A. N. S. P. Hawaiian Islands. Dr. J. K. Townsend.

This fish was originally identified by me with *Perca summana* var. *fuscoguttata* Forskål, a species to which it is certainly closely related. *Serranus* (*Epinephelus*) *dictyophorus* Steindachner, *Sitz. Ak. Wiss. Wien*, C, II, 1893, p. 219, from Honolulu, differs apparently, according to Dr. Steindachner's excellent description, in the deep body, narrower interorbital space, other proportions, etc.

(*Φυιὸς*, brown; *στίγμα*, spot.)

Other species examined are *Serranus heniochus*, *S. maculatus*, *S. sexfasciatus*, *S. megachir*, *S. dermochirus*, *S. horridus* and *S. lanceolatus*, all from Sumatra, and which I formerly included under *Epinephelus*.

Garrupa nigrita (Holbrook).

Serranus nigritus Holbrook, Ichth. S. Car., 1855, p. 173, Pl. 25, fig. 2. Type No. 13,468, A. N. S. P. Charleston, S. C. Dr. J. E. Holbrook.

This example is 16 inches long (caudal damaged), though Holbrook states that the total length is 2 feet. However, the original label indicates this as the type, together with the locality as Charleston. Holbrook also says that the caudal was somewhat mutilated in the only example he ever saw.

Color in alcohol of young deep chocolate-brown generally. Dorsals, anals and ventrals inclining to slaty or livid blackish. Margin of rayed dorsal broadly, and rayed anal more narrowly, becoming pale brownish and then whitish along edges. Caudal and pectoral white, latter chocolate-brown at base. Lower surface of head and jaws tinted with dull brown. Iris slaty. Length $3\frac{1}{2}$ inches. Katama Bay, Martha's Vineyard, Mass. Dr. H. M. Smith.

Epinephelus chloropterus (Cuvier).

St. Martin's (Dr. R. E. van Rijgersma).

Prof. Peters long ago examined Bloch's type of *Epinephelus afer* and found it identical with *Plectropoma chloropterum*. Provisionally, as Bloch's fish is said to have come from West Africa, I allow Cuvier's name to stand for the American fish.

Epinephelus Bloch, *Nat. Ausl. Fisch.*, VII (X), 1793, p. 11 (type *Epinephelus afer* Bloch first species) has priority over *Alphestes* Schneider, *Syst. Ich. Bloch*, 1801, p. 236 (type *Epinephelus afer* Bloch first species).

Epinephelus lightfooti sp. nov. Fig. 3.

Head $2\frac{1}{2}$; depth $2\frac{4}{5}$; D. XI, 18, I; A. III, 9, I; P. I, 16; V. I, 5; scales about 70 in lateral line to base of caudal, and about 10 more rather enlarged on latter; 12 scales in a vertical series between origin of rayed dorsal and lateral line; 26 scales in a vertical series between origin of spinous anal and lateral line; pores about 61 in lateral line to base of caudal and about 5 more on latter; width of head $2\frac{1}{4}$ in its length; depth of head over posterior margin of orbit $1\frac{3}{4}$; mandible 2; third dorsal spine $2\frac{3}{7}$; third dorsal ray $2\frac{1}{6}$; third anal spine $2\frac{1}{4}$; third anal ray 2; least depth of caudal peduncle $3\frac{3}{5}$; caudal $1\frac{4}{7}$; pectoral $1\frac{4}{7}$; ventral $1\frac{7}{8}$; snout $5\frac{3}{5}$ in head measured from tip of upper jaw; eye 4; maxillary $2\frac{2}{5}$; interorbital space 8.

Body elongate, compressed, rather ellipsoid, with evenly convergent convex profiles both in front and behind, back a little elevated and greatest depth about base of fourth dorsal spine. Edges of body rounded. Caudal peduncle compressed, and its length about $1\frac{1}{2}$ in its least depth.

Head compressed, rather elongate, upper profile nearly straight to predorsal region and a trifle more inclined than lower. Snout convex, and its length about $\frac{2}{3}$ its width. Eye circular, high or touching upper profile, rounded, and about first third in length of head. Mouth rather large, oblique, and mandible protruding. Maxillary exposed, reaching middle of orbit, and its distal expansion 2 in latter. Supplemental maxillary narrow. Lips rather thin. Teeth fine, pointed, in bands in jaws, some of inner anterior upper, and inner series of lower, a little enlarged and depressible. Mandibular teeth mostly biserial along sides. A pair of small curved canines in front of each jaw and mandibular close set. Fine teeth on vomer and palatines. Tongue elongate, slenderly attenuate, smooth and free. Nostrils close together on side of snout above front rim of eye, and of about equal size. Interorbital space flattened, with a slight depression in front. Margin of preorbital entire, slightly undulate. Posterior preopercular margin serrate, serræ enlarging towards angle which ends in a forwardly directed enlarged spine, and lower edge entire or but slightly roughened. Opercular spines 3, upper and median opposite though latter largest and nearer lowest, which is anterior.

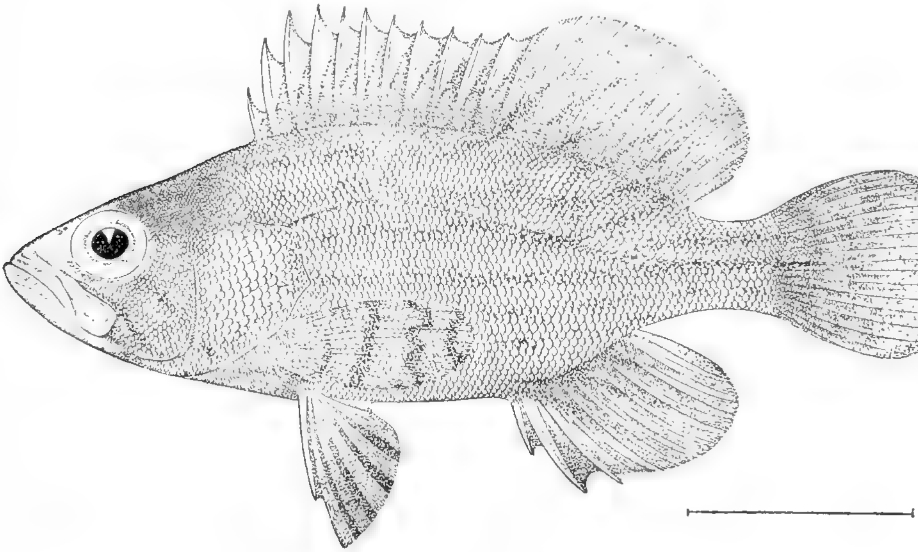

Fig. 3.—*Epinephelus lightfooti* Fowler. (Type.)

Gill-opening extending forward opposite middle of eye. Gill-rakers lanceolate, 7 + 15, equal to filaments or about $2\frac{1}{2}$ in eye. Pseudobranchiæ a little less than filaments. Isthmus narrowly convergent and with a median groove. Branchiostegals 7.

Scales smooth, cycloid, largest on opercle and side, and extending in slightly wavy longitudinal series crossing lateral line posteriorly. Small scales on bases of fins, especially vertical ones. Head largely scaly, except intermandibular region, lips and maxillary. Scales on cheek in 17 series. A broad scaly flap over axil of pectoral, which has a pit. Lateral line of small simple tubes, more or less concurrent with dorsal profile, though rather abruptly convex at summit, and running a little high along side of caudal peduncle.

Spinous dorsal inserted midway between tip of mandible and origin of rayed dorsal, and spines graduated down from third and fourth which are subequally longest, with margin of fin a little notched between each. Origin of rayed dorsal falling nearly midway between that of spinous fin and base of caudal, antero-median rays longest, and edge of fin rounded. Spinous anal inserted a little nearer origin of pectoral than base of caudal, and second and third spines subequal, much longer than first. Rayed anal similar to rayed dorsal only smaller. Caudal rounded. Pectoral rounded and reaching $\frac{4}{5}$ of space to spinous anal. Ventral inserted behind base of pectoral, reaching $\frac{5}{7}$ of space to origin of spinous anal, and spine $1\frac{1}{2}$ in fin. Vent in last third of postventral space just before tips of depressed ventrals.

Color in alcohol pale or dull tawny-brown, with traces of darker or deeper brownish longitudinal streaks over sides, and these slightly inclined on back to extend out on bases of dorsals. Some similar colored bars or streaks indistinctly on head. Rayed dorsal pale brownish on outer portion, and on caudal a trifle darker. Anal deep brownish like general body-color. Pectoral very pale brownish with about 4 deep brown transverse bands. Ventral pale brownish basally and becoming dusky-brown distally. Under surface of head and abdomen scarcely paler than sides. Iris slaty.

Length $4\frac{3}{16}$ inches.

Type, No. 16,514, A. N. S. P. San Domingo, West Indies. Prof. William M. Gabb.

The single example described above differs from *E. chloropterus* chiefly in coloration, the pectoral having but 3 dark transverse bands, while in the latter there are 8 or 9. They are shown by MM. Vaillant and Bocourt, in *Miss. Sci. Mex., Poiss.*, 1875, p. 107, Pl. 5, fig. 3 *a-c*, as rather large sparse pale brown blotches.

(Named for Benjamin H. Lightfoot, who collected fishes at St. Kitts, West Indies.)

Mycteroperca venenosa apua (Bloch).

St. Martin's, W. I. (Dr. R. E. van Rijgersma); St. Croix, W. I. (Dr. R. E. Griffith).

Mycteroperca acutirostris (Valenciennes).

Epinephelus chalinius Cope, Trans. Amer. Philos. Soc. Phila., (2) XIV, 1871, p. 465. Type, No. 12,768, A. N. S. P. St. Martin's, West Indies. Dr. R. E. van Rijgersma.

Head $2\frac{1}{2}$; depth $2\frac{5}{7}$; scales 72 in lateral line to base of caudal and 9 more on latter; about 22 scales between origin of spinous dorsal and lateral line in a vertical series; 34 scales in a vertical series between origin of spinous anal and lateral line; width of head 3 in its length; fourth dorsal spine 3; seventh dorsal ray $2\frac{1}{8}$; third anal spine $3\frac{1}{3}$; sixth anal ray 2; caudal $1\frac{1}{2}$; least depth of caudal peduncle $2\frac{7}{8}$; pectoral $1\frac{3}{5}$; ventral $1\frac{9}{10}$; snout $3\frac{9}{10}$ in head measured from tip of upper jaw; eye $4\frac{3}{4}$; maxillary $2\frac{1}{8}$; interorbital space $6\frac{1}{3}$. Body well compressed. Head compressed, rhomboidal. Snout short, convex. Eye a little longer than deep, high and anterior. Mouth oblique. Mandible protruding, with slight process at symphysis. Maxillary not quite reaching posterior margin of pupil, and its distal expansion $\frac{4}{7}$ of eye. Teeth biserial in jaws, conic, pointed, and inner mandibulars a little enlarged. A pair of canines in front above. Several depressible inner teeth in front of upper jaw. About 2 irregular series of small teeth on vomer and palatines. Tongue smooth, slender and free. Nostrils separated. Interorbital space nearly flat. Opercular spines 3, middle closer to lower, though most posterior. Gill-rakers III, 13 + 32, III, slender, a little longer than filaments or about $\frac{2}{3}$ of eye. Scales in rather wavy longitudinal series, upper crossing lateral line. About 25 series of scales on cheek. Tubes in lateral line simple. Spinous dorsal inserted much nearer origin of rayed dorsal than tip of snout. Rayed dorsal inserted about midway between origin of pectoral and base of caudal, rounded. Spinous anal inserted about midway between origin of ventral and tip of most posterior depressed anal ray, third spine longest, second but little shorter. Ventral spine about $\frac{2}{3}$ length of fin. Color in alcohol faded more or less brownish, and lower surface scarcely paler. From eye about 3 narrow deeper brown wavy lines extend longitudinally to become more or less reticulated about caudal peduncle. Also several others above and below though somewhat obscure. Traces of reticulated pattern are also seen on bases of vertical fins, whose edges together with those of ventrals are more or less broadly deep brownish. Iris silvery and brassy. Length $4\frac{1}{2}$ inches.

I do not accept Bloch's name *Epinephelus ruber*, as it does not seem to apply to the fish before me and therefore use the next one available.

Mycteroperca acutirostris tinca (Cantraine).

Italy (Bonaparte Coll.). Only a single large example, differing from the preceding a little in the fins, scales, etc., and therefore it may provisionally be retained as a distinct form until satisfactory comparisons can be made.

CENTROPRISTINÆ.

To replace *Serraninæ,* as *Serranus* replaces *Epinephelus.*

Hypoplectrus unicolor crocotus (Cope). Fig. 4.

Plectropoma crocota Cope, Trans. Amer. Philos. Soc. Phila., (2), XIV, 1871, p. 466. Cotypes Nos. 13,291 (type) and 13,292, A. N. S. P. St. Martin's, West Indies. Dr. R. E. van Rijgersma.

Width of head 2½ in its length; interorbital space 5 in head measured from tip of upper jaw. Body compressed and edges rounded. Caudal peduncle compressed. Head compressed, also snout and sides a little flattened, and its width about ⅞ its length. Rami of mandible elevated a little inside mouth. Teeth erect in jaws, in rather narrow bands in front with some of inner a little large and others becoming smaller posteriorly. Outer series a little enlarged along most of edge

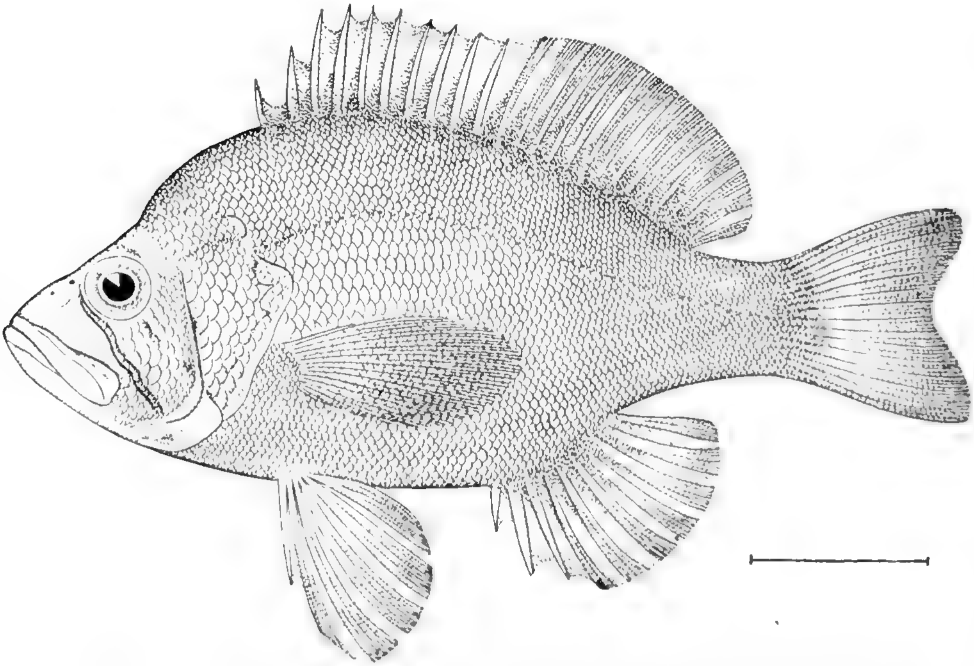

Fig. 4.—*Hypoplectrus unicolor crocotus* (Cope). (Cotype of *Plectropoma crocota* Cope.)

of upper jaw, though becoming progressively smaller posteriorly. Canines $\frac{2-2}{2-2}$ in front of jaws, lower pairs smaller. Mandible with a narrow band of fine teeth, becoming narrower posteriorly. Each side of mandible with about 5 or 6 enlarged canines. Bands of minute teeth on vomer and palatines. Tongue long, slender, pointed and free. Interorbital space flattened. Gill-opening forward to posterior nostril. Gill-rakers v, 2 + 9, ii, equal filaments and about half of eye. Pseudobranchiæ as long as filaments. Axil of pectoral rather deep. Scales finely ctenoid. Interorbital space and mandible naked. Tubes of lateral line simple. Vent about last fourth in space between tip of ventral spine and origin of spinous anal. Color in alcohol rather bright brown, back deeper colored, also upper surface of head. A deep brown ine along upper margin of preopercle a short distance and with others below. Around eye a more or less interrupted deep brown line which in front extends down across cheek behind maxillary to lower anterior edge of preopercle. On posterior part of cheek traces of a similarly inclined obsolete line towards angle of preopercle. On snout and preorbital several small brownish spots. Fins all plain or pale brownish, spinous dorsal darkest basally. Iris slaty. Length 5¼ inches. Type.

Hypoplectrus unicolor chlorurus (Cuvier).

St. Croix, W. I. (Thomas Davidson, Dr. R. E. Griffith).

Paralabrax nebulifer (Girard).

California? (E. D. Cope); San Diego, Cal. (Mus. Comp. Zool. Camb.).

Paralabrax maculo-fasciatus (Steindachner).

Los Angeles Bay, Cal. (W. N. Lockington).

Paralabrax clathratus (Girard).

Santa Barbara, Cal. (U. S. F. C.).

Centropristis striatus (Linnæus).

Bayport, Fla. (E. D. Cope); South Carolina (Dr. J. E. Holbrook); Newport, R. I. (Samuel Powell and Dr. J. Leidy); Wood's Hole, Mass. (U. S. F. C.).

Centropristis philadelphicus (Linnæus).

South Carolina (Dr. J. E. Holbrook).

Diplectrum radiale (Quoy and Gaimard).

Rio Janeiro, Brazil (Dr. W. S. W. Ruschenberger); Mananguez, Porto Rico (U. S. F. C.).

Diplectrum formosum (Linnæus).

Clearwater, Fla. (Dr. H. A. Pilsbry).

EUDULUS gen. nom. nov.

Type *Dules auriga* Cuvier.

The species of this genus are close to *Prionodes* Jenyns, but differ in having 6 branchiostegals and a truncate caudal. The typical species, *Eudulus auriga*, has the third dorsal spine whip-like and prolonged.

In the *Proc. Acad. Nat. Sci. Phila.*, 1907, p. 150, Dr. Theodore Gill has taken exception to my contention that his genus *Kuhlia* is superseded by *Dules* Cuvier and evidently that *Dules malo* Valenciennes is older than *Dules mato* Lesson. Although my conclusions will now be found to agree somewhat with Dr. Gill's they are the results of different methods. For those who contend that *Dulus* Viellot, *Anal. Ornith. Element.*, 1816, p. 42, proposed for a genus of birds, and *Dules* Cuvier, *Règne Animal*, Ed. 2, II, 1829, p. 147, are different names, *Dules* will still be found available in place of *Kuhlia.* This led me to frame *Duleidæ*, rather than *Dulidæ*, as emended by Dr. Gill. In the *Foreign Quarterly Review* for January to March, 1829, vols. I, II, IV and V of *Règne Animal*, Ed. 2, are reviewed, and volume III is said to be delayed a few months. In this journal for 1830 volume III is seen to have at last appeared. Still further evidence is found for the early appearance of Cuvier's *Règne Animal* in Férrusac's *Bull. Sci. Nat. Geol.*, Paris, XVIII, 1829, p. 95 where it is noticed by July. According to this last, in vol. XIX, 1829, p. 369, is found the first mention of vol. III, *Hist. Nat. Poiss.*, showing it and the succeeding volumes had not been received till November or December. Cuvier's footnote in the *Règne Animal* to "*Dules auriga* Cuv. et. Val., III, li;—*D. tæniurus*, ib., liii," etc., does not prove that they really did appear before the work in which they are quoted, thus leaving both of these names *nomina nuda* and therefore either not available as the type. In the bound copy of the plates before me only two species are shown, and both numbered 52, though the first has been corrected by the engraver as 51 for *Dules marginatus* and 52 allowed to remain for *D. auriga.* The next plate or 53 is *Therapon theraps.* The evidence I have gathered may be seen to have justified *Dules* Cuvier[1] replacing *Kuhlia* Gill, though I now consider the former preoccupied.

In the case of *Kuhlia malo* Lesson's work may have probably appeared later, as in *An. Mag. Nat.*, London, (7) XVII, 1906, p. 336, Messrs. Sherborn and Woodward make corrections to a previous paper on the dates. This would carry the reference to *Dules mato* back to Novem-

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[1] The species originally noted under this name by me may now be known as *Kuhlia marginata*, *K. marginata boninensis*, *K. rupestris* and *K. malo.*

ber 12, 1831. "March 22, 1828," is a mistake for p. 223 in volume I of the *Coquille.* Dr. Gill's argument may therefore be probably justified in this respect, though I do not accept *Kuhlia mato* now as the correct form, and that "Cuvier's name may have resulted from a typographical error."

The priority of the second edition of the *Règne Animal* and the early volumes of the *Hist. Nat. Poiss* seem to have been juggled by a number of writers, causing confusion in the selection of some names, so that it is hoped the above remarks may conduce to solve the problem. As an instance *Gempylus* will thus be seen to replace *Lemnisoma,* if identical.

(*Εὐ,* genuine; *δοῦλος, Dulus* or *Dules,* in the latter form an old name applied to these fishes, meaning a slave, with reference to the fish being under the lash of the long dorsal spine.)

CALLIDULUS subgen. nov.

Type *Centropristis subligarius* Cope.

Third dorsal spine not longer at any age than fourth.

This differs from subgenus *Eudulus* chiefly in the above character.

(*Καλλος,* beauty; *δοῦλος, Dulus.*)

Eudulus subligarius (Cope). Fig. 4.

Centropristis subligarius Cope, Proc. Acad. Nat. Sci. Phila., 1870, p. 120. Type, No. 13,675, A. N. S. P. Southern coast near Pensacola.

Width of head 2 in its length; interorbital space 7 in head measured from tip of upper jaw. Body compressed, edges rounded, and caudal peduncle compressed. Head compressed, its sides swollen below and becoming more narrow above. Snout much broader than long. Bands of small teeth in jaws, outer canines a little better developed than inner, and largest in front of upper jaw and on sides of mandible. Vomer with broad patch of fine teeth, and a narrow band on each palatine. Tongue narrow, free and smooth. Interorbital space narrow and flattened. Gill-opening not quite reaching front margin of eye. Rakers v, 1 + 7, v, much shorter than filaments which are 2 in eye. Gill-membranes free over broadly convex isthmus. Scales finely ctenoid. Interorbital space, mandible and branchiostegal region naked. Tubes in lateral line simple. Color in alcohol deep brownish, fading paler on lower surface of body and fins. Above lateral line about 5 narrow deeper brown lines than body-color parallel with courses of scales. Below lateral line each series of scales with a deeper brown longitudinal line similar to those above, though soon fading out on costal region. Rayed dorsal and anal, caudal and pectoral all marked with deep brown pencillings, due to each ray marked with as many as 10 short deep brown bars or spots. Ventrals pale, each with a dusky-brown broad shade from base to tip of longest rays, though leaving a pale margin in front. Preanal region white, strikingly in contrast with deep brown color above anal, and this pale color extending up till about level with lower border of orbit, where it fades out. Its width also decreases above and its anterior boundary dark and distinct. Cheek brownish. A deep dusky-brown blotch on front of rayed dorsal, beginning just behind tip of spinous fin, extends vertically down to back and fades out above base of spinous anal above. Also traces of another, though indistinct, from bases of last dorsal rays and ∧-shaped. At bases of uppermost caudal rays a vertical band of deep brown extends down, though it is dark and saddle-like above. Iris brownish. Length 3 inches.

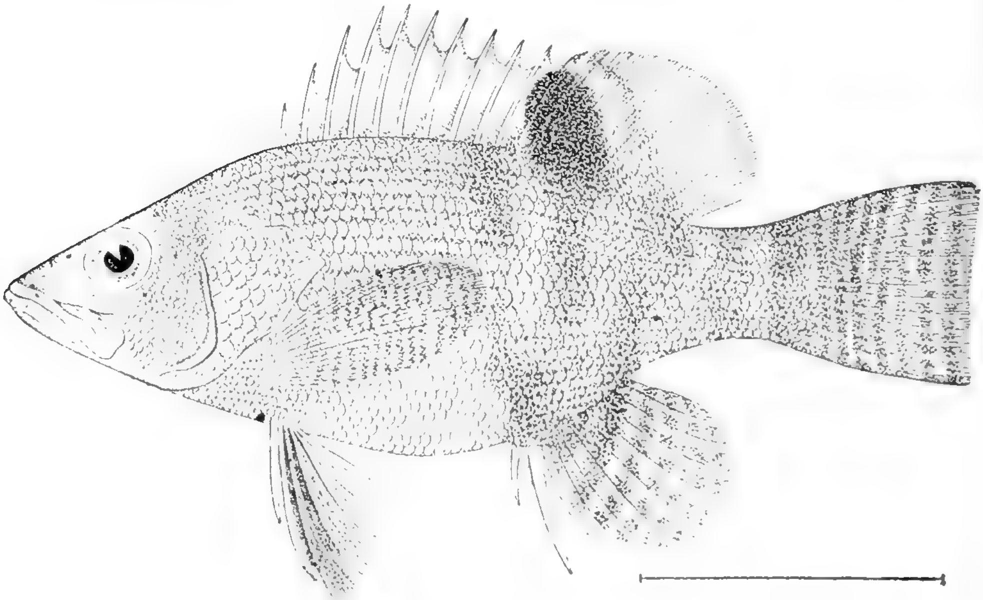


Fig. 5.—*Eudulus subligarius* (Cope). (Type of *Centropristis subligarius* Cope.)

Paracentropristis hepatus (Linnæus).

Italy (Bonaparte Coll.).

Serranellus cabrilla (Linnæus).

Italy (Bonaparte Coll.).

Serranellus scriba (Linnæus).

Italy (Bonaparte Coll.).

Paranthias furcifer (Valenciennes).

St. Croix, W. I. (Capt. Thomas Davidson).

Anthias anthias (Linnæus).

Italy (Bonaparte Coll.).

CALLANTHIINÆ.

Branchiostegals 6. Lateral line single, and lost on upper surface of caudal peduncle or under last dorsal rays. A single dorsal. Ventral rays 5.

Callanthias ruber (Rafinesque).

Anthias buphthalmus Bonaparte, Fauna Italica, Pesc. III, II, 1833, descr., Pl. 86, fig. 3. Cotypes, Nos. 13,624 (type) to 13,637, and 17,161, A. N. S. P. Italy. Bonaparte Coll. (Nos. 75 and 80)

Head $3\frac{2}{5}$; depth $3\frac{5}{6}$; D. XI, 10; A. III, 10; scales about 40 in lateral count to base of caudal and several more on latter; about 37 scales in median lateral line to base of caudal; about 24 tubes in dorsal lateral line; 2 scales between origin of spinous dorsal and dorsal lateral line; 5 scales between dorsal lateral line and median lateral line, in a vertical series opposite origin of rayed dorsal; 8 scales in a vertical series between median course of median lateral line and origin of spinous anal; width of head 2 in its length; eleventh dorsal spine $2\frac{1}{5}$; third dorsal ray $1\frac{1}{8}$; third anal spine $2\frac{2}{7}$; sixth anal ray $1\frac{2}{5}$; median caudal rays $1\frac{2}{5}$; least depth of caudal peduncle $2\frac{1}{5}$; pectoral $1\frac{1}{4}$; ventral $1\frac{1}{6}$; snout 4 in head measured from tip of upper jaw; eye $2\frac{2}{5}$; interorbital space $3\frac{1}{2}$; maxillary $2\frac{1}{10}$. Body well compressed, and edges more or less rounded, or predorsal region with only an obsolete median keel. Caudal peduncle compressed. Head well compressed. Snout about as wide as long. Lips thin. Rami of mandible a little elevated inside mouth. Teeth in jaws uniserial, conic and rather small. At front of each jaw a pair of canines which protrude somewhat, and others along each ramus of mandible. No vomerine or palatine teeth. Tongue narrow, free and pointed. Interorbital space convex. Gill-opening forward about first third of orbit. Rakers 10 + 25, slender, much longer than filaments or about equal to eye horizontally. Pseudobranchiæ nearly as large as filaments. Scales finely ctenoid. Color in alcohol faded more or less uniform brownish, fins pale. Iris brassy-yellow. Length $5\frac{3}{4}$ inches. Type.

PHAROPTERYGINÆ.

Branchiostegals 6. Vertebræ 25 or 26. Lateral lines 2, upper lost on upper surface of caudal peduncle or under last dorsal rays, and lower extending along middle of side of tail. A single dorsal. Ventral rays 4.

Pharopteryx corallicola (Bleeker).

Padang, Sumatra (A. C. Harrison and Dr. H. M. Hiller).

Rypticus xanti (Gill).

Head $2\frac{3}{4}$; depth $3\frac{2}{5}$; D. III, 25, I; A. 16, I; scales about 103 in lateral line to base of caudal and 8 more on latter; pores about 64 in lateral line to base of caudal; about 13 scales in a vertical series between base of second dorsal spine and lateral line; about 27 scales in a vertical series between origin of spinous anal and lateral line; mandible $1\frac{7}{8}$ in head; second dorsal spine 4; fifteenth dorsal ray $2\frac{1}{3}$; eleventh anal ray $2\frac{1}{2}$; least depth of caudal peduncle 3; caudal $1\frac{4}{5}$; pectoral $1\frac{7}{8}$; ventral $3\frac{1}{4}$; snout $3\frac{4}{7}$ in head measured from tip of upper jaw; eye $5\frac{1}{4}$; maxillary $2\frac{1}{4}$; interorbital space 2 in snout. Body long, rather slender, compressed and lower profile a little more convex than upper. Head compressed, and upper profile more or less straight from tip of snout to dorsal. Snout broad as long, surface convex. Eye circular, high and about first third in head. Mouth oblique, with robust mandible well protruding. Lips fleshy. Maxillary broad, reaching posterior margin of eye and its distal expansion $\frac{4}{5}$ of eye. Rather broad bands of teeth in jaws, and some of inner a little enlarged pointed though not depressible. Bands of fine teeth on vomer and palatines. Tongue long, slender and free. Nostrils near together in front of snout a little above, and anterior in a short cutaneous tube. Interorbital space rather narrowly convex. Preorbital with entire margin convex. Margin of preopercle with 3 spines, lowest largest and uppermost smallest. Opercular spines 3, median most posterior, closer to uppermost, and lowest most anterior. Gill-rakers VIII, 1 + 8, VII, short, robust, and a little longer than filaments or half of orbit. Scales small, smooth, and in more or less slightly wavy longitudinal series crossing lateral line behind. Small scales on bases of fins. Head covered with small scales, except on lips and maxillary, and about 24 series on cheek. Lateral line convex at first under spinous dorsal and then sloping gradually down, of simple tubes. Spinous dorsal inserted near first third in entire length of fish, and second spine longest. Rayed dorsal separated (though joined by membrane) by a space about same as space between last 2 dorsal spines, origin of fin midway in length of body and posterior fourth of fin highest with convex edge. Anal inserted midway between origin of pectoral and base of caudal and most of fin more or less equally high. Caudal rounded. Pectoral about $\frac{3}{5}$ to anal and median rays longest. Ventral inserted midway between tip of mandible and vent, well before origin of pectoral and reaching 3⅓ to anal or 3 to vent, and spine 2 in fin. Color in alcohol more or less pale or uniform brownish, above variegated with darker marblings and somewhat paler below. Fins all with more or less brownish. Iris pale slaty. Length 4¾ inches. Panama. Dr. W. S. W. Ruschenberger.

Rypticus saponaceus (Schneider).

West Palm Beach, Fla. (George B. Wood).

Rypticus coriaceus (Cope).

Eleutheractis coriaceus Cope, Trans. Am. Philos. Soc. Phila., (2) XIV, 1871, p. 467, fig. 3. Type, No. 13,445, A. N. S. P. St. Martin's, West Indies. Dr. R. E. van Rijgersma.

Width of head 2½ in its length; interorbital space 12 in head measured from tip of upper jaw. Edges of body rounded and caudal peduncle compressed. Head compressed. Supplemental maxillary narrow and long. Bands of small fine teeth in jaws and on vomer and palatines. Tongue edentulous, rather long, narrow and free. Interorbital space narrow and slightly convex. Gill-opening forward to posterior margin of pupil. Rakers IX, 2 + 5, IX, lanceolate, and about ⅗ of longest filaments which are ⅗ of orbit. Vent near front of anal. Color in alcohol more or less deep uniform brownish, fins little darker. Length 8¾ inches.

Rypticus bistrispinis (Mitchill).

Rhypticus maculatus Holbrook, Ich. S. Car., Ed. 2, I, 1860, p. 42, Pl. 6, fig. ? Type, No. 13,232, A. N. S. P. South Carolina (off Cape Romain). Dr. J. E. Holbrook.

The above example may be Holbrook's type, but his description gives the length of his single example as 8 inches, while the above is but 7¼. Also as the color has faded I cannot detect the markings or spots he indicates.

THE DISTRIBUTION OF THE NORTH AMERICAN GORDIACEA, WITH DESCRIPTION OF A NEW SPECIES.

BY THOMAS H. MONTGOMERY, JR.

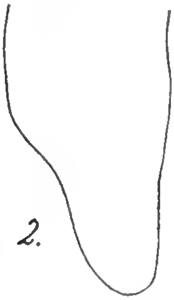
Through the kindness of Dr. Charles W. Stiles a collection of *Gordiacea* from the Smithsonian Institution was sent me for examination, which included the following new species:

1. Gordius alascensis n. sp.

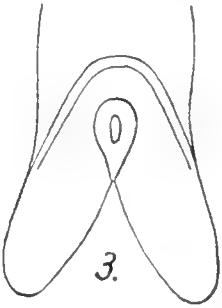
♂, Smithsonian Institution Coll. No. 6,962; Snug Harbor, Cook Inlet, Alaska.

Length, 120 mm.

1.



2.



3.

Form. Cylindrical, very slender, without median grooves; apex of head rounded, anterior portion of the body scarcely narrower than the middle portion. Tail lobes slightly longer than broad (fig. 3 on ventral and fig. 2 on lateral view), somewhat flattened medially, without hairs or spicules; the cloacal aperture is placed upon a slight eminence, and at a distance from the latter, anterior and lateral to it, is an arched integumentary ridge.

Cuticula (fig. 1) with low areolæ elongated parallel to the long axis of the body, irregular in form and size, close together and irregularly confluent; contiguous areolæ are interconnected by one or several narrow ridges.

Color iridescent dark brown with a darker neck ring, rounded tip of head white.

Diagnostic characters. The small size and even diameter, the confluent, interconnected areolæ, the precloacal ridge and the absence of hairs and spicules on the tail lobes afford a combination of characters that seem to distinguish this from all previously described species.

DISTRIBUTION OF THE NORTH AMERICAN SPECIES.

In previous papers[1] I have described most of the species from the continent of North America, and others have been described by Camerano[2] and Villot.[3] The tenable species known from this region are given below with their ranges, but it may be mentioned that specimens have been collected in only three localities north of the United States and from but a few in Central America.

1. **Paragordius varius** (Leidy).

This is the most abundant species in the United States. It is known from Mexico, Lower California, and Guatemala; and in the United States from Maine, New York, Massachusetts, New Jersey, Pennsylvania, Virginia, District of Columbia, Kansas, Texas, California, Illinois, Michigan, Arizona, South Dakota and New Mexico.

2. **Gordius villoti** Rosa.[4]

Mexico, Bay of Fundy, Ungava (Canada); and in the United States from Maryland, Massachusetts, District of Columbia, New York, Pennsylvania, Montana, Kansas, California, Michigan, Arkansas, Vermont, Tennessee, Oklahoma, North Carolina, South Dakota, Texas. It seems to be next abundant to the preceding.

3. **G. villoti difficilis** (Montg.).

North Carolina. This and the following may prove not to be tenable but to be neotenic forms of *G. villoti.*

4. **G. lineatus** Leidy.

New York, Maryland, Pennsylvania, Michigan; most of the specimens have been found in springs.

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[1] 1898, The Gordiacea of Certain American Collections, *Bull. Mus. Comp. Zool. Harvard*, 32.—1898, *Idem.*, II, *Proc. California Acad. Sci.* (3), 1.—1900, Gordiacea from the Cope Collection, *Biol. Bull.*, 1.—1901, The Identity of the Gordiacean Species, *Chordodes morgani* and *C. puerilis*, *Proc. Acad. Nat. Sci. Philadelphia.*

[2] 1898, 1897, Monografia dei Gordii, *Accad. Reale Sci. Torino.*

[3] Monographie des Dragonneaux, 1874, *Arch. Zool. génér. expér.*, 3.

[4] I would follow Camerano in dropping the name *Gordius aquaticus* Linn. on account of insufficient diagnosis, and in adopting *G. villoti* Rosa for the species described by Villot as *G. aquaticus* Linn. *G. robustus* Leidy, *G. aquaticus robustus* (Leidy) *mihi*, and *G. aquaticus* Linn. as previously used by me then become synonyms of *G. villoti.*

5. **G. densaræolatus** Montg.

Wyoming, Montana, California; evidently a Western form.

6. **G. platycephalus** Montg.

Ungava (Canada), Guatemala; and in the United States from Pennsylvania and Montana.

7. **G. violaceus** Baird.

California. I doubt whether this is tenable, since the diagnosis is meagre and males are unknown.

8. **G. longareolatus** Montg.

California.

9. **G. alascensis** Montg.

Alaska.

10. **Chordodes morgani** Montg.

Maryland, Pennsylvania, Michigan, Ohio, Florida, Iowa, Nebraska. Fairly common in the eastern portion of the United States.

11. **C. occidentalis** Montg.

Sonora (Mexico), and California, Arizona, Montana, Texas, Wyoming; on the western part of the continent this replaces the preceding.

12. **C. dugesi** Camer.

Vera Cruz, Mexico.

13. **C. griffinii** Camer.

Vera Cruz, Mexico.

14. **C. cameranonis** Montg.

Mazatlan or Panama.

From the United States there are then known some eleven forms, two or three of which may be found to be untenable. Of these the final hosts are known only for *Paragordius varius* (a Gryllid, *Acheta*), for *Gordius villoti* (Acridiids), for *Chordodes morgani* (a Blattid), and for *C. occidentalis* (an Acridiid).

BERTRAMIA BUFONIS, A NEW SPOROZOAN PARASITE OF BUFO LENTIGINOSUS.

BY HELEN DEAN KING.

In a paper dealing with the structure and development of "Bidder's organ," a rounded body found at the anterior end of each testis in various species of *Bufo*, Knappe[1] states that occasionally spermatozoa are found in the cells of this organ which is undoubtedly a rudimentary ovary; he adds, furthermore, that these spermatozoa have probably been formed from small follicle cells which have entered the cytoplasm of the undeveloped ova.

In the course of investigations which I have been making this past winter upon the development of the germ-cells and the structure of Bidder's organ in the common American toad, *Bufo lentiginosus*, I have found one individual in which the cells of Bidder's organ contain bodies, unquestionably parasites, which are very similar to those figured by Knappe as spermatozoa. It seems probable, therefore, that in the material studied by Knappe the "spermatozoa" are stages in the life cycle of some species of Sporozoa; for in the light of our present knowledge regarding the origin and development of germ-cells it is inconceivable that functional spermatozoa could be formed in or from the cytoplasm of rudimentary ova that are destined to undergo degeneration. Whether the species of parasite found in the American toad is the same as that infecting the European form I have not been able to determine, as details of structure cannot be made out from the figures given by Knappe.

The individual infected by the parasite was a young male which was killed on July 16, 1905, at Owego, N. Y. Nothing unusual or abnormal about the toad attracted my attention at the time that the animal was killed; and, as material was being collected for a study of the genital organs, only the testes, Bidder's organ, and a portion of the kidneys were preserved. The material was fixed in Flemming's solution and stained with iron-hæmatoxylin followed by orange G.

As so few of the organs of the body were preserved, it is impossible to state the extent of the infection. The parasite is found only in the ova of Bidder's organ, and not in the testes or in the renal tubules.

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[1] Knappe, E., Das Bidder'sche Organ, *Morph. Jahrb.*, Bd. XI, 1886.

Judging from the stages that I have been able to find, the parasite is undoubtedly a Sporozoan belonging to the order Haplosporidia. It does not fit in very well with the present scheme of classification of the Haplosporidia; but until its complete life history is known, I do not think it advisable to create for it a new genus. I shall, therefore, place it temporarily in the genus *Bertramia* (Caullery and Mesnil, 1897). As the parasite is apparently a new species, it may be known as *Bertramia bufonis*.

The youngest stage of the parasite that I have been able to find is a small, round or oval body with a diameter of about two microns (plate XXII, fig. 1, *a*). The cytoplasm is uniformly granular and the nucleus, which occupies the centre of the cell, is round or somewhat irregular in outline. The nucleus is composed, apparently, of a dense mass of chromatin, as it always appears homogeneous and stains intensely black with the iron-hæmatoxylin.

After the young parasite enters one of the ova of Bidder's organ it divides repeatedly, forming a number of cells similar to that shown in fig. 1, *a*. Cell division undoubtedly takes place by means of karyokinesis, as I have found several cases like that of fig. 1, *b*, in which faint traces of a spindle can be seen and also irregular masses of chromatin collected at the spindle poles. After the division of the chromatin, the daughter-nuclei assume a rounded shape (fig. 1, *c*), and subsequently division of the cytoplasm takes place. (fig. 1, *d*). Sometimes, as shown in fig. 1, *e* and *f*, one or both of the cells will have begun a second division before the first division is entirely completed. All of the stages shown in fig. 1, *a-f*, may be found in a single section of one of the large ova of Bidder's organ.

The period of multiplication is followed by a growth period in which each of the cells increases enormously in size and the nucleus divides a number of times without any corresponding division of the cytoplasm (figs. 2–5). The nuclear divisions at this stage of development are evidently also mitotic (fig. 3), although on account of the small size of the spindle and of the chromosomes it is quite impossible to make out any details of the process.

At a comparatively early stage in its development the trophozoite becomes surrounded by a thin membrane (fig. 4), which later forms a cyst wall enclosing the spores (fig. 7). The full-grown trophozoite has a diameter of 9–11 microns, and contains a large number of deeply staining nuclei which are usually irregular in outline (fig. 5). The multinucleated body soon segments into a mass of spores (fig. 6), which become round or oval as soon as separation is effected (fig. 7).

The mature cysts are about 15 microns in diameter and they are invariably rounded, unless, as occasionally happens, they are distorted by contact with adjacent cysts. Each cyst contains at least 30 spores. As the spores are closely crowded together, I have not been able to make out the exact number in any one cyst or to determine whether the number is constant for all of the cysts. The young spore has granular cytoplasm and a single, deeply staining nucleus (fig. 7, *a*). It resembles somewhat the stage of the parasite shown in fig. 1, *a*; but as it is considerably smaller and is always enclosed in a cyst, the two stages are easily distinguished. In their later history the majority of the spores follow one of two clearly marked modes of development, which, for convenience in description, will be designated as Type I and Type II.

The first change that takes place in the spores that develop according to Type I is the appearance of a clear area around the nucleus which occupies the centre of the spores (fig. 7, *b*). Owing to the small size of the spores it is impossible to determine whether the nucleus suddenly becomes vesicular at this time or whether the clear area is a fluid vacuole. Judging from the changes that take place in later stages of development, I am inclined to the opinion that the character of the nucleus does not change at this time and that the clear area around the nucleus is a vacuole. Soon after the formation of the vacuole the nucleus divides (fig. 7, *c*) and, as the spore elongates, the two nuclei separate and move to opposite ends of the vacuole which increases considerably in size (figs. 8, 9); subsequently the vacuole itself divides and each part comes to surround one of the nuclei (fig. 10). At the next stage the vacuoles, with the nuclei, are found at the ends of the spore which has now attained its final shape (fig. 11). The nuclei appear as large and stain as deeply at the stage of fig. 11 as they do in the young parasite; but in a slightly older spore they are considerably smaller and stain much less intensely (fig. 12). At a later period all traces of the nuclei are lost and the vacuoles appear perfectly clear and transparent (figs. 13, 14).

During all stages in the development of the parasite up to that of fig. 13, the cytoplasm appears granular and stains very faintly. When the nuclei disappear at the stage of fig. 13, the cytoplasm in contact with the vacuoles shows a strong affinity for the iron-hæmatoxylin, although the rest of the spore stains as faintly as before. In a slightly older stage the central portion of the cytoplasm stains as intensely as the end regions, and the entire spore, excepting the vacuoles, appears uniformly black (fig. 14). Somewhat later the vacuoles begin to decrease in size (fig. 15) and eventually they too disappear. The mature spore (fig. 16) is about 3 microns long and 1.5 microns wide; the ends are oval and a slight constriction is usually found in the middle region. In a single section of a cell of Bidder's organ one may find as many as 15 cysts, containing spores in practically all stages of development, from that shown in fig. 7, *a*, to that of the mature spore shown in fig. 16. As cysts containing spores that stain very faintly may lie adjacent to cysts in which the spores are all stained black, it is evident that the great affinity of the cytoplasm for the iron-hæmatoxylin is not due to an overstaining of the material, but to some change taking place in the substance of the spore itself.

As the more intense staining of the cytoplasm of the spore is invariably coincident with the disappearance of the nuclei from the vacuoles, it would seem as if the two phenomena must be related in some way; and it is possible that, after the stage of fig. 11, the chromatin substance gradually becomes distributed throughout the cytoplasm and brings about a deeper staining of the spore contents. Although I have found a large number of spores in which the nuclei are of various sizes and stain with different degrees of intensity at the outer border of the vacuoles, I cannot be certain that the nuclei break down at this place; for I have found several spores like those shown in figs. 24 and 25, in which two nuclei lie in the cytoplasm after the vacuoles have moved to the ends of the spore. I have not succeeded in finding any stages that would seem to connect fig. 11 with fig. 24, yet it is possible that soon after the stage of fig. 11 the nuclei pass quickly from the vacuoles into the cytoplasm which at once stains more intensely. From the evidence at hand, I am inclined to believe that the spores shown in figs. 24 and 25 are abnormal and that the nuclei gradually disintegrate at the outer border of the vacuoles.

In the second type of development, which is not as common as the type just described, the nucleus moves to one end of the spore and takes a position as shown in fig. 17. A vacuole then forms around the nucleus as in Type I (fig. 18), and subsequently the nucleus divides (fig. 19). Later the two nuclei, which stain as intensely as in the earlier stages, move to opposite ends (figs. 21, 22) or, in some few cases, to opposite sides (fig. 20) of the vacuole. The vacuole increases in size as the spore elongates; but, as far as I have been able to determine, it does not divide into two parts, as does the vacuole in the spores that follow the first type of development. After the disappearance of the nuclei in the stage succeeding that of fig. 22 the vacuole gradually becomes smaller (fig. 23), and the entire spore stains black and appears as in fig. 16.

Deviations from these two types of development are not uncommon, some of the more striking variations being shown in figs. 24–31. The spore from which fig. 24 was drawn seems to be a variation of Type I, in which the nuclei have moved into the cytoplasm instead of towards the outer border of the vacuoles. It is possible, as I have already suggested, that fig. 24 shows a normal stage in the development of the spore, and that it belongs between the stage of fig. 12 and that of fig. 13. In the spore shown in fig. 25 it is evident that, when the vacuole divided, both nuclei remained in one of the two vacuoles that were formed (as is shown in fig. 28), and that they passed into the cytoplasm after the vacuole had taken its position at the end of the spore. As indicated in fig. 25, the cytoplasm surrounding the nuclei stains considerably darker than that in the rest of the spore; and although the nuclei are clearly seen at this time, they are totally obscured in the following stage when the region in which they lie stains black (fig. 26). A spore in which one nucleus only has left its vacuole is shown in fig. 27; while variations in the number, size, and situation of the vacuoles are shown in figs. 28–31.

I can offer no explanation as to the way in which the cells of Bidder's organ become infected with the parasite. There is no direct means of communication between this organ and the testis, and therefore it does not seem possible that infection was through the cloaca and the kidneys, hence by way of the testis to Bidder's organ. As Bidder's organ contains a large number of capillaries, it seems most probable that infection took place through the blood. Although I have carefully examined sections of the blood vessels containing large numbers of corpuscles, I have found no traces of the parasite either in the corpuscles or in the plasma. In one instance three mature spores were found in the plasma of a capillary in Bidder's organ; but it seems probable that these spores were derived from one of the many cysts in the organ containing ripe spores. As all of the large ova in Bidder's organ eventually degenerate, usually through the rupture of the outer wall and the penetration of a capillary into the interior, it is evident that the spores finally get into the circulation. How they pass to the exterior and whether they subsequently undergo a further development in another host remains to be determined.

During recent years much interest has been taken in the life history of the Sporozoa which seem to infect many of the invertebrates as well as all classes of the vertebrates. Interest in this group has naturally centred in the parasites infecting the mammals; and the amphibians as a class have not been systematically examined, either in Europe or in

America, for Sporozoan parasites. In the list of Sporozoa and their hosts recently compiled by Minchin,[2] *Bufo lentiginosus* is given as the host of one known species, *Leptotheca* (*Chloromyxum*) *ohlmacheri*, a Myxosporidian which was first described in 1893 by Ohlmacher,[3] who found it in the renal tubules. In but two other instances have Sporozoan parasites been found in any species of *Bufo*, and comparatively few cases of infection have been recorded for the different species of *Rana*. As presumably the amphibians are as subject to parasitic infection as are the other vertebrates, they would seem to afford a profitable field of investigation for the discovery of new Sporozoan forms.

EXPLANATION OF PLATE XXII.

All figures were drawn with the aid of a camera lucida under a Zeiss apoc. obj. 1.5 mm. Oc. 8.

Fig. 1.—The young parasite and its division stages.
Fig. 2.—Trophozoite at the beginning of the growth period.
Fig. 3.—Mitotic division of the nuclei of the young trophozoite.
Fig. 4.—Formation of the cyst wall around the trophozoite.
Fig. 5.—Mature trophozoite before its division into spores.
Fig. 6.—Division of the trophozoite into spores.
Fig. 7.—Cyst containing young spores.
Figs. 8–16.—Stages in the development of spores according to Type I.
Figs. 17–23.—Stages in the development of spores according to Type II.
Figs. 24–31.—Spores showing apparent deviations from the usual modes of development.

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[2] Minchin, E. A., *Sporozoa: A Treatise on Zoology*, edited by E. Ray Lancaster, Pt. I, 1903.

[3] Ohlmacher, A. P., Myxosporidia in the Common Toad, with Preliminary Observations on the Chromophilis Substance in the Spore, *Journ. Amer. Med. Assoc.*, Vol. XX, 1893.

ORTHOPTERA FROM NORTHERN FLORIDA.

BY JAMES A. G. REHN AND MORGAN HEBARD.

The material treated in this paper was collected by the authors between the 10th and 20th of August, 1905. The localities at which collecting was done are treated below in detail. The material has been divided between the collection of the Academy and the collection of the junior author, all types remaining in the latter. The number of specimens examined is 1,356, representing eighty-nine species, of which four are described as new.

Localities.

Jacksonville, Duval County. The few specimens taken at this locality were captured in a weed-covered lot near the railroad station, among the shrubbery in Hemming Park, on the street, on the Clyde Line wharf, and at a suburb on the St. John's River known as Riverside.

Pablo Beach, Duval County. This small community, existing almost entirely as a summer resort, is situated on the Atlantic coast of the peninsula, seven miles south of the mouth of the St. John's River and eighteen miles east of Jacksonville. The characters of the regions or zones at this locality at which collecting was carried on are quite varied, and a detailed description is necessary.

The beach proper is very wide along this part of the coast, the angle of its slope is very slight, and its boundary formed by rather irregular sand dunes, some of which are thirty or more feet high. The upper slopes and tops of the dunes are covered with a growth of scrub or saw palmetto (*Serenoa serratula*). These dunes while irregular in height are very regular in the line of their steep barrier-like seaward slope.

Landward the dunes drop into a level tract of sandy barrens varying from one to two or more miles in width and extending for a considerable distance up and down the coast. The barrens are thickly covered with saw palmetto (*Serenoa serratula*) and several other low plants, making everywhere a low but thick tangle. While usually dry in character this open saw-palmetto region has numerous wet spots, some with the sand little more than damp and others with considerable areas of true marsh with some of the accompanying vegetation. About these marshy spots are frequently bushes ten or fifteen feet in height, which are the only vegetation of any height in the extensive "palmetto scrub," as this region is called in the following pages.

Farther north along the beach, and in a few localities about Pablo Beach, the ground immediately west of the shore dunes is covered with a dense tangle of numerous varieties of bushes, the majority of which are about ten feet high. It was in these bushes that *Cyrtophyllus* was abundant.

Inland the broad tract of open country is bordered by another area, bearing a scattering growth of pine and an occasional cabbage palmetto (*Sabal palmetto*) growing on marshy soil, this zone being distinctly narrower than the preceding one.

West of the scattered pine belt is a strongly marked zone of "hammock" land, the arborescent species of which are varied but in a large part cabbage palmetto, all very closely placed and woven together with numerous lianas. This zone is almost impenetrable, is about a mile in width and extends for miles up and down the coast, in most places being on higher ground than the immediately surrounding country.

Pablo Creek flows north on the west side of the hammock, emptying into the St. John's near Mayport, and extensive dependent marshes are present on the east side of the stream, between it and the "hammock" land. In little scattered areas here are marshy pine woods, but in no place in this creek marsh was the collecting found to be good.

Still farther inland, west of the stream and beginning at the western edge of the creek marsh, is the extensive long-leaf pine (*Pinus palustris*) forest which stretches westward to the St. John's.

Access to these various zones was gained chiefly by means of a railroad embankment, along the sides of which, in wet drains overgrown with grass and in cleared grass and weed covered right-of-way, much good collecting was done.

San Pablo, Duval County. This locality is situated in the long-leaf pine forest three miles west of Pablo Beach. The undergrowth in the woods here was dry and chiefly wire-grass. This situation was the nearest to Pablo Beach at which typical pine woods collecting could be secured. The Orthoptera taken at this locality showed a considerable affinity to that taken in the open saw palmetto at Pablo Beach.

Gainesville, Alachua County, is situated in northern Florida, sixty-two miles in an air-line southwest of Jacksonville. The region is that of the long-leaf pine (*Pinus palustris*) and forests of this noble tree surround the town, although large areas have been cleared and are either under cultivation or grown up as characteristic Southern "old fields." Excellent collecting was found here in the undergrowth in the pine woods, the gallberry bushes, scrub oaks and wire grass affording excellent cover. In several flooded sink-holes in the pine woods we found among the surrounding marsh grasses such moisture-loving forms as *Leptysma, Stenacris* and *Eotettix palustris.* Owing to the fact that our stay was limited to a day and a half, the collection from this locality doubtless does not include many species which might be found there, but the results for that length of time were extremely satisfactory.

Cedar Keys, Levy County. On a small coquina islet in the northern Gulf of Mexico, a short distance from the Floridan mainland, is the town of Cedar Keys. The town is on one of a number of keys to which collectively its name is applied. The surface of the main key is slightly rugged and the soil poor, owing to the almost bare coquina rock. Outside of the village scattered groves of short-leaf pine, numerous palmettos and an undergrowth of waist-high bushes comprise the principal floral features of the dry land. There are many large Indian shell-mounds on the key, and on them the forest growth is thickest. The key is indented by many lagoons and bays. along the edges of which are many wide areas of salt-marsh grass in which Orthoptera was exceedingly abundant.

Palatka, Putnam County. The material from this locality was taken in the town proper.

St. Augustine, St. John County. The few specimens from this locality were taken in the hotel grounds in the evening.

FORFICULIDÆ.

Anisolabis maritima (Bonaterre).

A pair of this species was taken from under rubbish on a lot in the city of Jacksonville, August 11.

Anisolabis annulipes (H. Lucas).

This widely distributed species was taken at three localities: Jacksonville, August 11, in company with *A. maritima,* one male; Pablo Beach, August 11 (marsh), one female; Cedar Keys, August 15, one female.

Labia burgessii Scudder.

Three females of this species were taken at Cedar Keys, August 15.

Labia guttata Scudder.

This species is represented by a single female from San Pablo, taken August 13 from under pine bark.

BLATTIDÆ.

Ischnoptera johnsoni Rehn.

An adult female of this species was taken at Pablo Beach, August 11, from under palmetto root.

Eurycotis floridana (Walker).

Two females from Cedar Keys, August 15, represent this species.

Periplaneta americana (Linnæus).

This species was noticed at every locality visited in Florida.

Periplaneta australasiæ (Fabricius).

This species is represented by a nymph from Cedar Keys, August 15, taken under adherent dead petiole bases of palmetto. Mature individuals were seen at St. Augustine and Palatka.

Periplaneta truncata Krauss.

The evening of August 20 this species was found very abundant on the Clyde Line wharf at Jacksonville. Portions of the wharf under the electric lights seemed to be their favorite haunts, and when disturbed they scurried rapidly away or hid in the crevices between the planking. A series of seven males, eleven females and two nymphs are in the collection. Unquestionably this species is becoming more generally distributed in the Gulf States, and from the evidence in hand its strongholds are probably the larger ports, to which it has no doubt been brought by shipping from the tropics.

The series mentioned above exhibits considerable variation in the length of the tegmina and wings.

Pycnoscelus surinamensis (Linnæus).

A series of six females represent this species, the localities being Cedar Keys, August 15, Gainesville, August 17 (in room), Palatka, August 19, and St. Augustine, August 19.

The Cedar Keys specimens are all small and quite dark, with the pale cephalic line on the pronotum broadly interrupted in the middle and much reduced laterad. The individuals from the other localities have the tegmina paler, the cephalic pronotal margin distinctly and continuously marked and the general size greater.

MANTIDÆ.

Stagmomantis carolina (Johannson).

This species is represented by five nymphs from Pablo Beach, August 11 and 13 (in grass, palmetto scrub and pine woods), two nymphs from Gainesville, August 16 (undergrowth in pine woods), and one adult female specimen from Cedar Keys, August 15. The latter specimen, while fully adult, has the tegmina and wings but slightly exceeding the margin of the second abdominal segment.

Thesprotia graminis (Scudder).

One male from Gainesville, August 16 (undergrowth in pine woods), represents this species.

PHASMIDÆ.

MANOMERA[1] n. gen.

1900. *Bacunculus* Scudder, Proc. Davenport Acad. Nat. Sci., VIII, p. 95. [Not of Burmeister, 1838.]
1903. *Bacunculus* Caudell, Proc. U. S. Nat. Mus., XXVI, p. 872. [Not of Burmeister.]

On comparison of material of Scudder's *Bacunculus tenuescens* with specimens and figures of typical species of *Heteronemia* Gray (*Bacunculus* of authors, but not of Burmeister), it is evident that no close relationship exists in that direction, and affinity really exists with *Diapheromera* instead of *Bacunculus* of authors.

The original description given by Scudder omits mention of the very distinct spines present on the median femora of the male, although his figures (pl. 1, figs. 1 and 2) show their presence. On the basis of Scudder's description, Caudell, who had never seen the male sex, says, in describing the genus, "Legs of male unarmed." The spine of the median femora of the male is placed in the same position as in *Diapheromera*, and is very similar in character but slenderer, the caudal femora, however, being unarmed.

The structure of the abdominal appendages is fundamentally the same as in *Diapheromera* and not as in *Heteronemia*, the subgenital opercule being in no way like the latter genus. From *Diapheromera*, *Manomera* can be separated in the male by the slender head, the absence of caudal femoral spines, the uninflated median femora and the more elongate abdominal appendages.

Manomera tenuescens (Scudder).

A male from Pablo Beach, August 12, another from San Pablo, August 13, and three males and five females from Gainesville, August 16, represent this peculiar Florida form. The male from Pablo Beach was swept from marsh grass, but all the other individuals taken were from the wire-grass and other low undergrowth in pine woods, where protective resemblance would appear to be an important factor in the life of the insect.

The specimens vary considerably in size, particularly in the male sex,

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[1] Μανος, *thin;* μηρα, *thighs.*

and represent two color phases, brown and green forms. These forms may be sexual as all the males are of the brown type and the females of the green, but it is hardly safe to assume this to be true on the amount of material in hand. The base color of the dorsum in the male varies from raw sienna to vandyke brown, the legs in all the specimens being greenish proximad, shading into olive or decided brownish distad. The lateral yellowish stripe is prominent in all the males, becoming whitish on the abdomen and extending to the base of the cerci. In the female this stripe is usually less prominent, and in one specimen is almost absent.

Aside from the above records this species has been recorded from Cedar Keys, Capron and Biscayne, Florida.

Anisomorpha buprestoides (Stoll).

Four males and three females from Pablo Beach, August 12 and 13, four males and six females from San Pablo, August 13, and one female from Gainesville, August 16, comprise the series of this species. Except for a Pablo Beach specimen taken in open palmetto scrub, all are from undergrowth in pine woods. A large part of the specimens were taken in coitu, and in one case two pairs and a single individual were taken from one plant.

From the material in hand it does not appear possible to separate two species, for while typical female specimens of what Caudell[2] calls *ferruginea* (Palisot) are in the series from San Pablo and a number of the others are true *buprestoides*, specimens from Gainesville and Pablo Beach connect the two extremes, the pale *ferruginea* and the strongly trilineate *buprestoides*. All the males collected are unquestionally true *buprestoides*. A pair from Osprey, Manatee County, Florida, in the Academy collection approach the pale type.

ACRIDIDÆ.

Nomotettix cristatus Scudder.

This species is represented by seven males and one female from Pablo Beach, August 12 and 13, one male and one female from San Pablo, August 13, and seven males, four females and two nymphs from Gainesville, August 16 and 17.

In the region examined this species appears to have little preference for one particular environment, as the Pablo Beach series contains specimens taken in undergrowth in open pine woods, on damp sand, in palmetto scrub and in grass. The San Pablo specimens were taken in pine woods undergrowth, and the Gainesville series in the same character of surroundings except one from the edge of a sink-hole.

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[2] *Proc. U. S. Nat. Mus.*, XXVI, pp. 880, 882.

Neotettix femoratus (Scudder).

One male and three females from Pablo Beach, August 12 and 13, taken in open pine woods undergrowth and palmetto scrub, represent this species. All the specimens are short-winged.

Neotettix bolteri Hancock.

An adult female and a nymph from Gainesville, August 16 and 17, belong to this rather scarce species. One was taken from a marshy sink-hole, the other in pine woods undergrowth.

Apotettix rugosus (Scudder).

A male individual from Cedar Keys, August 15, appears to represent this species. In the proportions of the pulvilli of the caudal tarsi it does not agree with the description given by Hancock,[3] and resembles in this respect the much smaller *Apotettix minutus* Rehn and Hebard. It is possible this specimen may not be true *rugosus*, but in all characters but the pulvilli proportions it is fully typical of that species.

Tettigidea spicata Morse.

A single male from San Pablo, August 13, was taken in undergrowth in pine woods. It belongs to the form with the elongate pronotum.

Tettigidea lateralis (Say).

This variable species is represented by a series of eight males and seven females from Pablo Beach, August 12 and 13, and one male from Gainesville, August 16. Individuals were taken in swampland, palmetto scrub, in undergrowth in pine woods and on damp sand. All the specimens are of the type with the produced pronotum, and considerable variation in the cephalic angle of the pronotum is observed.

Radinotatum brevipenne (Thomas).

This peculiar grasshopper was numerous in localities in pine woods undergrowth at Gainesville, August 16, two males, five females and one nymph being collected. At Pablo Beach, August 11 to 13, two males and five nymphs were taken in grass, palmetto scrub, pine woods undergrowth, and one of the males in marshland. Compared with spring experience around Thomasville, Ga., this species is not as common in the summer, but the number of adults is proportionately greater.

Mermiria alacris Scudder.

This strikingly colored species was numerous in pine woods undergrowth and palmetto scrub at Pablo Beach, August 11 and 13, six adult males, four females and three nymphs being collected. A single female from San Pablo, August 13, and three males from Gainesville,

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[3] *The Tettigidæ of N. Amer.*, p. 104.

August 16, were taken in pine woods. Cedar Keys is represented by a single male taken August 15.

Mermiria vigilans Scudder.

This species is more distinctly a marsh-loving form when compared with *M. alacris*, its favorite habitat being tall marsh grass in extensive tracts or narrow marsh drains. At Pablo Beach this species was common, particularly in a wet grassy drain along the railroad embankment, a series of fourteen males and twelve females being collected on August 11 and 12. At Cedar Keys, August 15, two males and two females were taken in salt marsh. In the series studied four females are in the green phase, while several males exhibit a similar tendency.

Mermiria intertexta Scudder.

A single male from Pablo Beach, August 13, represents this species, which can be separated from *vigilans* by the broader, distinctly triangular fastigium and the narrower disk of the pronotum.

Syrbula admirabilis (Uhler).

This species is partial to palmetto scrub and pine woods cover, being common but nowhere abundant at the localities visited. Pablo Beach is represented by seven males and four females taken August 11 to 13; Gainesville by three males, two females and one nymph; Cedar Keys, August 15, by one male.

All the specimens seen from Georgia and Florida are considerably larger than New Jersey individuals of the same sex.

Macneillia obscura Scudder.

In a restricted area in long-leaf pine woods at Gainesville, on August 16, this species was found in the undergrowth in moderate numbers, all the specimens seen being taken. A partiality on the part of the species for low oak growth was noticeable. The series in our hands from this locality consists of four adult males, six females and four nymphs. One of the males, two of the females and two nymphs have the median pronotal bar strongly marked, while one male and two females have it weaker but still quite apparent.

Amblytropidia occidentalis (Saussure).

Eight immature specimens from Pablo Beach, August 11–13, and four from Gainesville, August 16, appear to represent this species. Aside from individuals taken in dry palmetto scrub, these immature specimens were from pine woods undergrowth, in situations such as are favored by the adults in spring.

Orphulella pratorum Scudder.

The specimens from the localities given for this species have been compared with material from New Jersey, Maryland, Georgia, Florida and Alabama, all of which is considered by the authors to belong to this species. The Florida series here studied presents the usual color forms found in the species and was collected in a variety of habitats, ranging from dry pine woods undergrowth to open marsh. The localities represented are Pablo Beach, August 11–13, eight males, four females; Gainesville, August 16 and 17, six males, four females; Palatka, August 19, one female; Cedar Keys, August 15, two males. Nymphs were taken at Pablo Beach and Gainesville, and an adult male was taken during a train stop at Fairfax, S. C., August 10.

Orphulella pelidna (Burmeister). ?

The specimens here referred doubtfully to Burmeister's species have been carefully compared with the available determined material of this poorly understood species, and while they differ in a number of features from the other specimens, it can be positively asserted that they are not the allied *olivacea* or extremely large specimens of the species we consider to be Scudder's *pratorum.*

In size these specimens exceed any other North American individuals of the genus seen by us, particularly in the female sex. The fastigium is shaped much as in Nebraska specimens considered *pelidna,* but the tegmina and wings are very long, slender and not as broad as in *pratorum.* The largest male measures, length of body 20 mm; length of pronotum 4; length of tegmen 18.2; length of caudal femur 12.5; the largest female, length of body 27.5; length of pronotum 5; length of tegmen 23; length of caudal femur 17.

Aside from one male taken at Pablo Beach, August 12, the series of eleven males and twelve females were taken at Cedar Keys, August 15.

Dichromorpha viridis (Scudder).

This widely distributed species is represented by a series of twenty specimens, eight of which are in the brown phase. Jacksonville is represented by three males and six females, taken August 11, on a weedy lot in the middle of the city; Pablo Beach by three males, four females and two nymphs, taken August 11, 12 and 13, all in marsh except one male and a nymph from palmetto scrub and another nymph from grass; Gainesville is represented by two males and one female, August 16, in pine woods undergrowth and meadows.

Clinocephalus pulcher Rehn and Hebard.

This beautiful species is represented by an instructive series of forty-seven males and sixteen females, which show that it is quite closely related to *C. elegans*. A series of twenty-one New Jersey specimens of the latter species has been used for comparison and the differential characters are here treated separately.

Size.—This was the first character given in the diagnosis of *pulcher*, and the series in hand shows that *pulcher* is almost invariably larger than *elegans*, one male and one female alone being as small as the largest representatives of their respective sexes in the *elegans* series. The majority are as large, in general size, as the measurements of the types of *pulcher*.

Tegmina.—In none of the specimens examined are the tegmina quite as long as in the types of *pulcher*, and in the majority, particularly the east coast specimens, they are decidedly shorter, often no longer proportionately than in *elegans*.

Fastigium.—In the series of *pulcher* here studied the angle of the fastigium is less acute than in *elegans*. Some variation exists in the exact form of the angle, *i.e.*, the divergence of the margins; but as a whole, and in the vast majority of individuals, the fastigium is broader and less acute in both sexes.

Frontal costa.—In both sexes of *pulcher* the sulcation of the frontal costa is less pronounced and more rounded than in *elegans*, some of the Cedar Keys specimens having the sulcation very greatly reduced.

Color.—From a type similar to that found in *C. elegans* all the forms mentioned in the original description are contained in the series, in addition to which patterns there are several which suggest species of *Orphulella* in the way the dorsum is washed with rose purple.

To summarize, it appears that *Clinocephalus pulcher* is a southern representative of *C. elegans*, reaching its maximum of differentiation in southern Florida (Miami), where, as far as present material goes, it is a long-winged, or for the genus a long-winged, form. The specimens here referred are, on this account, not fully typical, but they are nearer to *pulcher* than to the small northern *elegans*. Gulf coast (Cedar Keys) specimens are as a rule nearer to typical *pulcher* than east coast (Pablo Beach and San Pablo) specimens, while interior specimens (Gainesville) are rather curious in that the males are similar to Cedar Keys males and the single available female is like east coast specimens.

That *elegans* and *pulcher* should be considered distinct appears to be the best way to handle the evidence the specimens give, the form of the fastigium and the depth of the sulcation of the frontal costa being "degree of difference" characters fully worthy of consideration, while the greater size of *pulcher*, and the complex coloration which it very frequently exhibits and which we have never seen in *elegans*, are to be given due consideration.

At Pablo Beach this species was abundant in a variety of localities, in dry palmetto scrub and undergrowth in pine woods, in rank grass growing in a wet drain along a railroad embankment and in open marshy spots. Twenty-four males, eleven females and two nymphs were taken at this locality, August 11 to 13. In pine woods at San Pablo two females were taken on August 13, and in a similar situation and at a wooded sink-hole two males and one female were taken August 16 and 17 at Gainesville. Cedar Keys is represented by twenty-one males, five females and two nymphs taken, August 15, in salt marsh and in palmetto scrub in open pine woods. Here the species was more abundant in salt marsh.

ŒDIPODINÆ.

Arphia xanthoptera (Burmeister).

A single female of this species from San Pablo, August 13, is in the collection. It was taken in pine woods undergrowth.

Arphia granulata Saussure.

Five males, three females and one nymph of this species were taken at Pablo Beach, August 11, 12 and 13, all captured in open palmetto scrub except one from grass.

There is a perceptible amount of variation in the arcuation of the crest of the pronotum, the majority having it distinctly but slightly arcuate, while the coloration of the caudal tibiæ is also variable, a pale disto-median annulus being present more or less distinctly in the majority of the specimens. With two exceptions the specimens have blackish brown predominating, the others being dull brownish.

Eucoptolophus costalis (Scudder).

This species enjoys a much wider distribution in the southeastern States than has usually been supposed to be the case. The present collection contains representatives from Jacksonville (one female, August 11, on city lot), Pablo Beach (three males, four females, August 11 and 12, palmetto scrub, grass and strand), Gainesville (one male, August 17, palmetto scrub) and Cedar Keys (one male, August 15).

In coloration a great amount of variation is present, the shades of brown ranging to seal brown, while the ochres are equally variable. One female from San Pablo has the whole head and pronotum, the better part of the caudal femora and patches on the distal portion of the tegmina green, while the Jacksonville individual has some green present on the tegmina, in the same position as on the above specimen.

An examination of available material shows this species to range along the Gulf coast from Texas to eastern Florida and south-central Georgia, the similarity of color phases and general appearance having caused in some instances its confusion with *Chortophaga viridifasciata*. Specimens from the following localities can be assigned to this species: Ocklockonee River and Thomasville, Thomas County, Ga.; Miami, Dade County, and Chokoloskee, Monroe County, Fla. Caudell has recorded it from Key West and Sanford, while the records of *Chortophaga viridifasciata* given by the authors[4] also belong to this species, as a re-examination of the material shows. Tampa is the only locality in the latter paper additional to those mentioned above.

Spharagemon bolli Scudder.

Two males and four females from Pablo Beach in open palmetto scrub, August 11 and 12, and a pair from Cedar Keys in palmetto scrub in pine woods, August 15, represent this species. The variations usually noticed in any series of this species, *i.e.*, shade of general color and strength of tegminal and femoral bars, are hardly as great as in northern specimens, and as a rule the specimens are more uniform than Maryland and New Jersey individuals.

Spharagemon collare wyomingianum (Thomas).

A single female from grassland at Gainesville, August 17, represents this race. The mottling of the head, pronotum, tegmina and femora is less striking than in New Jersey specimens of this form.

Scirtetica picta (Scudder).

A series of four males and two females from Pablo Beach, August 11, 12 and 13, and two males from Gainesville, August 17, represent this species. The Pablo Beach specimens were taken in a variety of habitats—strand, open palmetto scrub and along railroad tracks—while the Gainesville individuals are from palmetto scrub and grassland. One Pablo Beach specimen is quite uniform warm brown in color, the pale tegminal markings and the dark femoral bars alone but moderately indicated. The other extreme type, with great contrast between the bone white markings and blackish brown areas, is represented by one specimen from Pablo Beach, the remaining specimens presenting degrees of coloration intermediate between the two extremes. This species was noticed but not captured at Riverside, near Jacksonville.

Psinidia fenestralis (Serville).

This sand-loving species was taken at Jacksonville, one male, one

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[4] *Proc. Acad. Nat. Sci. Phila.*, 1905, p. 38.

female, August 11 and 20; Pablo Beach, three males, two females, one nymph, August 11 and 12, and Gainesville, one male and three females, August 16 and 17. At Jacksonville it was taken on a city lot and in a sandy field near the city; at Pablo Beach on the strand and in open palmetto scrub, and at Gainesville in palmetto scrub in pine woods and in grassland.

Trimerotropis citrina Scudder.

This widely ranging species is represented by material from Jacksonville and Pablo Beach. A single male from the former locality was taken August 11 on a city lot, and six males and four females from Pablo Beach were taken August 11, 12 and 13 on the strand, in palmetto scrub and along the railroad track. The strand was, however, the place of greatest abundance. A male taken at Swansea, Lexington County, S. C., August 10, in a sandy road is also referable to this species.

LOCUSTINÆ.

Dictyophorus guttatus (Stoll).

This curious grasshopper was numerous in tall weeds along the railroad track a short distance west of Pablo Beach, five males and two females being taken on August 13. The species was more abundant than the collected material would indicate as the remains of dozens of specimens were found along the track, the majority having been crushed by the wheels of the trains. The section where they were most numerous was bordered on the sides by woodland, and in the more open regions the species was not noticed. A female was captured on the hotel porch at Pablo Beach, August 12, and a single female was taken at Gainesville, August 16, in undergrowth in pine woods. Nymphs of this species were not noticed during the trip.

Stenacris chlorizans Walker.

At Pablo Beach, in open marshy spots scattered over the palmetto scrub, this species was numerous in grass of moderate height, and in a swampy area of tall grass north of the railroad track it was equally at home. In all situations its actions were similar to those noticed in the vicinity of Thomasville,[5] except that grass was used as a resting place instead of cat-tails, which did not occur except in the more pronounced portions of the wet areas. Nine males and five females were taken at this locality, August 11. Three males and two females were taken at Gainesville, August 17, in a marshy sink-hole in the pine woods.

Over half the specimens collected have the lateral pale bars either distinctly or slightly marked, while the dorsal aspect is strongly pur-

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[5] Vide *Proc. Acad. Nat. Sci. Phila.*, 1904, pp. 787, 788.

plish in one male and slightly so in several others. But four specimens are of the full green coloration, *i.e.*, without lateral pale bars or traces of dorsal suffusion of purplish.

Leptysma marginicollis (Serville).

This species was found at Pablo Beach associated with the preceding. Two males, six females and four nymphs, representing two stages, were collected on August 11. The least developed of the nymphs was taken in palmetto scrub.

The lateral pale bars are strongly indicated in but four of the adult specimens.

Schistocerca americana (Drury).

Two females taken at Gainesville, August 16 and 17, in grassland and in undergrowth in pine woods, represent this species.

Schistocerca damnifica (Saussure).

Two males from Pablo Beach (August 11 and 12), one from San Pablo (August 13) and another from Gainesville represent this species. The Pablo Beach individuals were taken in open palmetto scrub and the others in undergrowth in pine woods.

An interesting fact concerning this species is that New Jersey specimens have the tegmina and wings distinctly shorter than Florida and Georgia specimens, the tegmina also with distal extremity broad and blunter, while the antennæ are usually longer and slenderer in the southern specimens. This species was noticed but not captured at Riverside, near Jacksonville.

Schistocerca alutacea (Harris).

The authors being of the opinion that *S. alutacea* (Harris) and *rubiginosa* (Scudder) represent color phases of the same species, the two types are here treated together. Fifteen males and ten females are included in the collection, of which three males and one female represent the *alutacea* type, the others being similar to northern "*rubiginosa*" individuals from the immediate coast, but with longer tegmina and wings than representatives from points in the interior of the pine barrens of New Jersey.

The entire series except one male is from Pablo Beach, taken August 11 and 12, all from open palmetto scrub except one female of the *alutacea* form taken in a swampy spot. Two males of the *alutacea* type—in fact the only males of this type taken at Pablo Beach—were collected in the open palmetto scrub in association with "*rubiginosa*" type. Gainesville is represented by one male of the *alutacea* type, taken August 17 in grassland.

The "*rubiginosa*" individuals from Pablo Beach are identical with individuals from the coast of southern New Jersey, *i.e.*, Cape May and Anglesea. The form found in the interior of the New Jersey pine region possesses short tegmina and wings and, as a rule, is of smaller size. If the recognition of *alutacea* and *rubiginosa* as distinct species is conceded, it would also be necessary to separate the pine land type from the coast dune type.

Schistocerca obscura (Fabricius).

This form, which is separated from *alutacea* by the narrower incision of the subgenital plate of the male and the color of the caudal limbs, is represented by three males and five females. Of these six were taken at Pablo Beach, August 11 and 12, in tall marsh grass and open palmetto scrub; one female at Gainesville, August 16, in undergrowth in pine woods, and another at Denmark, Bamberg County, S. C., August 10, in high weeds. The males here referred to this species have the subgenital plate with the lateral portions lapped over the incision, while the caudal tibiæ are decidedly blackish in all except in one female which has them blackish purple. The bars on the dorsal face of the caudal femora are indicated more or less distinctly in all the individuals, but in no case are they prominent. The general base color of all the females, and to a lesser extent of the males, is maroon, while the size appears to be greater in the female than in the average of *alutacea*. The coloration of the female of this species is very striking, but the males do not present so rich an appearance. The real value of this form as distinct from *S. alutacea* cannot be fully determined without the study of a large amount of material, as the single character of the narrower incision of the male subgenital plate alone can be relied upon, the greater length of the antennæ, size and coloration being variable in the allied species.

Two female specimens of this species from Maryland have also been examined, one from Chestertown (August 17, 1898; E. G. Vanatta), the other from Druid Hill Park, Baltimore (September, 1902; H. A. Wenzel). These specimens extend the range of the species considerably to the north of the former northern limit—North Carolina.

Gymnoscirtetes pusillus Scudder.

This peculiar species is represented in the collection by a most interesting series of 153 specimens taken as follows: Pablo Beach, August 11, 12 and 13, sixty-eight males, fifty-nine females, two nymphs; San Pablo, August 13, seven males, four females; Gainesville, August 17, four males and seven females; Cedar Keys, August 15, one female.

As a whole the series shows a considerable amount of variation in size in both sexes, but the extremes of the female are proportionately greater. The Gainesville series as a whole is slightly smaller than the average of Pablo Beach and San Pablo individuals. The smallest male and female measure 12.7 and 16.3 mm. in length of body; the largest 15.3 and 22 mm., all measured individuals being from Pablo Beach.

The structural variations noticed in Georgia specimens of this species[6] are also present in this series. The chief color variation in the dried specimens is the depth and extent of the purplish-brown dorsal color.

The habitats frequented by this species are open palmetto scrub, open marsh, tall marsh grass, undergrowth in pine woods and grassland, by far the greater number of specimens being taken in the palmetto scrub, and all situations are represented in the Pablo Beach series. One specimen from the latter locality was the prey of an asilid fly (*Diogmites*, probably *winthemi* Wied.) but little larger than the *Gymnoscirtetes* itself.

The localities at which this species has been taken, in addition to those given above, are Jacksonville (type locality) and De Funiak Springs, Fla., Waycross and Thomasville, Ga.

Eotettix signatus Scudder.

This beautiful species is represented by a series of ten males and four females taken at Pablo Beach, August 11, in marshy spots scattered over the palmetto scrub area back of the beach dunes. In size the specimens are quite uniform, and as the female sex has not been recorded the following measurements of it may be of some interest: Length of body 26.5 mm.; length of pronotum 6.2; length of tegmen 7.6; length of caudal femur 15.5. In color the little variation that is appreciable is probably due to discoloration in drying.

The only previous record of this species is the original reference, the typical material being one male from East Florida.

Eotettix palustris Morse.

At Gainesville, in the rank vegetation around a flooded sink-hole in pine woods, five males and five females of this species were taken on August 16 and 17. In the female sex this species appears to be more variable than *E. signatus*, but the coloration is, as far as available material goes, constant except for a tendency to suffuse the whole insect with pinkish-red. The extremes of the female sex measure 20.8 and 25 mm. in length of body; 5 and 5.2 in length of pronotum; 4 and 4.8 in length of tegmen, and 12.3 and 14.6 in length of caudal femur.

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[6] Vide *Proc. Acad. Nat. Sci. Phila.*, 1904, p. 789.

The only previous record of this species is from Live Oak, Suwanee County, Fla.

Hesperotettix floridensis Morse.

Two males and a female of this peculiar species were taken at Pablo Beach, August 12 and 13, and a second female at San Pablo, August 13. The Pablo Beach specimens were taken among grass in marshy spots in the palmetto scrub, and in tall grass growing in a wet drain along the railroad track. The San Pablo specimen was taken in undergrowth in pine woods.

The previous records of this species are from Hastings, St. John County, Fla., and Waycross, Ware County, Ga.

Melanoplus propinquus Scudder.

This austral representative of *M. femur-rubrum* is represented by a series of thirty-three specimens taken at four localities, at all of which the species was abundant in a variety of situations. The localities and dates are: Jacksonville, August 11, two males, one female; Pablo Beach, August 11–13, fourteen males, three females; Gainesville, August 16, four males, two females; Cedar Keys, August 15, three males, four females. At Jacksonville it was taken on a city lot, while the Pablo Beach series was collected in palmetto scrub, open grassy stretches and in tall marsh grass.

Size is a very variable character in this species and does not appear to be correlated with exact environment, one of the smallest and one of the largest males both being from tall marsh grass at Pablo Beach. Maximum and minimum measurements from Pablo Beach males are as follows:

Length of body,	22.2 mm.	17.6 mm.
Length of pronotum,	5.1 "	4 "
Length of tegmen,	20.2 "	15.8 "
Length of caudal femur,	13 "	10.7 "

Melanoplus inops Scudder.

A series of sixty-nine specimens represents this species, which was taken at all the points where any amount of collecting was done. The localities represented are: Pablo Beach, August 11–13, nine males, nine females; San Pablo, August 12, four males, three females; Gainesville, August 16 and 17, twenty males, fourteen females; Cedar Keys, August 15, two males, seven females, one nymph. At Pablo Beach the species was numerous in the open palmetto barrens; at San Pablo, Gainesville and Cedar Keys it frequented the undergrowth in pine woods, sometimes, particularly at Cedar Keys, among saw palmetto.

The cerci of the males exhibit an appreciable amount of variation, and types with these appendages more curved or straighter than figured by Scudder[7] can be found in the series before us. In some individuals the cerci are more robust, in others slenderer; in some the extreme apex is slightly narrowed, in others obliquely truncate. The furcula are distinct in the majority of the specimens; in some present as considerably depressed trigonal lobes. Specimens with the furcula obsolete as described in the type are in the minority.

In size the specimens from the Atlantic side of the peninsula average larger than those from the Gulf coast and the interior pine land (Gainesville), the San Pablo males also averaging as large as the largest Pablo Beach representative of the same sex. As maximum and minimum measurements may be of interest the extremes of each sex are here given:

	Cedar Keys, Aug. 15. ♂	San Pablo, Aug. 13. ♂	Cedar Keys, Aug. 15. ♀	Pablo Beach, Aug. 11. ♀
Length of body, . .	14.6 mm.	17.5 mm.	17 mm.	21.6 mm.
Length of pronotum, .	3.5 "	4.5 "	4.1 "	5 "
Length of tegmen, . .	2.7 "	4 "	3.3 "	4.4 "
Length of caudal femur,	9 "	10.8 "	11 "	13 "

In coloration a considerable amount of variation is present in the tone of the general color and the presence or absence of femoral bars. The dark dorsal sections of the lateral lobes of the pronotum vary considerably in depth, being very prominent and solid in some specimens and almost absent in others, which also holds true regarding the two dark bars on the dorsal aspect of the caudal femora. These latter are quite broad, strongly contrasted and obliquely disposed in a few specimens, indicated in a less pronounced manner in the majority of specimens and almost absent in others. These variations as well as those in the tone of the general color are irrespective of locality or sex. The general tone varies from a grayish tendency through umbers to a burnt sienna type.

This species was described from a single male labelled "Florida," and up to this writing nothing additional has been published regarding it. A female from Lemon City, Dade County, Fla., has also been examined, the tegmina of which are somewhat smaller than those of individuals from northern Florida.

Melanoplus keeleri (Thomas).

Thirteen specimens are referred to this trim species distributed as follows: Pablo Beach, August 11, 12 and 13, five males, one female;

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[7] *Proc. U. S. Nat. Mus.*, XX, pl. XXII, fig. 4.

San Pablo, August 13, two males, three females, one nymph; Gainesville, August 16, one male. At Pablo Beach the species was found in palmetto scrub, in tall marsh grass and along a sparsely covered railroad embankment, while at San Pablo and Gainesville it was found in the undergrowth in pine woods.

In color the series exhibits a moderate amount of variation, chiefly in the shade of the base color, although the dark maculations also vary somewhat in extent and intensity in proportion to the depth of the base color, being weaker in the individuals with an ochraceous base and well marked in those with a brown general tint. The caudal tibiæ are scarlet vermilion in all the adults and glaucous in the single nymph.

The form of the male cerci is as variable in the present series as in the one from south Florida previously studied by the authors,[8] and the extremes in the series of eight males are well marked and a number of intermediates are also present, the latter constituting the greater part of the lot. The *keeleri* extreme with the slender elongate accessory lobe is on the other hand replaced by one with the accessory lobe almost absent, represented in fact by an angulation, while the other specimens when arranged according to their cercal character form a complete transition from one to the other.

On examining the original references of *keeleri* and *deletor* it is evident that the claim made by Scudder[9] that *keeleri* is smaller than *deletor* is refuted by the measurements originally given from typical material. Thomas gives the measurements of *keeleri*, a female, as follows: Length of body 1.12 inches (28.4 mm.), length of tegmen .88 (22.3 mm.), length of caudal femur .70 (17.7 mm.); while Scudder gives the following for *deletor:* Length of body, male 23.5 mm., female 30.5; length of tegmen, male 21, female 22; length of caudal femur, male 14.5, female 16. It would appear from the records and evidence of material that this species is small toward the northern limit of its range (at least on the Atlantic coast) in North Carolina, from which region it ranges along the coastal plain and Gulf region to Texas and up the Mississippi to Missouri, reaching in southern Florida its maximum of size. The type of *keeleri* was from Florida and those of *deletor* from Texas, the measurements of the original specimens of both species differing little, being very much the same as found in the material studied in this connection. On the other hand south Florida (Miami) specimens are uniformly larger,[10] an average pair measuring as follows:

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[8] *Proc. Acad. Nat. Sci. Phila.*, 1905, p. 40.

[9] *Proc. U. S. Nat. Mus.*, XX, p. 344.

[10] This is also true of *Melanoplus puer* (vide *Proc. Acad. Nat. Sci. Phila.*, 1905, p. 40), Miami individuals of which are very considerably larger than north and central Florida representatives.

	♂	♀
Length of body,	25 mm.	31 mm.
Length of pronotum,	6 "	7.2 "
Length of tegmen,	27 "	25.5 "
Length of caudal femur,	15.2 "	18.2 "

As I imagine Scudder's measurements, in his Revision of the Melanopli, were taken from the specimen of *keeleri* there figured, their small size is due to the fact the individual was from North Carolina.

On the evidence of the material examined I am compelled to consider *Melanoplus deletor* Scudder a synonym of *Melanoplus keeleri* (Thomas).

Paroxya atlantica Scudder.

A series of forty-five specimens represent this species, the several localities being as follows: Pablo Beach, August 11, 12 and 13, twenty-seven males, seven females; Gainesville, August 16 and 17, six males, two females; Cedar Keys, August 15, one male, two females. At Pablo Beach the species was numerous among the tall grasses growing in extensive wet areas, drains and in the smaller marshy spots in the palmetto scrub, while at Gainesville the vicinity of a sink-hole in the pine woods was frequented. Salt marsh was the environment in which it was found at Cedar Keys.

There is an appreciable variation in size in the Pablo Beach series, particularly in the males. In color there is considerable variation in the degree of purity of the yellow color. The two Gainesville females are deeper in color than the average Pablo Beach individuals, while both Cedar Keys females and one of two from Gainesville have the dorsum of the head, pronotum, caudal femora, face, limbs and ventral portion of the lateral lobes of the pronotum washed with wine purple.

Paroxya floridiana (Thomas).

At Pablo Beach this species was found frequenting tall grass growing along a railroad drain, four males and two females being taken on August 11. At Gainesville a single female was taken near a sink-hole in undergrowth in pine woods on August 16.

When compared with material from the northern portion of the range of the species the Florida specimens are seen to be much larger, and a comparison of material shows a steady increase in size as one proceeds southward. In view of this fact comparative measurements of specimens from several points within the range of the species are here given. No effort has been made in the selection of specimens for measurement to pick only those supporting the view expressed above, as on the contrary the individuals used have been taken haphazard when more than a single pair was available from the locality which it was desired to represent.

MALES.

	Arner, Ontario.	Bear Swamp, Burl. Co., N. J.	Roslyn, Va.	Pablo Beach, Fla.
Length of body, . .	20.6 mm.	22 mm.	24.2 mm.	32.5 mm.
Length of antenna, .	13 "	13.1 "	16.5 "	19.5 "
Length of pronotum, .	4.3 "	4.5 "	5.2 "	6.8 "
Length of tegmen, . .	11.2 "	16 "	16.4 "	22 "
Length of caudal femur,	12 "	12 "	14 "	17.5 "

FEMALES.

	Arner, Ontario.	Clementon, N. J.	Roslyn, Va.	Pablo Beach, Fla.
Length of body, . .	32 mm.	33.2 mm.	36.1 mm.	44 mm.
Length of pronotum, .	6.5 "	7 "	7.1 "	8.8 "
Length of tegmen, .	18.6 "	17.5 "	18.2 "	28.2 "
Length of caudal femur,	15.8 "	17 "	18.2 "	22.6 "

Aptenopedes sphenarioides Scudder.

This interesting species is represented in the material collected by a series of eighty-six individuals. The localities represented are Pablo Beach and Gainesville, the former by twenty-nine adult males, eleven adult females, six male nymphs and eighteen female nymphs; the latter by five adult males, one adult female, eleven male nymphs and five female nymphs. At Pablo Beach it was taken August 11, 12 and 13, in dry palmetto scrub, undergrowth in open pine woods, in grassland and in tall marsh grass. At Gainesville, on August 16 and 17, it was found chiefly in undergrowth in pine woods, the vicinity of a sink-hole being inhabited by it.

The nymphs represent two stages and show that the principal color characters of the adults are indicated for a considerable time before the individual is mature.

The size of the adult specimens is quite uniform in the Pablo Beach series, but the Gainesville males show a very appreciable amount of variation, the extremes measuring 18 and 20.8 mm. in length of body.

Aptenopedes aptera Scudder.

A series of eighty-six specimens represent this interesting species. Pablo Beach is represented by thirty-eight adult males, nineteen adult females, four male nymphs and nine female nymphs taken August 11, 12 and 13. At this locality the species was found associated with *A. sphenarioides* particularly in the palmetto scrub, and but slightly less abundant than the latter species. At San Pablo, August 13, two males and three females were taken in the undergrowth in the pine woods. One adult male and five female nymphs were taken at Gainesville, August 16 and 17, in pine woods undergrowth, chiefly scrub palmetto. Cedar Keys is represented by two adult males, one male nymph and two female nymphs, taken August 15 in pine woods undergrowth.

Two stages are represented in the nymphs from Pablo Beach, only one from the other localities. This species does not possess two color phases differing markedly as in *A. sphenarioides*, most of the variation observed being in the intensity of the median abdominal bars and the lateral bars of the pronotum. The nymphs in several instances have the abdominal bars strongly marked and almost wholly washed with purplish pink. The Pablo Beach series of adults is quite uniform in size, several females alone being conspicuous on account of their smaller size. The single Gainesville male, however, is distinctly larger than individuals of the same sex from any other locality, the length of body being 21.3 mm., while the largest Pablo Beach male measures 18.5.

This species has been recorded previously in Florida from Fort Reed, Orange County, Jacksonville, Duval County, and Miami, Dade County. A male from Gotha, Orange County, has also been examined.

TETTIGONIDÆ.

Arethæa phalangium (Scudder).

A single female of this interesting species was taken in the undergrowth in pine woods at Gainesville, August 16. This specimen was the only representative of the species noticed and constitutes the first record of the same from Florida. The previous records are Georgia (Scudder, Brunner), Thomasville, Ga. (Rehn and Hebard), and Victoria, Texas (Caudell).

Scudderia texensis Saussure and Pictet.

This widely ranging species was taken at Pablo Beach and Gainesville, two males being taken August 13 at the former locality and one of the same sex on August 16 at the latter.

The environment at the first locality was open grassland and the slope of a railroad embankment and undergrowth in pine woods at the second.

Scudderia laticauda Brunner.

At San Pablo a single female of this large form was taken August 13 in pine woods undergrowth. A series of three males and four females taken August 16 at Gainesville in a similar environment are also referred to this species. The Gainesville males show close relationship in the form of the genitalia to the figure of *S. curvicauda* given by Scudder, but the females are unquestionably *laticauda* by the size and shape of the ovipositor. The males are larger than northern specimens of *curvicauda*, agreeing in this respect with the associated Gainesville females and also with the measurements given by the describer.

Scudderia cuneata Morse.

A single female from Pablo Beach, August 11, in palmetto scrub, represents this species. A female from Miami has been used for comparison and the Pablo Beach individual differs only in its slightly smaller size.

The range of this species is now known to be from Alabama and southern Georgia (Thomasville) south to southern Florida (Miami).

Symmetropleura modesta Brunner.

This species, previously known only from the male type from "Carolina" and a female specimen from North Carolina, is represented by a male individual taken from floating water hyacinth (*Piaropus crassipes*) in the St. John's River by the wharves of Palatka, on August 18. No other specimen of the species was noticed.

When compared with Brunner's original description the Palatka male is slightly larger than the type, and also differs in having the margins of the tympanum and the caudal margin of the tegmina lined with ochraceous, in addition to the angles of the pronotum mentioned in the original description. The apices of the tegmina are slightly and the exposed portions of the wings are strongly washed with brownish.

Amblycorypha floridana Rehn and Hebard.

A series of two males and six females represents this species, the original basis of which was chiefly damaged material. With the material in this series more detailed comparisons can be made with *A. oblongifolia*, to which *floridana* is closely allied.

The less curved form and rather smaller size of the ovipositor will serve to separate the female of *floridana* from that of *oblongifolia*, while in the male the tympanum is distinctly narrower, both actually and proportionally, than in *oblongifolia*. The lateral angles of the disk of the pronotum are as a rule by no means as sharply rectangulate as in *oblongifolia* and the disk itself is broader caudad in the latter species. From the evidence in hand it appears that *floridana* represents the southern extreme of *oblongifolia*, as individuals from Thomasville, Ga., are as near *floridana* as *oblongifolia*, the ovipositor being more curved and larger and the pronotal angles more distinct than in *floridana*, but the narrower tympanum and the comparatively narrower caudal section of the pronotal disk show relationship to the same species.[11] In no one of the characters, however, is an extreme represented, but an intermediate position is clearly recognizable. Thus from the evidence in hand true *floridana* is apparently restricted to Florida, grading north over an undetermined area into true *oblongifolia*, the type locality of which is Pennsylvania.

The series in this collection was taken at Pablo Beach, August 11 and 13, two males, two females; San Pablo, August 13, one male, and Gainesville, August 16, three females. At Pablo Beach individuals were taken in salt marsh, swampland and in tall bushes on the dunes, and at San Pablo and Gainesville in undergrowth in pine woods.

The San Pablo individual is in the pinkish phase of coloration. Other individuals of *A. oblongifolia* in this type of coloration in the Academy collection are from Absecon, N. J., and Wood's Hole, Mass.

Amblycorypha uhleri Stål.

A single male of this species was taken at Gainesville, August 16, in undergrowth in pine woods.

This is the first Florida record of the species.

Cyrtophyllus (Lea) floridensis Beutenmüller.

This interesting katydid was found to be abundant in certain bushes about eight to ten feet high growing on the land face of the dunes at Pablo Beach. On August 12 six males and on August 13 nine males were captured. They were taken wholly with the aid of their song which began shortly before evening. The song, as was stated by Beutenmüller, is distinctly different from that of *C. perspicillatus*, being much lower, decidedly weaker and consisting of single notes separated by regular intervals.

The generic name *Lea* proposed by Caudell[12] is not applied by us, as the characters assigned to the genus do not appear to the authors to be of sufficient weight to have generic value, although *floridensis* is to our mind worthy of being considered subgenerically distinct from *C. perspicillatus*.

The color of the living individuals was essentially as in the dried specimens, which were stuffed in the field and have lost but little in consequence. The general dorsal color is bice green, becoming pale green on the limbs and olive-buff on the head and pronotum, the eyes cinnamon and the lateral margins of the disk of the pronotum and the tympanal fields of the tegmina raw umber. The thickened anal vein

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[11] *Proc. Acad. Nat. Sci. Phila.*, 1904, p. 795.

[12] Vide *Journ. N. Y. Ent. Soc.*, XIV, pp. 31 and 42.

of the male tegmina and the sutural margins of the same are yellowish or light greenish.

In size the species exhibits a considerable amount of individual variation, and the measurements of the extremes of the series of males and also of a female specimen are here given:

	♂	♂	♀
Length of body,	30 mm.	40 mm.	38.5 mm.
Length of pronotum,	6.4 "	7.5 "	7.5 "
Width of caudal margin of the pronotum.	6.3 "	7 "	6.8 "
Length of tegmen,	32 "	35 "	34.2 "
Length of caudal femur,	23.1 "	24.2 "	26 "
Length of ovipositor,			18.2 "

In addition to the fifteen Pablo Beach males a single female, of which the measurements are given above, from St. Augustine (C. W. Johnson) has been examined. The range of the species is now known to extend in a narrow strip along the coast from Pablo Beach, Duval County, to the vicinity of Grant, Brevard County, Fla.

Belocephalus subapterus Scudder.

A series of eleven specimens, one adult male, three adult females and seven immature individuals, represent this species. At Pablo Beach it was found on August 11, 12 and 13, in palmetto scrub and in low growth along the railroad track, three of the adults being taken at that locality. At San Pablo, August 13, one immature individual was taken in pine woods undergrowth. The remaining specimens were taken at Gainesville, August 16, in pine woods undergrowth. All the adults taken were in the green phase of coloration. The range of this species now extends from Thomasville, Ga., to Miami and Chokoloskee, southern Florida, specimens having also been recorded from Fort Reed, Orange County, Fla., in addition to the localities given above.

Conocephalus retusus Scudder.

At St. Augustine a series of four males and two females of this species were taken from the hedges of a garden on the evening of August 19.

When compared with the northern *Conocephalus atlanticus* Bruner, this species is seen to differ only in the somewhat greater general size and in the longer caudal limbs. Probably *atlanticus* will prove to be merely a smaller northern form of *retusus*, as a specimen from Roslyn, Alexandria County, Va. (October 22, 1900; J. A. G. Rehn), occupies an intermediate position. Typical females of the two forms and the Roslyn specimen measure as follows:

	Phila. Neck, Pa.	Roslyn, Va.	St. Augustine, Fla.
Length of body,	26 mm.	25.2 mm.	28.5 mm.
Length of pronotum,	6.5 "	6.2 "	7.5 "
Length of tegmen,	28.8 "	30.5 "	34.5 "
Length of caudal femur,	20.2 "	22.5 "	26.5 "
Length of ovipositor,	31 "	36.2 "	35 "

Conocephalus mexicanus Saussure.

A single female of this species was taken at Cedar Keys, August 15. The caudal femora are slightly longer than in a Tampa specimen, but otherwise the two are inseparable.

Conocephalus crepitans Scudder.

A single female of this species was taken at Warchard, Levy County, August 14, during a brief stop of the train. It was in undergrowth in the pine woods close to the railroad track.

When compared with a female of the species from Lincoln, Neb., the Florida specimen differs only in the slightly longer legs and ovipositor, being identical in all other characters. The measurements of the two specimens are as follows:

	Lincoln, Neb.	Warchard, Fla.
Length of body,	36.5 mm.	36 mm.
Length of pronotum,	8.5 "	8.8 "
Length of tegmen,	55 "	59.5 "
Length of caudal femur,	28.8 "	34.8 "
Length of ovipositor,	32.8 "	36.2 "

The capture of this species in Florida carries its range a considerable distance east, the previously known range extending from Nebraska and Iowa south to Texas and Arkansas.

Conocephalus melanorhinus n. sp.

Type: ♀; Cedar Keys, Levy County, Fla., August 12, 1905. (Hebard and Rehn.)

Allied to *C. robustus* Scudder and *lyristes* Rehn and Hebard, differing from the former in the blunter fastigium which is almost wholly black ventrad, the narrower disk of the pronotum, the straighter tegmina and the slightly deeper and considerably shorter ovipositor. From *lyristes* the new species differs in the larger size, the form of the fastigium, the more robust general form and the shorter ovipositor.

Size rather large; form elongate, rather slender. Head with the fastigium hardly elevated dorsad of the level of the occiput; fastigium distinctly longer[13] than the greatest width, apex blunt, subtruncate, ventral tooth separated from the frontal fastigium; angle of the face very considerable; eyes little prominent, slightly flattened; antennæ rather short, the length slightly exceeding that of the caudal femora. Pronotum rugoso-punctate, the dorsum deplanate, the lateral angles distinct caudad but not sharp; cephalic margin of the disk with a very slight median emargination, caudal margin of the disk moderately arcuate, lateral margins of the disk slightly diverging caudad; lateral lobes of the pronotum distinctly longer than deep, cephalic margin considerably oblique, caudal margin with a deep rectangulate sinus ventrad of which the margin is strongly rounded, ventral margin obtuse-angulate. Tegmina elongate, exceeding the tips of the caudal femora by about the length of the head and pronotum together, narrow, apex narrowly rounded. Abdomen with the terminal dorsal abdominal segment produced into a pair of spinose processes between which the segment is deeply cleft; supra-anal plate trigonal, produced mesad into a rather long finger-like process; styles rather short, thick, acute, slightly arcuate; ovipositor slightly shorter than the caudal femora, straight, rather broad and subequal, apex acute; subgenital plate moderately produced, apical margin emarginato-truncate. Cephalic limbs of medium build. Caudal femora rather slender, the proximal half moderately inflated, externo-ventral margin with two to four spines, interno-ventral margin with six to seven spines; caudal tibiæ more strongly spined on the dorsal than on the ventral margins; caudal tarsi quite elongate and slender.

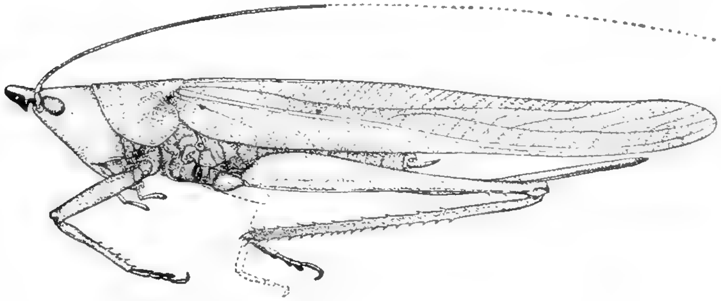

Fig. 1.—*Conocephalus melanorhinus* n. sp. Lateral view of type. (× 1½.)

General color apple green approaching oil green in areas on the dorsum of the fastigium and margins of the pronotum, lateral as well as dorsal. Fastigium marked laterad with maize yellow, ventral aspect of the fastigium black, oil green caudad; eyes ochraceous-buff;

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[13] Measurement taken from the interantennal space.

antennæ burnt carmine, pale and weak proximad. Pronotum with the lateral angles marked with maize yellow. Caudal tibiæ vinaceous pale on the angles; tarsi of all the limbs with the lateral portions dull purplish brown, the median area buff. Ovipositor ochraceous as is also the abdomen, distal two-thirds oil green, touched with brown at the apex, the median suture lined with black for the greater portion of its length.

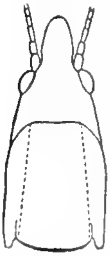

Fig. 2.—*Conocephalus melanorhinus* n.sp. Dorsal view of head and pronotum. (× 2.)

Measurements.

Length of body (exclusive of ovipositor),	35	mm.
Length of pronotum,	8	"
Greatest caudal width of disk of pronotum,	4.5	"
Length of tegmen,	48	"
Length of caudal femur,	27	"
Length of ovipositor,	22.8	"

The type of this species is the only specimen seen.

Orchelimum glaberrimum (Burmeister).

This species is represented by seven male individuals taken at five localities: Jacksonville, August 10 and 11, two taken from high bushes in city park; Pablo Beach, August 12, two from wet grassy spots in scrub palmetto barrens; San Pablo, August 13, one from undergrowth in pine woods; Gainesville, August 17, one from grassy margin of sinkhole; Cedar Keys, August 15, one from salt marsh.

In size some variation is noticed, chiefly in the length of the tegmina and wings and in the length of the caudal femora. The tegmen and wing variation is quite considerable, the extremes for the length of the exposed combined tegmina and wings being 27 and 34.5 mm.

Orchelimum nitidum Redtenbacher.[14]

Two males of this species were taken at Jacksonville, August 11, and Palatka, August 19. In both cases the specimens were taken in the city.

The absolute identification of Redtenbacher's species is attended with considerable difficulty, as the species here described as *O. molossum* is in many respects very closely allied. The present authors previously confused these two forms and recorded both as *O. nitidum*.[15] How-

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[14] Attempts to determine material by the presence or absence of spines on the ventral surface of the caudal femora having proved futile, we are compelled to abandon this character, which in our opinion is generally too individual in its variations to be diagnostic in this genus. The forms here treated have been recognized chiefly by characters of the genitalia of both sexes, which are more stable and of sufficient diversity to separate the species with the least difficulty.

[15] *Proc. Acad. Nat. Sci. Phila.*, 1904, p. 796. (Thomasville, Ga.)

ever, the form of the male cerci is the one character which will enable the student to recognize the two types with certainty and celerity. Redtenbacher's description says, "Cerci male subacuminati, vix compressi," and this clearly applies to the form for which his name is here used, *O. molossum* having the cerci depressed and not even slightly compressed. The cercus of *O. nitidum* is very slightly compressed in the distal half with a slight dorsal keel, and a figure is here given to fix the species with certainty. Cercal and ovipositor peculiarities are unquestionably among the chief characters to be used in separating the species of *Orchelimum*.

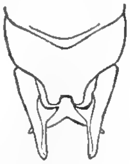

Fig. 3.–*Orchelimum nitidum* Redtenbacher. Dorsal view of apex of male abdomen. (× 4.)

Measurements of the specimen, of which a cercus is figured, are as follows:

Length of body,	22.5 mm.
Length of pronotum,	5.8 "
Length of tegmen,	23.5 "
Length of caudal femur,	20.2 "

The range of this species now includes Georgia and Florida.

Orchelimum molossum n. sp.

Types: ♂; Pablo Beach, Duval County, Fla., August 13, 1905. ♀; Gainesville, Alachua Co., Fla., August 16, 1905. (Hebard and Rehn.)

Closely allied to *O. nitidum*, but differing in the slightly heavier fastigium, the smaller pronotum with narrower lateral lobes, the smaller and more delicate tympanum of the male tegmina, the smaller, slightly depressed cerci, which have the tooth about median, and the slightly deeper emargination of the subgenital plate of the male.

Size moderately large (for the genus); form rather slender. Head rather broad; fastigium moderately broad, slightly elevated and rounded dorso-ventrad, apex more rounded transversely in the male than in the female, a fine median longitudinal depression present on the apex in both sexes, ventral portion narrowed and in contact with the fastigium of the face; eyes rather large, moderately prominent; antennæ extremely long. Pronotum with the dorsum flattened, caudal transverse sulcus impressed; cephalic margin of the disk subtruncate, caudal margin arcuate, lateral angles distinct only on the caudal lobe and there well rounded; lateral

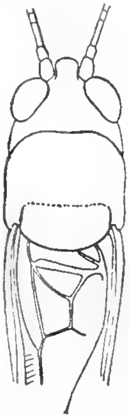

Fig. 4.–*Orchelimum molossum* n. sp. Dorsal view of head, pronotum and tympanum of male type. (× 3.)

lobe about as deep as long, the ventral margin subrectangulate, elytral sinus shallow and broad, the margin evenly arcuate ventrad of the same, convex callosity well defined in both sexes. Tegmina elongate, slightly tapering, apex rounded; tympanum rather light, slightly longer than wide. Wings projecting beyond the tegmina by less than the length of the head, apex narrowly rectangulate. Terminal dorsal abdominal segment of the male with two median rounded lobes separated by a deep rounded emargination; cerci straight except for a mesad bend at the middle, the proximal half robust, the distal portion tapering, acute, tooth on the internal face on the same plane as the cercus, stout, slightly recurved, acute; subgenital plate of the male ample, scoop-like, reaching about to the teeth of the cerci, distal margin rectangulate-emarginate, provided laterad with distinct but rather short styles. Supra-anal plate of the female acute-trigonal; ovipositor rather short, falciform, in length slightly shorter than the head and pronotum together, equal in width in the proximal half, tapering in the distal half, apex acute, the margins of the apex with slight traces of serrations; subgenital plate short, bullate, the extreme apex very slightly rectangulate-emarginate. Cephalic and median limbs moderately robust. Caudal femora about equal to three-fourths (♂) or four-fifths (♀) of the tegminal length, strongly bullate in the proximal half, externo-ventral margin armed with from two to five spines.

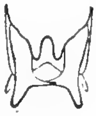

Fig. 5.—*Orchelimum molossum* n. sp. Dorsal view of male appendages. (× 5).

Fig. 6.—*Orchelimum molossum* n. sp. Lateral view of ovipositor. (× 2.)

General color pale apple green, washed on the dorsum with tawny ochraceous, a weak sub-lyrate pattern on the pronotal disk of the latter color, while the principal vein of the tympanum is also marked with it. Eyes of the male raw umber, of the female clove brown. Ovipositor greenish brown, male appendages ochraceous.

Measurements.

	♂	♀
Length of body,	21.5 mm.	21.8 mm.
Length of pronotum,	5 "	5.6 "
Length of tegmen,	24.5 "	25 "
Length of caudal femur,	17.6 "	20.8 "
Length of ovipositor,[16]		8 "

[16] Ventral length.

While this species is closely related to *O. nitidum*, it is not possible to refer the specimens here placed under the new form to the older species, and at the same time take proper cognizance of differences in the genitalia. As far as our available material goes the two forms are perfectly distinct, and for this reason it appears best to regard them for the present at least as separate species.

Three males and one female from Florida have been examined in addition to the types. One male is paratypic with the type of that sex, and the remaining individuals are paratypic with the female (August 16 and 17). At Pablo Beach the species was found in grass along railroad tracks, and at Gainesville it was taken in fields in the undergrowth of pine woods around a sink-hole. The species also ranges into southern Georgia at Thomasville (*vide supra*).

Such variation as exists in size in the specimens examined is comparatively slight, and in color the chief variation is in the intensity of the paired brown bars on the pronotum. The latter feature varies from a form with a pair of distinct slightly constricted, sublyrate bars to one in which they are only faintly suggested. In but one case, however, do they extend upon the metazona.

Experience in the field demonstrated the bulldog-like tenacity with which this species retains its grip when on the defensive, and the specific name has been given for this reason. In one case its hold was so strong that the head was torn from the body without the jaws relaxing their grip.

Orchelimum fidicinium n. sp.

Types: ♂ and ♀; Cedar Keys, Levy County, Fla., August 15, 1905. (Hebard and Rehn.)

Allied to *O. delicatum* and *gladiator* Bruner from Nebraska and Indiana, but differing from the former in the longer cerci of the male, the shorter subgenital plate of the same sex, and the slightly shorter and slenderer ovipositor. From *gladiator* it differs in the much slenderer ovipositor, longer limbs, shorter subgenital plate of the male and the heavier and longer male cerci.

Size small (for the genus); form elongate. Head with the fastigium not appreciably elevated above the level of the occiput; fastigium rather long, narrow, subequal, the apex rotundato-truncate when viewed dorsad, moderately rounded when viewed laterad, fastigium of the face in contact with that of the vertex; eyes rather large, somewhat prominent when viewed dorsad; antennæ about three times the length of the body. Pronotum with the disk but little flattened; cephalic margin slightly emarginato-truncate, caudal margin moderately arcuate, no lateral shoulders present on the prozona, present but rounded on the metazona, transverse sulci moderately distinct; lateral lobes very slightly longer than deep, the humeral sinus shallow and broad, ventral margin obtuse-angulate, convex callosity moderately distinct. Tegmina slightly longer than the body, their apices reaching to the genicular extremity of the caudal femora, narrow, apex narrowly rounded; tympanum of the male rather small and weak. Wings exceeding the closed tegmina by about the length of the head. Terminal dorsal abdominal segment of the male very narrowly divided mesad; cerci nearly straight, robust in the distal half, apical half tapering, immediate apex blunt, tooth placed interno-ventrad, rather long but not stout, recurved, acute; subgenital plate hardly surpassing the base of the cercal tooth, moderately inflated, subcarinate caudo-laterad, caudal margin obtuse-angulate, styles very short. Supra-anal plate of

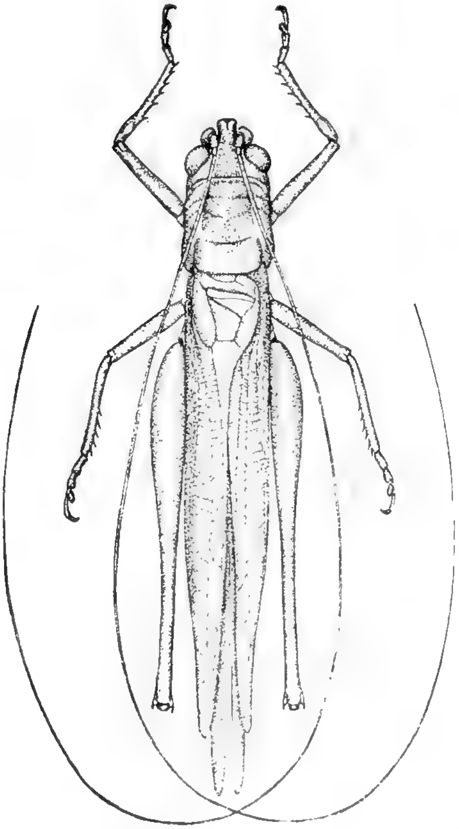

Fig. 7.—*Orchelimum fidicinium* n. sp. Dorsal view of male type. (× 3.)

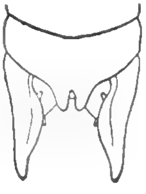

Fig. 8.—*Orchelimum fidicinium* n. sp. Dorsal view of apex of male abdomen. (× 6.)

Fig. 9.—*Orchelimum fidicinium* n. sp. Lateral view of ovipositor. (× 3.)

the female lanceolate; styles slightly arcuate, tapering; ovipositor slightly less than twice as long as the head and pronotum together, slightly falcate, moderately broad and subequal in the proximal half, tapering distad to the acute apex; subgenital plate of the female trigonal, somewhat inflated, the narrow apical portion subtruncate. Caudal femora considerably inflated proximad, ventral margins unarmed.

General color varying from buff to tawny olive, distinctly greenish in life, the lateral aspects of the head, pronotum and pleura pale olive-buff in the dried specimen. Eyes broccoli brown; antennæ burnt umber becoming drab distad; a broad median bar from the fastigium to the caudal section of the pronotal disk burnt umber, broken and irregular in the female; caudal tibiæ with the dorsal face olive.

Measurements.

	♂	♀
Length of body,	18.5 mm.	16 mm.
Length of pronotum,	3.8 "	4 "
Length of tegmen,	20 "	21 "
Length of caudal femur,	16 "	16.8 "
Length of ovipositor,		10 "

A paratypic series of ten males and nine females have also been examined, as well as a single male taken at Gainesville (August 16; in pine woods). The series exhibits some slight variation in size and considerable in the intensity of the broad median bar on the head and pronotum. In several specimens the latter is hardly indicated. The amount of variation in the shape of the ovipositor is very slight, and practically no variation is noticed in the form of the male cerci.

This species was found in the flooded salt marsh among tall grasses. The individuals displayed great agility in eluding capture, using both their leaping and flying power, those taken being secured chiefly by beating.

Orchelimum militare n. sp.

Types: ♂ and ♀; Gainesville, Alachua County, Fla., August 17, 1905. (Hebard and Rehn.)

Allied to *O. delicatum* Bruner and *O. volantum* McNeill, differing from both in the very long ovipositor and peculiar cerci. From *delicatum* it also differs in the larger size and the shorter subgenital plate of the male.

Size medium (for the genus), form moderately slender. Head with the fastigium very slightly elevated, the fastigium longer than broad and narrower proximad than distad, apex subtruncate when viewed dorsad, rather narrowly rounded when viewed laterad, the apex sometimes with a fine impressed medio-longitudinal line, fastigium of the face in contact with the fastigium of the vertex; eyes rather large, moderately prominent; antennæ at least three and a half times the length of the body. Pronotum with the disk not strongly flattened; cephalic margin subtruncate, caudal margin moderately arcuate; lateral shoulders present only on the metazona and there rounded, transverse sulci indicated but not deeply impressed; lateral lobes about as deep as long, cephalic margin obtuse-angulate, ventral margin subrectangulate, humeral sinus shallow and broad, convex callosity elliptical, distinct. Tegmina exceeding the genicular extremity of the caudal femora by nearly the length of the head, narrow, apex rounded on the costal margin, subtruncate on the sutural margin; tympanum of the male moderately large, slightly longer than the pronotum.

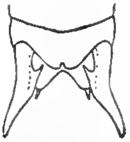

Fig. 10.—*Orchelimum militare* n. sp. Dorsal view of apex of male abdomen. (× 4.)

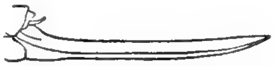

Fig. 11.—*Orchelimum militare* n. sp. Lateral view of ovipositor. (× 2.)

Wings extending beyond the tegmina by nearly the length of the head. Terminal dorsal abdominal segment of the male narrowly divided for nearly half its length; cerci elongate with a median obtuse angulation, the proximal half being robust and subcylindrical, the distal half being tapering, slightly falcate and distinctly depressed, the apex rather blunt, tooth on the internal margin mesad, directed strongly proximad, stout at the base, tapering, slightly curved; subgenital plate of the male cymbiform, keeled, hardly reaching to the middle of the cerci, the apical margin subrectangulate emarginate, styles short and tapering. Ovipositor over twice as long as the head and pronotum together, straight and subequal in the proximal two-thirds, tapering and very slightly curved dorsad in the apical third, apex acute and with its margins very faintly crenulate; subgenital plate rather short and broad, bullate, the immediate apex subtruncate. Caudal femora with the proximal half moderately inflated, in length about equal to two-thirds that of the tegmina, the external face with traces of a loricate pattern, ventral margins unarmed or with a single spine.

General color clay-color, distinctly green in life, some traces of the original color remaining; head varying from ochraceous to brick red, particularly along the median area of the face; dorsum of the pronotum and head marked more or less distinctly with a pair of fine ferruginous lines diverging caudad; eyes drab; antennæ raw umber finely annulate with vandyke brown, becoming uniform very dark brown distad.

Measurements.

	♂	♀
Length of body,	22 mm.	18 mm.
Length of pronotum,	4.6 "	4.5 "
Length of tegmen,	25.5 "	25.4 "
Length of caudal femur,	17.8 "	17.5 "
Length of ovipositor,		15.2 "

A single paratypic female has been examined in addition to the types. It is very slightly larger than the female type, but otherwise inseparable.

The three specimens secured were taken from a marshy sink-hole in pine woods.

Xiphidion fasciatum De Geer.

A series of twenty-four individuals represent this widely distributed form, taken as follows: Jacksonville, August 11, two males, three females; Gainesville, August 16 and 17, three males, four females; Cedar Keys, August 15, three males, eight females; Fairfax, Barnwell County, S. C., August 10, one male.

The environments represented are a city lot (Jacksonville), undergrowth in pine woods and sink-hole in the same (Gainesville), and open marsh (Cedar Keys).

Xiphidion nigropleurum Bruner.

Sixteen individuals are referred tentatively to this species, as there exists a possibility that one or more distinct species are included in the Florida material. The localities represented are: Gainesville, August 16, one female; Pablo Beach, August 11, one female; Cedar Keys, August 15, seven males, seven females.

When compared with Nebraska and Indiana males of undoubted *nigropleurum* the Cedar Keys individuals are as a rule larger; all belong to the brown form described by Blatchley,[17] with the pronotum very dark mesad. The tegmina are as rule somewhat shorter than in typical *nigropleurum* males and the cerci are slenderer and slightly more produced. Variability in the divergence of the apices of the

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[17] *Orth. of Indiana*, p. 376.

latter is a very distinct feature, but otherwise the general form of the cercus is much the same in all the seven males.

The Florida females present very puzzling degrees of variation in the curve of the ovipositor. When compared with two Indiana females of true *nigropleurum* the ovipositor is seen to be slightly deeper in all the Florida specimens, straight as in the Indiana individuals in one Florida representative, very slightly curved dorsad at the apex in three and gently but appreciably curved in the remaining five. These types seem to shade one into the other, although the individuals with the ovipositor curved average somewhat larger, one, however, being no larger than in the opposite category. The tegmina vary from half the abdominal length to equal length, the latter seen only in one specimen. The variation in the ovipositor is irrespective of locality, both extremes having been taken at Cedar Keys. Until more evidence is in hand to prove the two extremes distinct, we are under the necessity of considering them purely variations within specific limits, and the same is true with the differences noted between the typical *nigropleurum* and the Florida forms or variants.

At Gainesville this species was taken in pine woods, and at Cedar Keys in salt marsh grass, where specimens were extremely abundant and although very active easily taken with the net.

The range of this species is here carried south from the Ohio Valley and New York State.

Odontoxiphidium apterum Morse.

A series of 101 specimens represents this very distinct genus and species, taken at the following localities: Pablo Beach, August 11, 12 and 13, thirty-five males, thirty-seven females; San Pablo, August 13, one male; Gainesville, August 16, twelve males, twelve females; Cedar Keys, August 15, three males, one female. Several specimens from each locality except San Pablo are immature, in some cases apparently two stages before the mature condition.

In size there is considerable variation, as previously evidenced by the measurements in the original description, while the color variations are almost wholly in the intensity of the median dark bar and in the extent of pale brown suffusion on the limbs.

A variety of environments are frequented by this species, ranging from dry palmetto scrub and undergrowth in pine woods to grassland, tall fresh marsh grass and salt marsh. The species was found most plentiful in the low parts of the open palmetto scrub at Pablo Beach. The insects were noticed to prefer the damp locations, but none were found in true marshlands. At Gainesville, also, specimens were abundant in the low places in the pine woods where the wire-grass was most luxuriant. Individuals were usually sufficiently inactive to be caught easily, with or without a net.

The range of this species now extends from Thomasville, Thomas County, and Brunswick, Glynn County, Ga., to Cedar Keys, Levy County, and Sanford, Orange County, Fla.

Atlanticus gibbosus Scudder.

Four adults, three males and one female, taken at Pablo Beach, August 11 and 14, represent this species. The individuals collected were taken in palmetto scrub and salt marsh and the species was not common.

As the information regarding this species is very meagre, measurements of an individual of each sex are here given.

	Pablo Beach, Aug. 11, 1905. ♂	Pablo Beach, Aug. 11, 1905. ♀
Length of body,	29 mm.	28 mm.
Length of pronotum,	13 “	12.5 “
Length of caudal femur,	32.2 “	34.5 “
Length of ovipositor,		29.2 “

This species possesses greater strength in the jaws than any other North American orthopterous insect known to us. A single bite can easily pierce the cuticle and cause the blood to flow. In consequence the field collector quickly acquires a wholesome respect for their defensive abilities. Individuals showed surprising activity in escaping when alarmed by seeking hiding places under the scrub palmettoes, to which they hurried with seeming ungainliness but nevertheless considerable speed.

GRYLLIDÆ.

Mogoplistes slossoni Scudder.

A single male individual was found August 12, in a bed at the hotel at Pablo Beach where the authors stayed. The specimen is considerably rubbed and in consequence the silvery scales of the perfect insect are almost entirely gone. The antennæ show no signs of annulations, but the limbs are supplied with imperfect and irregular rings of blackish brown and pale ochre.

The measurements of the specimen are as follows:

Length of body,	8 mm.
Length of pronotum,	2.8 “
Caudal width of pronotum,	2 “
Length of caudal femur,	4 “
Length of styles,	6.2 “

The range of this species now extends from the Biscayne Bay region north to Pablo Beach.

Liphoplus krugii Saussure.

This interesting species is represented by eleven individuals, adults and nymphs, representing two stages. The localities represented are: Pablo Beach, August 11, 12 and 13, two adult males, one immature male, three immature females; San Pablo, August 13, one adult male, two immature females; Gainesville, August 16, one immature male, one adult female. At Pablo Beach it was taken in grassland, under boards and beaten from weeds; at San Pablo and Gainesville it was found in the undergrowth in pine woods.

The adult male of this species has the pronotum considerably extended over the dorsum of the abdomen as in *Cycloptilum* and *Ectatoderus*, but the presence of a tambourine on the cephalic tibiæ as well as the divided interantennal process distinguishes *Liphoplus* from both of the allied groups. The measurements of an adult male and female are here given.

	Pablo Beach, Fla. ♂	Gainesville, Fla. ♀
Length of body, ...	8.6 mm.	8.2 mm.
Length of pronotum, ...	4.2 "	2.5 "
Length of caudal femur, .	5.2 "	5.3 "
Length of ovipositor, ...		5.8 "

The species is now known to range north into Florida as far as Pablo Beach and San Pablo; Key West, the Bahamas, and Cuba being the only localities from which it has previously been recorded.

Nemobius socius Scudder.

Nine individuals represent this species, which possesses three phases rather similar to those of *N. fasciatus*. The localities represented are: Pablo Beach, August 11 and 12, two males, three females; Gainesville, August 16, one female; Bronson, Levy County, August 16, one male; Cedar Keys, August 15, one male, one female. At Pablo Beach it was found in wet and dry grass, and at Gainesville in the brush in pine woods.

The phases of this species are as follows: A long-winged type with the tegmina reaching nearly to the apex of the abdomen and the wings long caudate; another apparently wingless with the tegmina similar to the first form described; a third wingless and with the tegmina hardly reaching caudad of the middle of the abdomen. Each of these phases is represented by three individuals in the series before us, and, possibly by coincidence, all the three with the short tegmina are from the Gulf coast or drainage, the previously recorded specimens of this phase also being from that coast at Tampa.[18] However, one of the long-winged type is from Bronson, Levy County, not far from the Gulf, while both types described first are from Pablo Beach.

Some specimens are decidedly more blackish than others, and color pattern visible in the more brownish specimens is obliterated in the blackish individuals.

This species is known to range from Georgia south to Charlotte Harbor, Fla., and west to the Gulf coast of Texas.

Nemobius ambitiosus Scudder.

This species, probably the most attractive of our forms of the genus, is represented by a series of thirty-five individuals from the following localities: Pablo Beach, August 12, one immature female; San Pablo, August 13, one female; Gainesville, August 16 and 17, seventeen males, sixteen females. At San Pablo and Gainesville the undergrowth in pine woods was its favorite habitat, while at Pablo Beach it was found in palmetto scrub.

A very perceptible amount of variation in the shade of the base color of the tegmina and of the cephalic markings is noticeable, some individuals having these parts more brownish than others. The yellow line bordering the eye caudo-laterad is also absent or faint in several specimens, the same being true of the medio-longitudinal line on the external face of the caudal femora. In general size there is considerable variation, but the tegmina appear to be of a comparatively uniform length.

This species ranges from southern Georgia (Thomasville) to Miami, Dade County, Fla. The localities in addition to the above from which it has been recorded, all in Florida, are Leon County, Fort Reed and Sanford, Orange County; Jacksonville, Duval County; Ormond, Volusia County; Tampa, Hillsboro County; Charlotte Harbor and Indian River.

Gryllus rubens Scudder.

The localities at which this species was taken are Jacksonville, August 10, one male; Pablo Beach, August 13, one female; Gainesville, August 16 and 17, two males, one nymph. At Gainesville both the pine woods undergrowth and open field were the situations in which specimens were taken; at Jacksonville a city park, and at Pablo Beach grassland.

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[18] *Proc. Acad. Nat. Sci. Phila.*, 1905, p. 50.

Œcanthus quadripunotatus Beutenmüller.

A male from Cedar Keys, August 15, and a female from Pablo Beach, August 13, represent this species. Both individuals were swept from grass.

Anaxipha exigua (Say).

A single male of this species was taken at Gainesville, August 16, from the wire-grass in pine woods, in company with *Falcicula*. In size it agrees with Pennsylvania and Delaware males.

Falcicula hebardi Rehn.

This sprightly little cricket was taken at but one locality, Gainesville, August 16. Here it was abundant in the wire-grass in long-leaf pine woods, apparently, however, quite local, and very elusive when located on account of its very protective coloration. As Gainesville was the only locality aside from San Pablo which is in any way similar to the type locality of the species, the lack of suitable environment was no doubt the reason it was not observed elsewhere. At San Pablo, our stay was too limited to be a fair test of the locality. The series captured comprises ten males, thirteen females and one nymph.

The range of this species in the southeastern States is from Thomasville, Thomas County, Ga., to Gainesville, Alachua County, Fla.

Hapithus quadratus Scudder.

A single male of this species was taken at Pablo Beach, August 11. When compared with males of *H. agitator* from New Jersey and Pennsylvania, the Florida form is seen to be larger with distinctly longer caudal limbs, the mediastine vein of the tegmen also having more numerous and more regular rami.[19]

Measurements of *quadratus* and *agitator* are as follows:

	agitator		*quadratus*	
	Riverton, N. J.	Tinicum, Pa.	Pablo Beach, Fla.	Miami, Fla.
	♂	♀	♂	♀
Length of body, . .	9.8 mm.	10 mm.	9.5 mm.	14.5 mm.
Length of pronotum, .	1.5 "	1.8 "	2 "	2.5 "
Length of tegmen, .	5.5 "	5.6 "	6.5 "	9 "
Length of caudal femur,	7.5 "	7.5 "	9.8 "	11.1 "
Length of ovipositor, .		7.2 "		9.6 "

Hapithus brevipennis Saussure.

A series of four adult males and five immature individuals represent this species, the localities being Pablo Beach, August 12 and 13, two

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[19] *Vide* Rehn and Hebard, *Proc. Acad. Nat. Sci. Phila.*, 1905, p. 52.

adults and two nymphs; San Pablo, August 13, one adult; Gainesville, August 16, one adult and two nymphs, and Cedar Keys, August 15, one nymph.

At Gainesville and San Pablo it was found in the undergrowth in pine woods, at Pablo Beach in palmetto scrub and along a railroad embankment, and at Cedar Keys in salt marsh.

The range of this species now extends from Louisiana to Georgia, south to Pablo Beach and Cedar Keys, Fla.

THE EMBRYOLOGY OF FULGUR: A STUDY OF THE INFLUENCE OF YOLK ON DEVELOPMENT.

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I. INTRODUCTION.

1. GENERAL.

It is generally believed that the accumulation of yolk in the eggs of certain animals has greatly modified their original manner of development. For example, selachians, reptiles and birds are probably derived from animals in which the eggs contained much less yolk than at present in these classes, and in which the development was different in many respects from that which now obtains among these forms. The effect of the loss of yolk upon development has been studied experimentally by Morgan (1893), but the influence of an increase in the amount of yolk, while the protoplasmic portion of the egg remains the same, has not been studied experimentally, and may perhaps lie beyond the test of experiment.[1] Such experiments, however, nature has performed in several different phyla of animals, but nowhere are natural conditions more favorable for a study of the influence of yolk on development than among the mollusks. Brooks (1879) long ago called attention to this fact, though it has not been reinvestigated in the light of the modern cellular study of development.

The comparison of the development of large eggs with that of small ones, with especial reference to the organization of the egg and the history of the cleavage cells, should be of considerable general interest. Does a great accumulation of yolk change the localization of morphogenetic processes and substances in the egg? Does it alter the developmental history and destiny of the blastomeres? Is the yolk itself localized in any definite germinal region of the egg? In what manner does a great mass of yolk alter the gastrulation and later embryonic development? These are questions upon which a detailed comparison

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[1] The fusion of different eggs to form giants, such as occurs abnormally in certain cases, is not a case in point, since the relative amount of yolk and protoplasm remains the same in the fused eggs as in the single ones.

of the normal development of large and of small eggs might be expected to shed some light. Undoubtedly experiments, if they could be successfully performed, would be of great value in answering these questions, but in the case of the gasteropods which I have studied I have not found it possible to test these questions experimentally.

The development of gasteropods is extraordinarily varied in respect to the manner of nourishing the embryo and larva. In some cases, and these presumably the more primitive, the eggs are small and contain little yolk and the free swimming larvæ (veligers) are set free at an early age to shift for themselves (*e.g., Crepidula plana, Patella, Acmæa*, etc.). In others the eggs contain a larger quantity of yolk and the free-swimming life is correspondingly reduced (*e.g., Crepidula fornicata, Illyonassa*, etc.). In still others the eggs contain a yet greater quantity of yolk and the veliger stage is passed entirely within the egg capsules, the young escaping in practically an adult condition (*e.g., Crepidula convexa* and *adunca, Urosalpinx, Sycotypus, Fulgur*, etc.).

A most curious and interesting method by which nutriment is supplied to the embryo is found in those gasteropods in which a large number of relatively small eggs is laid, only a few of which develop, the others being eaten as food by the developing embryos (*e.g.*, *Purpura, Buccinum, Fasciolaria, Neritina*, etc.).

For the purposes of the present study the only instances which we shall consider are those in which the food for the developing embryos is contained within the egg in the form of yolk. The early development of a considerable number of gasteropods is now well known, but most of these belong to that group having relatively small eggs. It has seemed to me worth while to compare with these the development of the largest gasteropod egg of which I have any knowledge, viz., that of *Fulgur carica*. The eggs of this species are about one-sixteenth of an inch in diameter; those of a closely allied form, *Sycotypus canalliculatus*, are about one-twenty-fifth of an inch in diameter. The eggs of *Fulgur* are about thirteen times the diameter and about 2,200 times the volume of the eggs of *Crepidula plana*, with which I shall particularly compare them. I have also studied several other species in which the eggs are intermediate in size between these two extremes, as shown by the following table:

Fulgur	*carica,*	1,700 μ	in diameter.
Sycotypus	*canalliculatus,*	1,000 μ	"
Crepidula	*adunca*	410 μ	"
"	*convexa,*	280 μ	"
"	*fornicata,*	182 μ	"
"	*plana,*	136 μ	"

The great difference in the sizes of these eggs is not due to a proportionate difference in all their constituents, viz., protoplasm as well as yolk, but almost entirely to the varying amounts of yolk which they contain, and this fact suggests the possibility of examining the influence of yolk upon development by comparing the development of one of the largest gasteropod eggs with one of the smallest.

A paper on the embryology of *Fulgur* was published by McMurrich (1886) more than twenty years ago. This paper deals in a general way with the development of this genus, questions of cell lineage and egg organization being at that time almost unknown. Further reference to McMurrich's work will be made throughout the course of this paper. A subsequent paper by the same author (1896) deals with the yolk lobe and centrosome of *Fulgur*. Some features in the development of this form were also considered by me (1897) in a paper dealing more particularly with *Crepidula*. Other than this the development of *Fulgur* has not been made the subject of any detailed study.

2. BREEDING HABITS.

For the sake of completeness I shall here mention some observations on the breeding habits of *Fulgur* and *Sycotypus*. In both of these forms the eggs are laid in peculiar disk-shaped or lenticular capsules which are attached in a series along a central cord. With the exception of the first few capsules formed, which are small and usually contain no eggs, each capsule contains from ten to twenty eggs embedded in a gelatinous substance which fills the capsules.

The method of forming the peculiar string of capsules characteristic of these genera is sufficiently interesting to merit a brief description. During the process of egg-laying, the foot of the female is contracted and partially withdrawn within the shell. A mucous-like secretion is then poured out from the nidamental organ through the folds of the partially contracted foot, and this secretion is applied to some solid object to which it adheres, or it is merely buried in the sand. In the case of *Fulgur* this first formed portion of the "string" is buried deeply in the sand; in certain specimens of *Sycotypus* which I kept in a wooden car, or float, the egg string was attached to the boards of the car. The first formed capsules on the string are small, far apart and contain no eggs. Later formed capsules increase in size and in the number of eggs contained in each, and successive capsules lie closer together on the string. During the process of laying the female is quiescent, and is usually buried beneath the surface of the sand, only the siphon protruding. The eggs, surrounded by the albumen and the secretion which forms the capsules, are poured out of the oviduct into a small cavity in the folded foot. Here the capsule-forming material comes into contact with the sea water and hardens, after which the capsule is released from the foot and another is formed. The average length of time taken by *Sycotypus* in forming a capsule is about three hours, and as the "egg string" may contain as many as seventy capsules, the egg laying may cover a period of several days.

The eggs of *Fulgur* are laid at Beaufort, N. C., during the months of May and June principally.[2] *Sycotypus* lays its eggs at Woods Hole late in August or early in September. The rate of development in these gasteropods is very slow. I can give no definite figures as to the length of the period of development, since the eggs which have been brought into the laboratory do not long continue to develop normally, but from such evidence as I have been able to gather I conclude that the development within the capsules occupies several months; indeed I have frequently found egg strings in midwinter with partially developed embryos, indicating that the eggs which are laid in the fall may not hatch until the following spring. As might be expected where eggs are so greatly laden with yolk, the entire embryonic and larval development is passed within the egg capsules and the young hatch in practically an adult condition.

3. METHODS AND MATERIAL.

The eggs of *Fulgur* and *Sycotypus* are very soft and are difficult to preserve. When removed from the very thick jelly in which they are enclosed within the capsules they usually flatten into thin disks under their own weight, or become otherwise distorted. There are no egg membranes except those formed by the surrounding gelatinous substance, and the thin pellicle of protoplasm which surrounds the egg is too weak to preserve the spherical shape or even to retain the yolk unless the eggs are floating in water or jelly. Since the jelly must in most cases be removed before the fixation of the eggs, special means must be employed to prevent them from bursting or becoming distorted. Many rapid fixing fluids, such as hot sublimate, alcohol and alcohol-acetic mixtures, cause the eggs to crack open, or even to split into fragments after they have been apparently well fixed. After experimenting with many fixing fluids, the only successful method of preservation which I have found, is to open one side of the capsule

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[2] I wish here to acknowledge my indebtedness to Hon. George M. Bowers, U. S. Commissioner of Fisheries, and to Dr. Caswell Grave, Director of the Fisheries Station at Beaufort, for the many courtesies extended to me while I was at the Beaufort Station.

and place the capsule containing the eggs in the jelly in 20 per cent. formalin for an hour or two, and then shake the eggs out of the jelly into a mixture of 20 per cent. formalin and 70 per cent. alcohol, equal parts, afterwards transferring them to 80 per cent. alcohol. Unfortunately this method leaves shreds of the jelly adhering to the eggs, and as these shreds stain intensely they interfere with the study of the eggs, which are to be stained and mounted entire. To preserve eggs entirely free from the jelly I have found it advisable to slit open the jelly and allow the eggs to drop out into a tall jar of 20 per cent. formalin, or into a mixture of pure formalin (40 per cent.) and a saturated solution of corrosive sublimate, equal parts. If the jar is quite tall (at least eighteen inches) the eggs may be sufficiently hardened before they reach the bottom to preserve their spherical shape, especially if there is a layer of absorbent cotton at the bottom of the jar. After a preliminary hardening in this fluid the eggs may be transferred to other fixing fluids or to alcohol. These eggs were then stained in dilute Delafield's hæmatoxylin, and were mounted entire in the manner described by me (1897, 1902) for other kinds of eggs.

II. CLEAVAGE.

1. THE UNSEGMENTED EGG.

I have made no attempt to study the phenomena of maturation and fertilization in these eggs since they are particularly unfavorable for such work, owing to the difficulties of fixation, already referred to, and to the great quantity of yolk, which make the eggs difficult to section.

The most striking feature of the unsegmented egg is the extremely small quantity of the nuclear and cytoplasmic material as contrasted with the yolk. The area of cytoplasm and the nuclear spindle shown in Plate XXIII, fig. 1, are but little larger than in the egg of *Crepidula*, though the entire egg of *Fulgur* is about 2,000 times the volume of the egg of *Crepidula*. The great increase in the size of the egg of *Fulgur* as compared with that of *Crepidula* is due almost exclusively to the increased quantity of the yolk.

2. FIRST AND SECOND CLEAVAGES.

It is one of the surprises connected with the development of this egg that although the yolk is so abundant the cleavage is yet holoblastic. When this work was first begun I had thought that the cleavage in this egg, which is larger than the eggs of many cephalopods, might show some resemblances to the meroblastic cleavage of the cephalopod egg. However, this is not the case, for the cleavages, at least as far as the 56-cell stage, are identically like those of *Crepidula* save for the enormous size of the macromeres. In the positions of the mitotic spindles, the direction and rhythm of division, and the shapes, relative sizes and number of the micromeres these two genera are practically identical. In the later development of *Fulgur* the yolk cells do not divide, although their nuclei do, and this may be an approach to the condition found in meroblastic eggs. Many characteristic differences appear between *Fulgur* and *Crepidula* in the later cleavages, and this fact is another evidence in favor of the view, which I have maintained elsewhere (Conklin, 1897, 1898), that the form of the early cleavage is more constant than that of the later cleavage; indeed the early cleavage pattern may be reckoned as one of the most conservative features in the development of any gasteropod.

The first cleavage divides the egg into two equal cells, one of which forms the anterior half of the future animal, the other the posterior half (fig. 2). At the close of this cleavage the nuclei and cytoplasmic areas rotate first in a dexiotropic and then in a læotropic direction, as in *Crepidula*, showing that the first cleavage is spiral in character.

During the first cleavage and again during the second a small lobe is formed at the vegetal pole, which again fuses with one of the macromeres at the close of the cleavage. This is the yolk lobe which has been observed in so many different animals. In forms in which the first two cleavages are equal this lobe is small, *e.g.*, in *Crepidula* it is quite inconspicuous, in *Fulgur* it is larger but still not more than one-sixth the diameter of the macromere; in forms in which the first two cleavages are unequal this lobe may be larger than the macromeres, *e.g., Urosalpinx.* McMurrich mistook this lobe for the polar body, but afterwards (1896) corrected this mistake.

The second cleavage is at right angles to the first and divides the egg into right and left halves. It is not possible to affirm that the median plane of the future animal coincides precisely with the second cleavage plane, but it is evident that the two are very nearly, if not exactly, coincident. In this respect, as also in the læotropic position of the spindles and the relative positions of the daughter nuclei and spheres, this cleavage is similar to the corresponding one of *Crepidula.*

It is a surprising fact that a mitotic figure so small as that shown in fig. 1 can bring about the division of so large a cell. It does not seem possible that the mechanical influence of the amphiaster could cause so large a result, except as it may serve as a stimulus to other forces. It is doubtful too whether cytoplasmic movements of a vortical nature are sufficient to explain the division of a cell body in which there is so small an amount of cytoplasm and so large a quantity of yolk. The superficial layer of cytoplasm is so thin and weak that at first thought it would seem incapable of constricting and ultimately dividing this great cell. But although the factors named seem inadequate to produce so large a result it must be borne in mind that the yolk is relatively soft, almost fluid, and that a considerable quantity of cytoplasm is distributed through the yolk at this stage; furthermore the rate of division is extremely slow, many hours being necessary for the completion of each of the first two cleavages. These are the only equal divisions of the entire yolk which I have seen. Although the four macromeres give rise to many cells in the course of development they still constitute the chief volume of the embryo as late as the veliger stage (pl. XXVIII, fig. 31), thus showing that the yolk content of these cells has remained practically as in the 4-cell stage.

3. SEGREGATION OF THE GERMINAL LAYERS.

The third cleavage is very unequal and separates the first quartet of micromeres from the macromeres in a dexiotropic direction (pl. XXIII, fig. 4); these cells come to lie in the furrows between the macromeres, and their shape is consequently like the corresponding cells in *Crepidula*.

The fourth cleavage (fig. 4) separates the second quartet of micromeres from the macromeres in a læotropic direction. In anticipation of this cleavage the nuclei with the surrounding cytoplasm rotate læotropically until they lie in the upper left-hand corner of each cell, then the mitotic figures appear and the cleavage takes place precisely as in *Crepidula* and other gasteropods.

The first quartet cells then divide læotropically, giving off at their peripheral borders the "turret cells," and a little later the macromeres again divide in a dexiotropic direction, giving rise to the third quartet (fig. 5). Simultaneously the cells of the second quartet divide dexiotropically. These divisions are shown in figs. 5 and 6. As a result of these divisions twenty micromeres are formed, of which eight belong to the first quartet, eight to the second and four to the third (fig. 6). The entire ectoderm comes from these twenty cells. The micromeres are composed almost entirely of cytoplasm and are relatively free from yolk; in the macromeres the cytoplasmic areas surrounding the nuclei lie at the periphery of the cap of micromeres. The visible quantity of the cytoplasm has increased very considerably since the beginning of cleavage, as is readily seen by comparing figs. 1 and 6. This is probably due to the segregation of cytoplasm, originally distributed through the yolk, into the micromeres and cytoplasmic areas of the macromeres, rather than to the conversion of yolk into cytoplasm, since the yolk becomes less fluid and more firm during this period.

In *Fulgur* and *Sycotypus*, as in every other gasteropod so far studied, there are only three quartets of ectomeres. This is especially interesting in view of the enormous size of this egg, where we might expect, if anywhere, to find a much larger number of micromeres formed. McMurrich supposed that a large number of micromeres were budded off from the macromeres in *Fulgur*, and that the number of such micromeres varied with the size of the egg. Viguier (1898) and Fujita (1895) also reached the same conclusion, maintaining that the number of quartets formed in *Tethys* and *Siphonaria* is greater than three. This view is in my opinion wholly without foundation. Whether the egg be large or small three quartets of ectomeres are formed, no more and no less, and by the subdivision of the cells of these quartets all the ectoderm of the embryo is formed. In the cases cited by Viguier and Fujita it can readily be seen, from their own figures, that they have mistaken the subdivision of certain quartet cells for the formation of new quartets from the macromeres.

Since there are only three quartets of micromeres in *Fulgur*, and since these cells must overgrow the enormous yolk, it would seem reasonable to expect that the rate of subdivision of these quartets would be accelerated, as compared with forms in which the yolk is small. However this is not the case; the first quartet divides about the time of the formation of the second quartet, and the latter divides coincidently with the formation of the third quartet, just as in *Crepidula*. In much later stages the micromeres do divide more rapidly, but the early subdivisions of the three quartets is not more rapid in the case of this largest of gasteropod eggs than in the case of the smallest. In every respect except the size of the macromeres, the early cleavage of *Fulgur* is almost identically like that of *Crepidula* or any other prosobranch. In the number, position, shapes and relative sizes of the micromeres and in the positions and sizes of the nuclei and spheres there is the closest similarity between the largest and smallest of gasteropod eggs.

The next division is a highly characteristic one for annelids and mollusks, viz., the formation of the first member of the fourth quartet, 4*d*, by læotropic cleavage of the left posterior macromere.

After its formation it moves over into the furrow between macromeres *D* and *C*, as shown in pl. XXIV, fig. 8. This cell, 4*d*, is formed in advance of the other members of the fourth quartet and it contains a considerable quantity of yolk. In all of these regards it resembles the corresponding cell in all annelids and mollusks, with the exception of the cephalopods, in which the cell-lineage has been studied.

But the feature of particular interest in this cell is its destiny rather than its origin. In all annelids and mollusks, so far as known, the anterior portion of this cell gives rise to most of the mesoderm, while from its posterior portion the terminal part of the alimentary canal arises. This cell is therefore known as the mesentoblast. The history of this cell in *Fulgur* conforms entirely to what we know of it in other forms, as will appear later.

With the formation of the mesentoblast the segregation of the substances of the different germinal layers is nearly completed. I have not observed that the substances composing the mesentoblast differ visibly from those of the ectoblasts and entoblasts, except in the quantity of yolk which these different cells contain. But in *Limnæa*, *Physa* and *Planorbis* I have been able to distinguish the substance of the ectomeres from that of the mesomeres and entomeres before the first cleavage of the egg. In these fresh-water snails, therefore, there is a definite localization of the substances of the different germinal layers, and I have elsewhere shown reason for believing that it is the fact of this localization which determines that the ectoblast shall be separated in three quartets, and that the mesoblast shall arise from one cell of the fourth quartet. Since the segregation of the germinal layers occurs in exactly the same way in *Fulgur* as in these other gasteropods, it seems probable that there is here also the same type of localization of the germinal substances of the egg, and that the enormous accumulation of yolk in this egg has not altered in any fundamental way the localization of its various substances.

The other members of the fourth quartet, 4*A*, 4*B* and 4*C*, are not formed until the 50-cell stage (fig. 9). They are much larger than the cell 4*d* and contain a much greater quantity of yolk. Because of their great size I shall speak of them as the "secondary macromeres." These cells are purely entoblastic in character and give rise to a portion of the alimentary canal. In every one of these details they closely resemble the corresponding cells of *Crepidula*.

4. FURTHER HISTORY OF THE ECTOMERES.

The further history of the three quartets of ectomeres may now be followed through the development up to the time when they give rise to the first recognizable organs. About the time of the formation of the cell 4*d* all of the twenty micromeres divide so that forty micromeres are formed, as shown in fig. 8 (in this figure all the micromeres have divided or are dividing except the two posterior turret cells, which divide a little later, fig. 9). The directions of these divisions and the relative sizes of the daughter cells is the same as in *Crepidula*, and the time at which the divisions occur is also the same, except that the turret cells divide earlier in *Fulgur* than in *Crepidula.*

The latest stage to which I have been able to trace with certainty the lineage of every cell is shown in fig. 9. At this stage there are present the following cells:

Ectomeres.	42
Mesentomeres.	6
Entomeres.	7
Total	55

Fig. 10 shows spindles in two cells of the second quartet, and when the divisions here indicated are completed in the four quadrants the number of cells of known lineage is raised to 59. As a result of this work on the early cleavage it may be affirmed with confidence that in *Fulgur* the lineage of every cell up to about the 60-cell stage is identically like that of *Crepidula.*

a. The First Quartet.—Ectodermal Cross.—In *Crepidula* and many other prosobranchs one of the most striking appearances in the early history of the ectomeres is the formation of the so-called "ectodermal cross." This cross is composed of all the cells of the first quartet, except the turret cells, and of four cells of the second quartet, one of which forms the tip or terminal cell of each arm of the cross. The center of the cross lies exactly at the animal pole, and one of the four arms is anterior, one posterior, one right, and one left. This ectodermal cross, composed of exactly the same cells as in *Crepidula*, is present in *Fulgur* also (fig. 9 *et seq.*). It is not, however, so distinctly marked off from the other micromeres as in *Crepidula*, and it is therefore much more difficult to trace its subsequent history. In pls. XXIV, XXV, figs. 8–16, the outlines of the cross are shown in heavy lines, the center of the cross is marked by a short cross line, and the tip of each arm is lightly stippled. In fig. 8 the cross consists of three cells in each quadrant, an "apical," a "basal" and a "tip" cell (the anterior tip cell is not yet formed). In fig. 9 the basal cells in the right and left arms have divided, and in fig. 10 the basal cell of the anterior arm has also divided. There are at this stage four apical cells and three cells in each arm of the cross, except the posterior one which contains but two. Later, as shown in fig. 11, the basal cell in the posterior arm also divides and at this stage the cross consists of sixteen cells. Still later the apical cells bud off small cells between the bases of the arms, the "rosette" cells of *Nereis* and *Crepidula* (fig. 12). In every one of these details of cleavage the history of the cross in *Fulgur* is like that in *Crepidula*. The latest stage in which I have been able to identify all the cells of the cross is one slightly later than the one shown in fig. 12. At this stage the cross consists of the following cells:

Apicals	4
Rosettes	4
Basals	7
Middles	7
Terminals	4
Total	26

In later stages the entire cross cannot be recognized with certainty. In figs. 13–16 the center of the cross, where the apical cells meet, can be located, and the terminal cells may be seen more or less clearly, but the other cells cannot always be surely identified. In fig. 13 the arms of the cross can be plainly seen, each consisting of four cells in a single linear series, as well as the four derivatives of the turret cells which lie between the arms of the cross, but the apical and rosette cells cannot be identified. In fig. 14 the cross is scarcely apparent at all, and no part of it can be identified with certainty. In fig. 15 a cross is shown with four cells in a series in each arm, just as in fig. 13. Fig. 16 shows a central plate of cells surrounded by heavy lines which probably represents the cross; the center of the apical cells may be recognized, more or less doubtfully, at the place marked by the cross line, and the terminal cells are indicated by the stipples. Midway between the terminal cells on each side of the plate is a group of four cells, also enclosed in heavy lines, which are the derivatives of the turret cells. There are thirty-six cells in the cross in this latest stage in which it is recognizable, eight of which are derived from the second quartet. Deducting these second quartet cells and including the turret cells, we find that there are forty-four cells of the first quartet shown in pl. XXV, fig. 16.

In *Crepidula* seven large cells of the anterior arm of the cross form a peculiar "apical cell plate," while a number of large ciliated cells derived from the posterior arm and the posterior turret cells form a large "posterior cell plate," which becomes the head vesicle of the larva. In *Fulgur* none of these structures are visible at any time, and although the cross may be recognized clearly enough in its earlier stages, it is quite evident that it is not so definite a landmark here as in *Crepidula*, where its cells may be identified with great certainty up to a stage where it consists of sixty-six cells. The turret cells in *Crepidula* grow to an enormous size and remain undivided up to a stage with more than 100 cells; in *Fulgur* they do not become larger than the other cells of the first quartet, and they divide twice before the 100-cell stage, as shown in figs. 13 and 16.

b. Second and Third Quartets of Ectomeres.—As far as I have been able to follow the lineage of these cells in *Fulgur*, it coincides precisely with that of the same quartets in *Crepidula*. The first subdivision of the second quartet in *Fulgur* is shown in fig. 7; the first division of the third quartet and the second of the second quartet in figs. 8, 9 and 10. As a result of the divisions indicated in these figures two cells of the third quartet and four of the second are formed in each quadrant of the egg. By the divisions indicated in fig. 10 one additional second quartet cell is formed in each quadrant, and by the spindles shown in fig. 12 still another cell is formed, making six second quartet cells in each quadrant of the egg shown in fig. 12. All the third quartet cells then divide, as indicated by the spindles in two of the cells in fig. 11, thus giving rise to four third quartet cells in each quadrant. In figs. 12–16 there are six cells of the second quartet and four of the third in each quadrant. Every one of these ten cells has its homologue in the corresponding stages of the egg of *Crepidula*.

This is as far as I have traced the lineage of all the cells of the second and third quartets, though individual cells of these quartets may be recognized in later stages (fig. 17). These cells of the second and third quartets are in general larger than those of the first quartet, which they completely surround. The third quartet cells are especially large, and in some cases (figs. 13, 15, 16) are quite as large as the derivatives of 4*d*.

In the stage shown in fig. 16 there are eighty-eight ectomeres as follows:

First quartet cells	44
Second quartet cells	28
Third quartet cells	16
Total	88

5. FURTHER HISTORY OF THE MESENTOMERES.

The cell 4*d*, formed at the 24-cell stage by læotropic division of the macromere *D*, undergoes dexiotropic cleavage into two equal cells, $4d^1$ and $4d^2$ (fig. 9). At first these two cells lie to the left of the median plane, but they later shift position so that the plane of division between them comes to coincide with the plane of bilateral symmetry. The next division of these cells separates an anterior protoplasmic portion from a posterior yolk-laden one (fig. 9), and this process is repeated at a slightly later stage (fig. 12), thus giving rise to six cells derived from the cell 4*d*, three on each side of the median plane.

Of these cells the two anterior ones on each side are small protoplasmic cells which lie wholly under the layer of ectodermal cells; these cells give rise to the mesoblastic band of each side. The posterior cells are much larger and contain a considerable quantity of yolk; they are only partially covered by the cap of ectodermal cells (fig. 12); they ultimately give rise to the terminal portion of the intestine. I have not followed in detail the cell lineage of these cells in later stages, owing in part to the fact that they lie close under the thin layer of ectoderm, and it is frequently difficult to distinguish one from the other in surface views. However it is sufficiently evident that these cells show fundamental resemblances in origin, history and destiny to the mesentoblast cells of *Crepidula* and other gasteropods. The "mesoblastic bands" of *Fulgur* do not present a single series of cells, as in some annelids and mollusks, but rather a broad, irregular band of cells which has the general form of the letter Y. The stem of the Y lies in the median plane behind the area of the shell gland, while its two branches diverge on each side of this structure (figs. 19–24).

Some distance in front of the anterior ends of these bands a few cells appear beneath the ectoderm, which are probably the homologues of the "larval mesoderm" of other forms (figs. 19–22). They are in close relation to the ectoderm cells which give rise to the cerebral ganglia. I have not followed these "larval mesoderm" cells until they give rise to mesodermal structures, but have classed them as mesoderm because they lie beneath the surface and resemble in appearance the cells of the mesodermal bands.

6. THE ENTOMERES.

Up to a stage when there are approximately fifty cells in the entire embryo the entomeres consist of the four macromeres only. These macromeres are all of about the same size, and they contain an enormous quantity of yolk as compared with the amount of protoplasm. Each macromere contains an area of cytoplasm relatively free from yolk, in which lie the nucleus and sphere. These cytoplasmic areas lie as near as possible to the animal pole and to the free surface of the cell; with the extension of the cap of ectomeres these cytoplasmic areas with their enclosed nuclei and spheres are not overgrown by the ectomeres, but they move out over the yolk at the margin of the ectodermal cap, and this position they retain until the blastoderm has overgrown much of the yolk (pl. XXVII, fig. 26).

At a stage of about fifty cells, the macromeres *A*, *B*, and *C* divide in a læotropic direction, giving rise to the remaining members of the fourth quartet, 4*A*, 4*B* and 4*C* (fig. 9). These cells are very large and full of yolk, and for these reasons I have called them "secondary macromeres." They come to lie in the furrows between the macromeres, and in this position they are partly overgrown by the advancing ectoderm and partly shoved before it. They serve as an excellent means of orienting the egg and embryo, since they are found at the right, left and anterior poles only, the posterior pole being occupied by the derivatives of the much smaller mesentoblast cell, 4*d*.

The secondary macromeres are purely endodermal in character. Although their nuclei subdivide (pls. XXV, figs. 17, 18, *et seq.*), their cell bodies usually remain undivided until the closure of the blastopore (pl. XXVIII, fig. 31). Throughout all of this period the entomeres consist of the four macromeres and of these three secondary macromeres. Even as late as the gastrula stage, shown in fig. 31, these are the only entoderm cells present except those derived from the cell 4*d*, which give rise to the terminal portion of the intestine (*In.*, figs. 29–31).

In *Crepidula* a fifth quartet of cells, which are purely entodermal in character, is formed from the macromeres about the time of the closure of the blastopore; and at the same time the cells 4*A*, 4*B* and 4*C* divide. These divisions have not been observed in *Fulgur*, but, with these exceptions, the origin, history and destiny of the entomeres of *Fulgur* are almost precisely like those of *Crepidula*. The four primary macromeres are similar in all regards, save only in bulk; the secondary macromeres arise at the same cell stage and behave in the same manner in these two genera. In *Crepidula*, as in *Fulgur*, these seven cells, together with the entoblastic derivatives of the cell 4*d*, constitute for a long period the whole of the entoblast.

With the stage represented by fig. 17, in which there are about 121 cells, the ectomeres become so numerous that their lineage cannot readily be traced. At a slightly later stage, regions of the blastoderm begin to differentiate into characteristic structures. We shall therefore consider this stage as the close of the cleavage and the beginning of the period of organ formation.

In conclusion we find that the cleavage of *Fulgur* resembles that of *Crepidula* in almost every detail. Such slight differences as do exist, as, for example, in the relative development of the "cross" in the two forms, are only such as frequently exist between other genera in which the eggs are about equal in size. In short the enormous size of the *Fulgur* egg, which has so greatly altered the relative proportions of cytoplasm and yolk, and of micromeres and macromeres, has not modified in the least the pattern of the cleavage. It has not modified the localization in the egg and the segregation in the cleavage of the substances of the germinal layers. In all of these respects the egg of *Fulgur* is typically like that of other gasteropods, and it shows no approach whatever to the condition found in the eggs of cephalopods.

7. RELATIVE SIZES OF NUCLEI AND CELLS.

The great quantity of yolk in the egg of *Fulgur* introduces some interesting cytological conditions. I have already called attention (p. 325) to the extremely small nuclear spindle in the first cleavage, and to the problem of how this little spindle and the small amount of cytoplasm around it can bring about the division of so great a cell body. Another, though related, problem is found in the relative sizes of the nucleus and cell body at different periods of the cleavage.

In all the early cleavages the nuclei and spindles are very small, even in the macromeres (figs. 1–6). Indeed the nuclei and spindles in the macromeres are not larger than those in the micromeres during the formation of the three quartets. After the formation of the third quartet (fig. 7) there is a relatively long resting period for all of the macromeres except *D*, consequently the nuclei in *A*, *B*, and *C*, fig. 8, have grown to nearly double the diameter of those in fig. 7. The macromere *D* divides before its nucleus becomes very large, giving rise to the mesentomere, 4*d*. About the 50-cell stage, fig. 9, the macromeres *A*, *B*, and *C* divide, giving rise to the secondary macromeres 4*A*, 4*B*, and 4*C*. The mitotic figures for this division are quite large and are proportional in size to the resting nuclei from which they arise.

From this stage onward the nuclei of all the macromeres enjoy a long "rest," during which they grow to double their maximum diameter at any previous stage (figs. 9–24). The greatest diameter of the nucleus during the 2-cell and 4-cell stages is about 40 μ; during the formation of the three quartets the nuclear diameter is not greater than this, but rather smaller; before the formation of the secondary macromeres (fig. 8) the diameter of the nuclei in *A*, *B*, and *C* is about 50 μ; at the close of their long rest and just before their next division (fig. 24) the nuclei are about 80 μ in diameter.

The diameter of the unsegmented egg is about 1,700 μ; that of each of the macromeres during the formation of the quartets about 970 μ; while in the stages after the formation of the fourth quartet it is somewhat less, say about 900 μ. Therefore, although the diameter of the cell body in these later stages is but little more than half that of the unsegmented egg, the nuclear diameter is twice as great as at any previous stage.

The ratio of the nuclear diameter to the cell diameter, the "Kernplasmarelation" (k/p) of Hertwig (1903), is about 1 : 40 in the unsegmented egg; about 1 : 24 in the 4-cell to 24-cell stages; about 1 : 20 just before the formation of the secondary macromeres; and about 1 : 12 at the close of the long resting period of the macromeres, shown in fig. 24.

In the micromeres of the 8–24-cell stages the ratio of the nuclear diameter to the cell diameter is about 1 : 5; and in the later stages, such as fig. 18, it rises to 1 : 3.

It seems perfectly evident from these figures that the absolute size of the nucleus is dependent not only upon the size of the cell, but also upon the length of the resting period; and by the same showing the length of the resting period is not determined primarily by the size of the nucleus. In all the earlier divisions of the macromeres of *Fulgur* the division comes on when the nucleus is relatively small (k/p = 1 : 24); in later stages it does not come on until the nucleus has grown to twice this size (k/p = 1 : 12).

In *Crepidula* I found (1902) that the size of the nucleus, chromosomes, centrosomes, spindles and asters was, in the last analysis, proportional to the volume of the cytoplasm, and I tried to show that the immediate cause of division was the growth of the nucleus to a point where the ratio of nucleus to cytoplasm exceeded a critical limit. This is certainly not the principal factor which brings on division in *Fulgur*; and the fact that mitosis may occur in one cleavage when the nucleus is relatively small and in another not until it becomes very large, suggests that the moment of division may be dependent upon some intrinsic condition in the nucleus or centrosome, rather than upon the ratio of nuclear size to cell size. Support is lent to this view by the phenomena of oogenesis; here we have in the germinal vesicle the largest nucleus in the entire life cycle, following upon one of the longest resting periods, while the second maturation division follows immediately after the first; here also the moment of division seems to depend upon intrinsic conditions in the cell.

In the division of the cell body *Fulgur* presents some interesting conditions. Attention has been called to the fact that although the spindle in the first cleavage is very small the entire egg divides. Equally surprising is the fact that in the divisions of the primary and secondary macromeres subsequent to the formation of the fourth quartet. the nucleus only divides while the cell body remains undivided (figs. 17–28). The cell bodies of these entomeres do not divide again until very late in development, if at all; even in figs. 34 and 35, in which the embryo shows many definitive structures, the furrow between two of the original macromeres can be seen running obliquely through the region below the head vesicle (*H. V.*).

It seems to me that the following explanation may be offered of this apparent anomaly. In the early stages of development the cell substance is quite fluid, as has been pointed out (p. 326), whereas in the later stages the substance of the macromeres becomes much more consistent. In the later stages of development the macromeres do not show the tendency to burst or to undergo distortion during fixation, which is so troublesome in the earlier stages; this is, I believe, due to the greater consistency of the yolk during the later stages. This same difference in consistency may explain also the curious fact that the entire cell divides in the early stages, whereas only the nucleus divides in later stages.

In this connection attention may be called to the fact that there is apparently a great increase in the quantity of cytoplasm in the later stages, as compared with the earlier ones (cf. figs. 1, 6, 25). This increased quantity of cytoplasm might be due to the liquefaction of the yolk and its transformation into cytoplasm, or it might be the result of the segregation into the ectodermal cap of cytoplasm originally spread through the yolk substance. It is probable that both of these processes occur, but in view of the increasing consistency of the yolk during the period of quartet formation, it seems very probable that most of the cytoplasm of the early stages was present as such, but in a diffused form, in the unsegmented egg.

III. ORGANOGENY.

It has been shown that there are but few and minor differences between *Fulgur* and *Crepidula* in the cleavage up to a stage of about 100 cells (fig. 16). After this stage the differences in development become more marked. The first notable difference is found in the number of micromeres; by repeated divisions of the three quartets of ectomeres these cells become very numerous in *Fulgur,* as shown in figs. 17, 18, *et seq.*, whereas in *Crepidula* the number remains relatively small. It is evident that the same cell stages in the two no longer represent similar stages in differentiation; for example, the shell gland is one of the first organs to appear, and is first visible in *Crepidula* when there are about 250 cells present (Conklin, 1897, fig. 74); while it first becomes visible in *Fulgur* when there are about 1,000 cells (fig. 23). The period of the closure of the blastopore is very different in the two; in *Crepidula* this occurs before any organs are visible (fig. 65), in *Fulgur* only after almost all the larval and many of the definitive organs are present (fig. 31).

Other striking differences between *Fulgur* and *Crepidula* are found in the form and character of the different organs and in the time at which they appear, but most of all in the method of formation of these organs and in their relation to the yolk.

1. OVERGROWTH OF THE YOLK AND CONCRESCENCE OF THE EMBRYO.

Owing to the fact that the entomeres are so large in *Fulgur*, organs begin to differentiate long before the closure of the blastopore, indeed while the blastoderm is still a small cap at the animal pole of the egg (figs. 23–26). The organ bases are here spread out as in a mercator's chart, whereas in *Crepidula* the organ bases do not appear until the blastoderm has overgrown the yolk and they occur over the sphere, so that only a few of them can be seen from a single point of view.

In the earlier stages of *Fulgur* the organ bases occur in the anterior half as well as in the posterior portion of the blastoderm (figs. 21–23); later by the very rapid growth of the median anterior portion of the blastoderm these organ bases are displaced laterally and posteriorly until they come to form a kind of germ ring, or crescent, along the posterior margin of the blastoderm (figs. 24–28). This germ ring contains the bases of all the future organs, whereas the rest of the blastoderm forms a kind of yolk sac.

The manner of the overgrowth is represented diagrammatically in the accompanying text figure. The outlines of the blastoderm in successive stages of the overgrowth are indicated by the numerals 1–8. By superimposing on the same figure these different stages of the overgrowth it is possible to see at a glance the character and relative amount of the movement of the different organ bases. Thus in 1, the center of the blastoderm is approximately the center of the animal pole; in front of this lie the cerebral ganglia (*cb*) and velar row (*v*), while the buccal ganglia (*bc*) lie at the right and left margins of the blastoderm. Posterior to the animal pole is

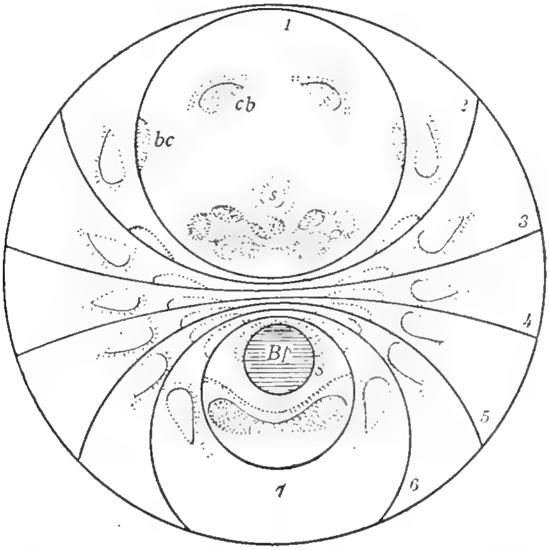

DIAGRAM illustrating the more important phases in the overgrowth of the yolk by the blastoderm in *Fulgur carica*. The outer circle represents the outline of the entire egg, and the smaller circles, numbered 1 to 8, represent the margins of the blastoderm in successive stages of the overgrowth. The egg is represented as seen from the posterior pole, and in order to bring all stages into one figure the arc through which the posterior margin of the blastoderm moves is represented as less than is actually the case. The outline of the blastoderm and the positions of the organ primordia in stage 1 correspond to figs. 25 and 26, plate XXVII; stages 2 and 3 correspond to fig. 27; stage 4 to fig. 28; stage 5 to fig. 29; stages 6 and 7 to fig. 30; stage 8 to fig. 31. In stage 1 the velar cells are represented as a double line of stipples anterior and lateral to the cerebral ganglia (*cb*); the buccal ganglia (*bc*) lie at the lateral margins of the blastoderm; immediately posterior to the shell gland (*s*) is the primordium of the intestine; on the left of this is the abdominal ganglion, and on each side of the latter are the parietal ganglia, the pleural ganglia, the otocysts and the pedal ganglia. In stages 2–7 the cerebral and buccal ganglia are represented in dotted outlines; in stages 1 and 8 they are stippled, as are the other primordia.

found an organ complex which includes the shell gland, intestine, abdominal, parietal, pleural and pedal ganglia, and the otocysts.

By the growth of the median anterior portion of the blastoderm, the cerebral ganglia and velar cells and the buccal ganglia are carried around to the successive positions indicated in the diagram, while the organ complex described above undergoes little movement. The diagram is faulty in that it shows too little movement of the organ complex of the posterior lip, and thus represents the final position of the blastopore too near the posterior pole, but it represents fairly well the relative movements of the different organ bases during the first four stages shown (1–4). Reference to the first and second cleavage furrows between the macromeres, shown in figs. 25–28, will show that the posterior margin of the blastoderm remains relatively fixed during this period, while at the same time the blastoderm extends forward and laterally; still later the blastoderm extends posteriorly also, and finally the blastopore closes at the vegetal pole (fig. 30).

2. APICAL INVAGINATION.

The first structure which appears in the course of development is an invagination of ectodermal cells just anterior to the animal pole and in the region of the anterior arm of the cross. This invagination is preceded by a broad depression of the blastoderm (fig. 18), and then the center of this depression becomes deeply cup-shaped (fig. 19), and finally tubular in form (fig. 20). The axis of this tubular invagination at first runs forward under the ectoderm; then it becomes perpendicular to the surface of the blastoderm; and subsequently it runs backward under the ectoderm, its opening being at its anterior end (fig. 20). The inner, blind end of this invagination lies near the anterior end of the polar furrow, and in some instances, though not in all, a few cells are separated from the invagination at this point. The anlagen of the cerebral ganglia are formed on the right and left of this invagination, but they do not appear to be derived from it. Similarly a few mesoderm cells, which probably correspond to the "larval mesoderm" of other mollusks, lie on each side of the invagination, though they are not derived from it (see the black nuclei in figs. 19 *et seq.*).

Subsequently this conspicuous and definite structure completely flattens out and disappears (figs. 21 *et seq.*), leaving not a trace behind. This fact seems so remarkable and the significance of the invagination is so problematical that I have devoted considerable time and effort to the study of it.

It is evident that this invagination is not merely the result of the sinking in of the blastoderm over a cavity in the yolk. There is frequently a cavity between the macromeres, but this invagination invariably lies anterior to this cavity, and in many cases it actually forces its way into the substance of the yolk. In some cases also a prominent evagination is formed instead of an invagination, showing that there is very active growth in this region of the blastoderm.

It seems to me probable that this invagination is a mechanical adaptation to secure a rapid extension of the anterior half of the blastoderm over the yolk. During the growth of the invagination the area of the blastoderm remains stationary, or actually grows smaller; as soon as it flattens out there is a very rapid increase in the area of the blastoderm (cf. figs. 20 and 21), especially of that portion lying anterior to the first cleavage plane. Coincidently with this increase in area the secondary macromere, *4B*, begins to move forward in the furrow between the macromeres and the blastoderm rapidly extends forward. The remarkable extent of the growth of this anterior portion of the blastoderm may be seen by comparing the positions of the organ bases in figs. 19–30. In the earlier figures the shell gland and the two cerebral ganglia form the angles of an isosceles triangle, the base of which is directed forward (figs. 21 and 22); in later stages the ganglia separate more widely and the triangle becomes equilateral (figs. 23 and 24); still later the cerebral ganglia are separated so widely that they lie in line with the shell gland (figs. 27 and 28); and finally the cerebral ganglia again approach each other on the ventral side of the embryo (figs. 29 and 30). The greatest growth of the blastoderm takes place in the area between and in front of the cerebral ganglia, in the very region of the apical invagination, and it seems reasonable to suppose that the remarkable growth of this region is associated with the formation and subsequent flattening out of this structure.

McMurrich (1886) described at some length this invagination, and he compared it with a similar formation observed by Blochmann (1883) in *Neritina*, and by Sarasin (1882) in *Bythinia*. He says: "It seems very strange that an invagination so well marked as it is in *Neritina* and *Fulgur* should disappear and leave no trace of its existence, but so it seems to do." His further conclusion that it would be found to occur in most, if not all, of the prosobranch gasteropods has not been justified by later studies.

3. SHELL GLAND, SHELL AND MANTLE.

The shell gland is one of the earliest and largest of the developing organs, and is the one most instrumental in shaping the form of the embryo. It appears as an aggregation of ectodermal cells in the median plane posterior to the apical pole (figs. 21, 22). These cells, which are probably derived from the cell *2d*, increase greatly in number and form a saucer-shaped depression (figs. 23–26, *Sh.*). This depression then becomes deeper and smaller in surface area (figs. 27, 28) and subsequently it evaginates in the manner characteristic of gasteropods, the margin of the gland forming a ridge, the mantle edge, while the center is covered by the cuticular substance which forms the earliest shell; beneath this shell is a very thin layer of ectoderm, in which the nuclei are few and far apart. The margin of the shell gland, or mantle edge, is at first circular in outline; then it becomes uniformly elliptical (figs. 29 and 30); finally it continues to extend in all directions, except where it comes into contact with the organ complex on the ventral side of the embryo; here the growth of the mantle edge is arrested, and consequently a notch in the developing shell and mantle appears here, which notch grows deeper as the mantle edge extends farther (figs. 31–36).

The area covered by the shell grows larger continually and the yolk appears to slip through the ring formed by the mantle edge, while at the same time the blastoderm and its organ anlagen are retained in front of this ring. In this way the yolk slips out of the anterior portion of the embryo, and the tension on the blastoderm being relieved in this manner, the latter is free to undergo the foldings necessary to form the head vesicle, velum, larval kidney and heart; at the same time the mantle edge, continuing to grow forward on the dorsal side, gives rise to the mantle fold and mantle chamber. On the ventral side the forward growth of the mantle edge is stopped by the organ complex (figs. 35, 36).

In the earlier stages of this overgrowth, the mantle edge and organ complex are apparently bilaterally symmetrical; in later stages it can be seen that the organs are more developed on the right side (left in ventral view) than on the left, and consequently the notch in the mantle edge is displaced from the median plane toward the right. In this way the assymetry of this gasteropod makes its appearance. Along the left side of the notch (right in ventral view) a cellular thickening of the blastoderm occurs near the mantle edge (figs. 34, 35, *CmM.*) which gives rise to the columellar muscle, while the shell formed along this portion of the mantle edge is the columella.

It is well known that in annelids the ectoderm of the trunk is derived from the ectomere $2d$ ($=$ X). In *Fulgur, Crepidula* and several other gasteropods, cells derived from the ectomere $2d$ give rise to the mantle edge and fold and to the layer of cells covering the yolk under the shell. This fact suggests that the elongation of the embryo through the ring of the mantle edge may possibly be comparable to the elongation of the trunk of the annelid.

4. NERVOUS SYSTEM AND SENSE ORGANS.

In their earliest stages the organ bases may be recognized by the fact that the nuclei are closer together and the protoplasm stains more deeply than in other portions of the blastoderm. In the case of the nervous system certain of the ganglia are from the first clearly distinguishable, whereas some others in the organ complex posterior to the shell gland (fig. 23) cannot be distinguished until a later stage.

a. Cerebral Ganglia.—The group of cells which will form the cerebral ganglia appears at a very early stage. It is shown in figs. 19 and 20 on each side of the apical invagination, and closely connected with the group of cells lying beneath the superficial layer, which I have identified, somewhat doubtfully, with the "larval mesoderm" (fig. 21, *Lm.*). The cells which give rise to the cerebral ganglia arise in the region of the blastoderm, on each side of the anterior arm of the cross and in front of the transverse arms, probably from the "rosette" cells, exactly as in *Crepidula,* and they probably correspond in origin as well as destiny to the cells of the "cephalic neural plate" of *Nereis* (cf. Conklin, 1897, p. 110).

With the great growth of the anterior part of the blastoderm, which follows the flattening out of the apical invagination, these cerebral ganglia are carried laterally until they lie near the margin of the blastoderm (figs. 21, 22, *Cb.*). In figs. 23 and 24 they lie still nearer the margin, and their protoplasm and nuclei are somewhat more condensed than in the previous stage; the bases of all the organs now stain more deeply and they are all connected together by deeply staining protoplasm (figs. 23, 24). In all these stages the cerebral ganglia lie anterior to the middle of the blastoderm and are the anteriormost organs present. Later they are carried back until they lie in the posterior lip of the blastopore and at opposite ends of a transverse line which lies nearly in the plane of the first cleavage, and along which line most of the organ bases of the embryo are found (text fig. and figs. 27, 28). Still later, by a continuation of the movement already described, the cerebral ganglia are carried posterior to the first cleavage plane and to the other organs of the posterior lip, and they then approach each other on the ventral side of the embryo, and come to lie on each side of the blastopore (figs. 29, 30). This movement of the cerebral ganglia may be better described by pointing out their position with reference to the shell gland, which may be considered as a fixed point. In earlier stages the shell gland forms the apex of an isosceles triangle, the other angles being formed by the cerebral ganglia; then by the separation of the ganglia the triangle becomes equilateral, and still later the angle at the apex increases until the ganglia and the shell gland lie in one straight line; then by a continuance of the movement of the ganglia a triangle is formed on the opposite (ventral) side of the shell gland, which develops in the inverse order of that on the dorsal side (text figure). In the stages shown in figs. 30 and 31 the cerebral ganglia lie lateral and slightly posterior to the blastopore; in fig. 32 they lie on the sides of the blastopore, and a process is growing out from each toward the other in front of the blastopore; in fig. 33–36 they lie in front of the blastopore and are closely connected together by the cerebral commissure.

Along the posterior edge of each cerebral ganglion a leaf-like process is formed which is the tentacle (figs. 35, 36, *T.*), and at the outer end of the furrow which separates the tentacle from the blastoderm the eye appears (figs. 34–36).

b. Buccal Ganglia.—Lateral and slightly posterior to each cerebral anlage is a group of cells which gives rise to the buccal ganglion (figs. 22, 23, *Bc.*). These cells lie at the very periphery of the blastoderm and are probably derived from the ectomeres 2*a* and 2*c*. In the overgrowth of the yolk they accompany the cerebral ganglia, moving from the dorsal to the ventral side in the posterior lip of the blastopore (figs. 27–29), and finally coming to lie along the posterior border of the blastopore (fig. 30). When the blastopore closes the buccal ganglia of the two sides come into contact on the posterior side of the blastopore (fig. 31 and text figure).

c. Pleural, Pedal, Parietal and Abdominal Ganglia.—The other ganglia of the nervous system form part of the complex of organs lying between the shell gland and the posterior lip of the blastopore. The pleural ganglia lie on each side of the shell gland and on the lateral borders of the organ complex (figs. 23, 24); the pedal ganglia lie on the median side of the pleurals; close behind the shell gland are the groups of cells which give rise to the parietal and abdominal ganglia. The anlagen of these ganglia are not clearly separated at this time, and only in the later stages (fig. 28 *et seq.*) are they quite distinct. When the foot begins to appear (fig. 31) the pedal ganglia are included within it, and the pleural ganglia lie on each side of the foot, while the otocysts lie between the two (fig. 28 *et seq.*). The otocysts are here, as elsewhere, formed as an invagination of the superficial ectoderm. All the ectodermal organs of this region are derived from the cell 2*d*, with the possible exception of the pleural ganglia, which lie on the lateral borders of the organ complex and may therefore come, in part, from the cells 3*c* and 3*d*. In annelids the ectoderm of the trunk region and the ventral neural plate, which gives rise to all the nervous system posterior to the mouth, come from this same cell, 2*d*, the "first somatoblast." Lillie (1895) found the same condition among lamellibranchs.

Among the gasteropods this cell is not larger than the other members of the second quartet, but it is destined to give rise to all the important ectodermal organs posterior to the mouth. In this fact we have a striking illustration not only of the value of cell-lineage in comparative embryology, but also of the fundamental similarity of annelids, lamellibranchs and gasteropods.

The parietal and abdominal ganglia, with their connectives, are recognizable as thickenings of the blastoderm in a stage as early as fig. 28, but they are not clearly distinguishable until a later stage (figs. 30, 33, 34). In these figures the entire nervous system is easily recognizable. The cerebral ganglia are connected by the cerebral commissure anterior to the mouth, and they are united with the pleurals and pedals by the cerebro-pleural and the cerebro-pedal commissures respectively on each side of the œsophagus. The parietal ganglion of the left side lies almost directly behind the foot, and is connected with the pleural of the left side by the pleuro-parietal connective; the parietal of the right side lies on the right side of the foot and is connected with the pleural of that side, while the two parietals are connected together by the nerve loop which runs alongside of the intestine and near its middle bears the abdominal, or visceral, ganglion.

In these and the following stages (pl. XXVIII, figs. 35 and 36) the entire nervous system and the twisting of the parietal loop may be seen with diagrammatic clearness. This twisting, which is a part of the general movement toward the right of all the organs posterior to the foot, carries the left parietal ganglion to the right side of the foot, where it lies in contact with the right pleural, while the abdominal lies still farther toward the right and the dorsal side (fig. 36); at the same time the right parietal is carried up to the dorsal midline, where it lies on the dorsal side of the œsophagus (fig. 36). The entire nervous system, except the buccal ganglia, which are here hidden from view by the cerebrals, is shown in very nearly its definitive position in fig. 36. All of the six pairs of ganglia may be recognized in fig. 39, and four pairs are recognizable in fig. 23.

In all of these regards the nervous system of *Fulgur* shows fundamental resemblances to that of *Crepidula*. To one who had not observed the earlier stages in the origin of the cerebral ganglia it might seem that these ganglia, which lie so near the periphery of the blastoderm and so closely connected with the other organs of the posterior lip, could not possibly have arisen from cells of the first quartet anterior to the transverse arms of the cross. It is only by a study of the early history of these ganglia and their subsequent movements that one can determine that the cerebral ganglia, and indeed all the ganglia, arise in corresponding parts of the egg in *Fulgur* and *Crepidula*. Such a study shows that amidst all the differences in the mode of development of these ganglia, there is the most fundamental resemblance in their places of origin in the egg, and that therefore the localization of the germinal substances of the egg in the early cleavage cells follows the same pattern in these two genera.

5. THE VELUM.

The velum arises in close relation to the cerebral ganglia, and its place of origin furnishes another striking illustration of what are apparently fundamental differences between *Fulgur* and *Crepidula*, but which are in reality fundamental resemblances. In *Fulgur* the velum is first visible as a dense band of nuclei on the median and posterior sides of the cerebral ganglia (fig. 28, *V.*). These velar bands are widely separated from one another and are entirely disconnected. In later stages these velar bands more completely encircle the cerebral ganglia; each has somewhat the form of a parabola, one limb of which runs forward in the lip of the blastopore, while the other, which lies posterior to the cerebral ganglion, runs out towards the lateral regions of the embryo and there ends in the general blastoderm (figs. 29, 30). Subsequently, when the blastopore narrows and closes, the two limbs which run forward in its lips unite in front of the mouth (figs. 31, 32), while the lateral limb turns forward over the sides of that portion of the embryo which will become the head vesicle (figs. 33, 34). From the posterior side of each band there is given off a branch which runs across the embryo posterior to the mouth and there joins its fellow of the opposite side, thus giving rise to the post-oral band, while that portion of the velum which runs in front of the mouth is the pre-oral band. Both of these bands were observed and described by McMurrich (1886).

In subsequent stages the velum is drawn out into a prominent bilaminar fold (figs. 35, 36). This velar fold or lobe grows out to a very great size, much larger than is shown in fig. 36, the ciliated velar cells being borne around its edge, as in other prosobranchs. By the beating of these cilia it is probable that the embryos are able to move very slowly within the egg capsules, though they never swim freely, the young escaping from the capsules only after the velar lobe has been absorbed. The velum in *Fulgur* is not a highly sensitive and contractile organ, as in *Crepidula* and in many other forms; apparently, it cannot be retracted, even in its most fully developed stage, and it is needless to say that in the stage shown in fig. 36 there is no cavity into which the velum, the head or the foot could be retracted.

From the preceding account it is evident that during the later stages of its development the velum in *Fulgur* is much the same as in *Crepidula* or any other prosobranch. In its early history, however, it seems to be altogether different. It appears, as has been said, on the median and posterior side of the cerebral ganglia when these structures lie far apart in the posterior margin of the blastoderm (fig. 28); in *Crepidula* it first appears about the time of the closure of the blastopore as a transverse row of cells in front of the mouth. In *Fulgur* it consists of two bands of cells on opposite sides of the embryo, which are entirely separate from each other; in *Crepidula* it is a single structure continuous from side to side.

However, in spite of these striking differences, it can be shown, I think, that the velum has a similar origin in both of these genera. Traces of the velum in *Fulgur* may be found at a much earlier stage than that shown in fig. 28; thus in fig. 23 a row of what I take to be velar cells may be seen on the lateral and anterior sides of the cerebral ganglia (the nuclei of these cells are shown in heavy outline). The position of this row of cells indicates that it has arisen from the cells adjoining the ganglion on the anterior and lateral sides, and since the ganglia themselves come, in all probability, from the "rosette" cells, the velar cells must have come from the anterior "turret" cells and perhaps also from the terminal cells of the transverse arms of the cross. In short, the velar cells arise in *Fulgur* in the same region and probably from the same cells as in *Crepidula*. Here again, as in the case of the cerebral ganglia, there is fundamental agreement between *Fulgur* and *Crepidula* in the early and late stages in the development of the velum; it is only in those stages of the overgrowth of the yolk, which are undoubtedly highly modified in *Fulgur*, that we find striking differences between these two genera.

6. BLASTOPORE, MOUTH AND ŒSOPHAGUS.

By the very great growth of the blastoderm in the region of the apical invagination the anterior portion of the blastoderm rapidly surrounds the yolk, while its posterior margin, containing all the organ bases, remains relatively fixed in position near the animal pole (figs. 25–28). Subsequently this posterior margin also extends over the yolk to such an extent that the blastopore finally lies at the vegetal pole of the egg (fig. 30). The anterior lip of the blastopore is always composed of an extremely thin layer of cells, and this portion of the blastopore is usually circular in outline; the posterior lip of the blastopore is always composed of a thicker layer of cells than the anterior lip, and it is not circular but is compressed laterally, as shown in fig. 30.

The blastopore then narrows until it is almost if not entirely closed (figs. 31, 32), and an invagination of ectoderm cells occurs here, which is the stomodæum. The mouth is formed at the very place where the blastopore closes, and the œsophagus is formed by the elongation of the stomodeal invagination (fig. 36, *Œ.*).

In the closure of the blastopore and the formation of the mouth and œsophagus *Fulgur* completely resembles *Crepidula.*

7. INTESTINE AND OTHER PORTIONS OF THE ALIMENTARY CANAL.

The intestine is formed from enteroblast cells derived from the mesentomere 4*d*. These enteroblasts lie in the midline behind the shell gland and they constitute the stem of a Y-shaped group of cells, the branches of the Y being the mesodermal bands (figs. 22, 23). In its earliest stages the intestine is a round, densely staining group of cells, which lies at a lower level than surrounding portions of the blastoderm. After the posterior margin of the blastoderm has extended over to the ventral side of the embryo, the intestine lies between the margin of the shell gland behind and the visceral nerve loop and abdominal ganglion in front (figs. 28–30).

About the time of the closure of the blastopore the anlage of the intestine elongates toward the right (left in ventral view), becoming at first elliptical in shape (fig. 31) and then tubular (fig. 32 *et seq.*). Up to the time of this elongation it lies in the median plane; after this it, together with other organs posterior to the foot, moves to the right. The end of the intestine which remains nearest the midline is the anal end, though the anus does not form until a much later period; the end farthest to the right is the gastral end. The intestine lies just in front of and parallel with the edge of the shell; in fig. 32 its course is nearly transverse to the long axis of the embryo, the notch in the shell being at this stage very shallow. As the shell grows forward on the dorsal side more rapidly than on the ventral, this notch grows deeper, and the right edge of the shell becomes parallel with the long axis of the embryo (figs. 33–35); at the same time the intestine turns from a transverse to a longitudinal course. The visceral nerve loop accompanies the intestine in this movement, the abdominal ganglion always lying close to the mesial side of the intestine.

Finally the mantle cavity begins to form on the mesial side of the intestine, and the latter is thus carried into the roof of the mantle chamber, the anal end of the intestine remaining near the mantle edge, while the gastral end reaches to the deepest portion of the mantle chamber (fig. 36). In all of these details as to the formation of the intestine there is striking similarity between *Fulgur* and *Crepidula.*

In *Crepidula* the gastral end of the intestine opens into a lumen between the yolk cells, which give rise to the stomach and liver. In *Fulgur* I have observed no such lumen between the yolk cells, and while I think it probable that these cells form the stomach and liver in this animal, I have not traced their history far enough to speak with certainty upon this point. In *Fulgur* as in *Crepidula* the secondary macromeres lie at the inner end of the stomodæum (fig. 31), and they probably form that section of the alimentary canal immediately following the stomodæum.

8. THE FOOT.

The development of the foot is practically the same in *Fulgur* as in other prosobranchs. It appears as a thickening of that portion of the blastoderm lying between the otocysts behind, the blastopore in front, and the pedal ganglia on the sides (figs. 29 and 30). It is at first wide in transverse direction and narrow antero-posteriorly and it is bilobed, the two lobes being separated on the side of the blastopore by a groove in which the blastoderm remains thin (figs. 30 *et seq.*). The foot then gradually rises above the general level of the blastoderm until it becomes prominent, becoming about half as wide from side to side as in earlier stages (figs. 33, 34); at the same time it takes into itself the pedal ganglia and otocysts.

At the posterior end of the groove between the two lobes an invagination is formed which becomes the pedal gland (*P. G.*, figs. 33, 34). A transverse furrow on the surface of the foot then constricts off a smaller anterior lobe, the propodium, from a larger posterior one, the mesopodium and metapodium (figs. 35, 36).

9. LARVAL AND DEFINITIVE KIDNEYS.

Running laterally from the foot a ridge of cells develops on the right and left sides; this ridge lies some distance posterior to the velum, with which it is nearly parallel; its free border, or crest, becomes crenated (figs. 34, 35, *Ex.K.*). This is the larval or external kidney and, as in other prosobranchs, consists of large ectodermal cells which become loaded with nitrogenous waste substances. It is an interesting fact that the larval kidney of *Fulgur* does not appear until after the basis of the permanent kidney is present (figs. 32, 33), and its relatively small size seems to indicate that it is never an important excretory organ in this animal. I have not observed the destiny of these excretory cells in *Fulgur*, but in *Crepidula*, where they are relatively larger, they are ultimately pinched off and set free with their load of nitrogenous waste. In *Fasciolaria*, as Glaser (1905) has shown, the external kidneys become colossal organs, which are filled with nitrogenous waste substance. Here the great size of these organs is probably associated with high metabolism of nitrogen, the result in this case of the cannibalism of the embryo. The small size of these organs in *Fulgur* probably indicates low nitrogenous metabolism in the embryo.

The definitive kidney has no structural connections with the larval ones. It appears as a single structure near the gastral end of the intestine (figs. 32 *et seq.*), and a duct develops from it which runs along the right side (left in ventral view) of the intestine (figs. 34, 35). As a result of the invagination which forms the mantle chamber, both the kidney and the intestine come to lie in the roof of that chamber, and since the kidney lies near the edge of the mantle it undergoes little movement during this invagination; the intestine, which lies farther from the mantle edge, moves under the kidney during this invagination, and thus the relative positions of these two organs are interchanged, the kidney coming to lie on the left side of the intestine (fig. 36).

10. GILL AND HEART.

At its earliest appearance the gill lies on the anterior side of the kidney and in close contact with it (figs. 33, 34). Before the formation of the mantle chamber it is merely an aggregation of cells and shows no characteristic structure. After the formation of the mantle chamber it lies on the left side of the kidney and its anterior border becomes crenated, each of these lobules giving rise later to a tentacle-like process.

The larval heart (figs. 35, 36, *L.H.*) appears as a blister under the blastoderm at the right of the larval kidney (fig. 34). The walls of this vesicle contain smooth muscle cells and are pulsatile. I have observed no definite vessels leading to or from this heart, and it probably serves merely to keep lymph moving through irregular channels. In later stages the larval heart is carried up on to the dorsal side of the embryo behind the head vesicle and velum (fig. 36); this movement is a part of the general twisting of all the organs, which were originally posterior to the foot.

I have not observed the manner of origin of the definitive heart and have not been able to recognize its anlage, unless it may be the dark body between the reference letters *M* and *Pa* in fig. 36.

IV. Conclusions.

The development of the principal organs and organ systems of *Fulgur* has now been described, with especial reference to their cell-lineage and topographical relations. It has not been possible to trace the entire cell-lineage of any organ, owing to the very large number of cells which are present before organs appear, but it is possible to determine the quartet and usually the individual cell of the quartet from which any organ arises. In a few cases (cerebral ganglion, velum, intestine) organs may be traced back to individual cells of a stage much later than the quartet formation, but in no case is it possible to observe every division of the cells which enter into the formation of an organ. This lack of a complete knowledge of the cell-lineage is not peculiar to *Fulgur*, but is general among forms in which the cell-lineage has been studied, and it is not a great hindrance to the study of the localizations of morphogenetic substances and processes of the egg. If groups of cells which give rise to certain organs can be traced back to certain quartet cells, this is usually sufficiently detailed information as to the cellular origin of an organ. In *Fulgur* it is unusually easy to trace this connection between blastomeres and organs, owing to the fact that the organs appear while the blastoderm is still a flat plate.

Next to the resemblances between *Fulgur* and *Crepidula* in the early cleavages, there is no similarity between these forms more striking than that which is found in the cellular origin of homologous organs. Although the organs of these two genera may differ widely in size and early position, there is not a single instance in which there is any good reason for supposing that these organs have arisen from unlike cleavage cells of the early stages. On the other hand, there is the best of evidence that homologous organs in *Crepidula* and *Fulgur* arise from corresponding cells of the different quartets, and even from corresponding cells of much later stages (60-cell stage), even though in still later stages these organs may occupy widely different regions of the embryo, as in the case of the cerebral ganglia.

With regard to the later cleavages, it is not only impossible to follow the lineage of individual cells until they give rise to organs, but it is certain that the cells of these two genera cannot be individually compared, since there are many more cells in *Fulgur* at a given stage of differentiation than in *Crepidula*. For example, there are about 250 cells in the embryo of *Crepidula* at the time of the first appearance of the shell gland, in *Fulgur* there are about 1,000 cells, and in any comparison of the cells at this stage it must be remembered that in general four cells of the latter are equal to one of the former. Not only does the number of cells differ in corresponding stages of differentiation in these two forms, but even in the same species there are variations and irregularities in the later cleavages which are not present in the earlier ones. When these irregularities of the later cleavages are compared with the invariable features of the early ones, such as the segregation of the ectoderm in three quartets of cells and the origin of the mesoderm of the trunk region from one cell of the fourth quartet, it is impossible to avoid the conclusion that the early cleavages are of greater morphogenetic value than the later ones. Furthermore, the conditions found in *Fulgur*, as compared with those in *Crepidula*, show that neither the presence of a large amount of yolk in the egg before cleavage, nor the modifications of the later stages, due to the presence of this yolk, affect the localization of the morphogenetic materials and processes in the earlier stages. The conclusion seems to be justified that the type of this localization is a more general and fundamental character than the form of gastrulation, or any other relatively late process in the ontogeny.

In *Fulgur* as in many other animals the egg shows polar differentiation while it is still in the ovary, and even before yolk formation begins. The yolk is laid down in all parts of the egg, and before maturation one pole is not noticeably richer in protoplasm than another. With the maturation of the egg the segregation of the protoplasm and yolk begins, most of the protoplasm passing to one pole and becoming the future ectoderm, while the yolk remains at the opposite pole and with a relatively small amount of protoplasm gives rise to the endoderm. In the first two cleavages this yolk is distributed equally to the four quadrants of the egg, and since the blastopore forms at the vegetal pole, the ectoderm must extend equally (but not synchronously) over the yolk in all directions. In the early stages of this overgrowth the anterior portion of the blastoderm extends more rapidly than the posterior portion, and by this means the cerebral and buccal ganglia are brought into close relation with the other organs present in the posterior margin of the blastoderm.

In many animals the yolk is not distributed equally to the four quadrants of the egg (*e.g.*, *Urosalpinx*, *Nassa*, *Dentalium*, *Chætopterus*, etc.), and wherever this is the case a "yolk lobe" of considerable size is present. When one macromere is much larger than the others a large yolk lobe is attached to it; when the cleavage is approximately equal the yolk lobe, if present, is small. Crampton (1896) has shown that the removal of the yolk lobe causes the absence of mesoderm in *Illyonassa*; and in his beautiful "Studies on Germinal Localization" Wilson (1904) has found that when the polar lobe of *Dentalium* is removed the resulting larva lacks the post-trochal region and probably also the mesodermal bands. Both of these authors found that following the removal of the lobe the four quadrants of the egg were equal in size. It cannot be assumed that the size of the lobe is proportional to the size of the somatoblasts 2*d* and 4*d*, or to the size of the post-trochal region, or to the quantity of mesoderm which is formed later. In *Fulgur*, *Crepidula* and all other cases in which the quadrants are nearly equal in size, the yolk lobe is much smaller than the post-trochal region or the mesentomere 4*d*, or even the mesodermal bands; while in *Illyonassa*, *Tritia*, and other forms in which one of the macromeres is much larger than the others, the yolk lobe is much larger than the cell 4*d*. On the other hand the lobe is usually associated with unequal division of the yolk, and its size is proportional to that inequality. Therefore I believe that the real significance of the yolk lobe is to be found in its relation to equal and unequal cleavage.

Since the blastopore forms at the vegetal pole in all gasteropods, so far as known, unequal division of the yolk must lead to unequal growth on the part of the blastoderm; if the posterior macromere is large the overgrowth must be greater in a posterior direction than in any other; if the anterior macromere is larger than the others, as in certain opisthobranchs, the blastoderm must grow more anteriorly than posteriorly. When all the macromeres are equal the overgrowth must take place equally in all directions, though the case of *Fulgur* shows that it may be accelerated at one time in one portion of the blastoderm and at another time in another portion.

The most striking difference between *Fulgur* and other gasteropods is found in the manner of this overgrowth, and consequently in the manner in which the different organ bases are carried from their point of origin to their definitive positions in the embryo. In both the point of origin and the definitive position of the various organs there is fundamental agreement between *Fulgur* and *Crepidula*, but in the manner of passing from their point of origin to their final position there is marked dissimilarity. In *Crepidula* the region of greatest growth of the blastoderm lies on the dorsal side between the anlagen of the cerebral ganglia and the shell gland; in *Fulgur* it lies anterior to the cerebral anlagen. In *Crepidula*, as a result of this condition, the cerebral ganglia are carried forward around the anterior end of the embryo until they come to lie anterior to the mouth on the ventral side. In *Fulgur* the same ganglia are carried backward around the yolk until they finally reach the same position on the ventral side of the embryo.

It has been customary hitherto to regard such peculiarities of the embryo as primary, and the associated peculiarities of cleavage stages as secondary adaptations to these later appearing peculiarities; but this puts the cart before the horse. The adaptations of cleavage are adaptations to conditions pre-existing in the egg, and not adaptations to conditions which appear later in the embryo or adult. Given the enormous yolk of *Fulgur* or the small yolk of *Crepidula plana*, and the embryo must adapt itself to these conditions of the egg; or, in other words, the earlier conditions in ontogeny stand in the relation of cause to the later conditions, and not the reverse.

When I first observed in *Fulgur* the great modifications in the location of organ bases, which is unlike anything hitherto described, and found, for example, that the cerebral ganglia and velum were located in the posterior lip of the blastopore, I thought, for a time, that here was a new pattern of germinal localization, and that the generalization that homologous structures always come from homologous regions of the egg had broken down. Further study has shown that this is not the case, and that the great modifications in the location of embryonic organs in *Fulgur* are not primary but secondary, while the localization pattern in the early cleavages is the same as in other gasteropods.

Hence I regard the case of *Fulgur* as a triumph for the method and doctrine of cell-lineage. Those who see in this method only 'the counting of cells,' 'mitotic book-keeping,' 'the drudgery of dull minds,' have missed the whole point and significance of this method, which is not to name every cleavage cell, but to determine in what areas of the egg certain morphogenetic processes are located. To know that such processes may be localized in the egg is valuable information, even though the pattern of this localization should differ for every animal; but to have discovered that through all the multifarious modifications which are found in the embryos and adults of great animal classes, such as the gasteropods or annelids, this same pattern runs unchanged,—this is illuminating.

SUMMARY.

1. The eggs of *Fulgur carica* are among the largest of gasteropod eggs, their relatively great size being due almost exclusively to the great quantity of yolk which they contain. These eggs are thirteen times the diameter and about 2,000 times the volume of those of *Crepidula plana*, with which particularly they are compared.

2. The cleavage of the egg of *Fulgur* is, cell for cell, like that of *Crepidula* up to the 56–60-cell stage, the only difference being in the

relative sizes of the macromeres in these two genera. Some of the individual features in which the cleavage of *Fulgur* resembles that of *Crepidula* are the following:

a. The direction, rhythm and quality of each cleavage is the same.

b. The first and second cleavages are equal; the first is transverse to the median plane of the embryo, the second coincides with that plane; a small yolk lobe is formed during each of these cleavages.

c. The ectoderm is segregated in three quartets of micromeres.

d. The first formed member of the fourth quartet, 4*d*, is the mesentomere; its anterior portion gives rise to the mesodermal bands and its posterior portion to the intestine.

e. The remaining members of the fourth quartet, viz., 4*A*, 4*B*, 4*C* are entomeres and give rise to all portions of the alimentary canal and its outgrowths, save the intestine and stomodæum.

f. The first quartet of ectomeres forms a "cross", with its centre at the apical pole and with anterior, posterior, right and left arms. Between the arms are the "turret" cells, and between these and the apical pole are the "rosette" cells; all of these cells are derived from the first quartet, except the "terminal" cells of the arms which are derived from the second quartet. The cross is formed of exactly the same cells in *Fulgur* as in *Crepidula*, but it is neither so distinct in form nor so persistent.

g. The second and third quartets surround the first and are composed of cells which divide in the same order and direction as in *Crepidula*.

3. In later cleavages many more ectoderm cells are formed in *Fulgur* than in *Crepidula* at corresponding stages of differentiation.

4. The overgrowth of the yolk is highly peculiar in *Fulgur*. By very great extension of the anterior half of the blastoderm, while the posterior half remains relatively fixed, all the organ bases are carried to the posterior margin of the blastoderm, where they form a kind of germ ring. Subsequently the posterior margin also moves over the yolk, so that the blastopore is finally formed at the vegetal pole.

5. Before the extension of the anterior portion of the blastoderm an apical invagination of ectoderm cells is formed in the region of the anterior arm of the cross. This invagination subsequently flattens out and completely disappears. Its function seems to be connected with the rapid extension of this part of the blastoderm.

6. The cerebral ganglia arise on each side of the apical invagination, probably from the anterior "rosette" cells. The velar cells arise around the outer margins of the ganglia, probably from the anterior

"turret" cells. By the rapid growth of the anterior portion of the blastoderm these organ bases are forced far apart and posteriorly until they come to lie in the posterior margin of the blastoderm, and by a continuation of this movement they are carried around to the ventral side of the embryo, where the two halves of these organs approach each other and finally unite in front of the mouth.

7. The paired buccal ganglia arise lateral to the cerebral and probably from derivatives of *2a* and *2c*; they extend over the yolk in the same manner as the cerebrals and finally concresce on the ventral side of the embryo posterior to the mouth.

8. All other organs (shell gland, pedal, pleural, parietal and abdominal ganglia, foot, intestine, kidney, gill, heart, etc.) arise from the median posterior portion of the blastoderm, and chiefly, if not entirely, from the two "somatoblasts," *2d* and *4d*. The bases of all of these organs, except the last three, appear when the blastoderm is still a small plate, and in the case of paired organs they are from the first connected across the median plane and do not, therefore, undergo concrescence. The origin of these post-oral organs from the two somatoblasts is strikingly like the condition found in annelids, and the elongation of the body of the gasteropod through the shell gland is similar to the elongation of the body of the annelid.

9. All homologous organs arise from corresponding cleavage cells in *Fulgur*, *Crepidula*, and probably all other gasteropods. Great increase in yolk does not modify the type of germinal localization, though it does profoundly modify gastrulation and later stages.

10. This indicates that germinal localization in the egg and in the cleavage stages is more fundamental and primitive than are the later processes of ontogeny.

CYTOLOGICAL.

11. During quartet formation the nuclei of the macromeres divide at relatively short intervals and they remain relatively small, the ratio of maximum nuclear diameter to cell diameter ("Kernplasma-relation" K/p) being 1 : 24. In later stages the resting period of the nucleus is very long and the ratio rises to 1 : 12. The size of the nucleus is therefore dependent not only upon the size of the cell, but also upon the length of the resting period. There is in this species no fixed ratio of nuclear size to cell size, and the cause of cell division cannot be found in the maintenance of a constant ratio.

12. After the formation of the fourth quartet the macromeres do not again divide, although the nuclei do. In the first and second cleavages the macromeres divide equally; this apparent anomaly is

probably due to the fact that cytoplasm is distributed through the yolk in the early stages and is lacking in the later ones. This suppressed cleavage of the yolk in the later stages is an approach to the condition found in meroblastic eggs.

References.

No attempt is made in this paper to review recent important contributions on cell-lineage, foremost among which must be mentioned the important memoirs of Robert (1903) on Trochus, Wierzejski (1905) on Physa, and Carazzi (1906) on Aplysia. The papers here listed are those mentioned in the body of this work.

Blochmann, F. 1882. Ueber die Entwicklung der *Neritina fluviatalis*, *Zeit. wiss. Zool.*, XXXVI.

Brooks, W. K. 1879. The Acquisition and Loss of Food Yolk by Molluscan Eggs, *Studies from Biol. Lab. Johns Hopkins University*, Vol. I.

Conklin, E. G. 1897. The Embryology of Crepidula, *Jour. Morph.*, XIII.

——. 1902. Karkokinesis and Cytokinesis in the Maturation, Fertilization and Cleavage of Crepidula, *Jour. Acad. Nat. Sci. Phila.*, Vol. XII.

Crampton, H. E. 1896. Experimental Studies on Gasteropod Development, *Arch. Entwm.*, III.

Fujita, T. 1895. Preliminary Note on the Mesoderm Formation of Pulmonata. *Zool. Mag. Tokio*, Vol. VII.

Glaser, O. C. 1905. Ueber den Kannibalismus bei *Fasciolaria tulipa* (var. *distans*) und deren larvale Excretionsorgane, *Zeit. wiss. Zool.*, LXXX.

Hertwig, R. 1903. Ueber Korrelation von Zell- und Kerngrosse und ihre Bedeutung für die geschlechtliche Differenzierung und die Theilung der Zelle, *Biol. Centralb.*, XXIII.

Lillie, F. R. 1895. The Embryology of the Unionidæ, *Jour. Morph.*, Vol. X.

McMurrich, J. P. 1886. A Contribution to the Embryology of the Prosobranch Gasteropods, *Studies from Biol. Lab. Johns Hopkins University*, Vol. III.

——. 1896. The Yolk Lobe and Centrosome of *Fulgur carica*, *Anat. Anz.*, XII.

Morgan, T. H. 1893. Experimental Studies on Teleost Eggs, *Anat. Anz.*, VIII.

Sarasin, P. 1882. Entwicklungsgeschichte der *Bythinia tentaculata*, *Arb. Zool. Inst. Würzburg*, VI.

Viguier, C. 1898. Contribution a l'étude du development de la *Tethys fimbriata*, *Arch. Zool. Exp.*, 3, XVI.

Wilson, E. B. 1904. Experimental Studies on Germinal Localization: I. The Germ Regions in the Egg of Dentalium, *Jour. Exp. Zool.*, I.

Reference Letters.

A, *B*, *C*, *D*, Macromeres.
1a, *1b*, etc., First quartet cells.
2a, *2b*, etc., Second quartet cells.
3a, *3b*, etc., Third quartet cells.
4d, Mesentoblast.
4A, *4B*, *4C*, Secondary macromeres.
A.I., Apical invagination.
Bp., Blastopore.
Cb., Cerebral ganglion.
Bc., Buccal ganglion.
Pl., Pleural ganglion.
Pd., Pedal ganglion.
Pa., Parietal ganglion.
Ab., Abdominal ganglion.
E., Eye.
G., Gill.
H.V., Head vesicle.
I., Intestine.
K., Kidney.
Ex.K., Larval kidney.
L.H., Larval heart.
L.M., "Larval mesoderm."
M., Mantle.
Ms., Mesodermal bands.
O., Otocyst.
P.G., Pedal gland.
Sh., Shell gland.
T., Tentacle.
V., Velum.
Cm.M., Columellar muscle.
Oe., Œsophagus.

Description of Plates XXIII—XXVIII.

All the figures were drawn at the stage level with the aid of the camera lucida; plates XXIII, XXVII and XXVIII under Zeiss Apochromatic Obj. 16 mm., Oc. 4; plates XXIV, XXV and XXVI with Obj. 8 mm., Oc. 4. The figures of the former plates are therefore magnified 62 diameters; of the latter, 124 diameters. In the process of reproduction the figures were reduced a little more than half, so that as they appear on the plates they represent a magnification of about 30 diameters and 60 diameters respectively. All the drawings are of eggs or embryos of *Fulgur carica*, fixed, stained and mounted as described in the first section of this paper.

Plate XXIII.—Entire eggs; 1-cell to 24-cell stages.

Fig. 1.—Unsegmented egg, showing first cleavage spindle and surrounding cytoplasm.

Fig. 2.—Two-cell stage, showing læotropic turning of cytoplasm, nuclei and spheres preparatory to the second cleavage.

Fig. 3.—Four-cell stage; the positions of nuclei and spheres indicates that the transverse furrow is here the second one.

Fig. 4.—Eight-cell stage, showing first quartet of micromeres which have turned in a dexiotropic direction; in two of the macromeres are nuclear spindles for the formation of the second quartet, which arises in a læotropic direction.

Fig. 5.—Sixteen-cell stage. The first quartet has divided læotropically, giving rise to the "apical" cells centrally and the small "turret" cells peripherally. The second quartet cells are dividing in two quadrants, and the third quartet cells are arising dexiotropically from the micromeres.

Fig. 6.—Twenty-four-cell stage, resulting from the completion of all the divisions initiated in the preceding figure.

Plate XXIV.—Blastoderms during the earlier stages of cleavage.

Fig. 7.—Same stage as shown in fig. 6, but magnified twice as much; twenty micromeres and four macromeres; the separation of the ectoderm from the macromeres is now complete.

Fig. 8.—Forty-five-cell stage. Every cell of the preceding stage has divided, or is dividing, except the macromeres *A*, *B* and *C*. The "apical" cells have given rise to the "basals" of the arms of the cross; one second quartet cell in each quadrant has produced the "tip" cell (stippled) of each arm; the third quartet cells are dividing læotropically, and the macromere *D* has produced the mesentoblast cell, 4*d*.

Fig. 9.—Fifty-five-cell stage. All divisions initiated in the preceding figure are here completed, and in addition the basal cells of the transverse arms of the cross have divided. The mesentoblast (4*d*) has given rise to six cells (two large and four small ones), and the macromeres *A*, *B* and *C* have given off the other members of the fourth quartet, viz., 4*A*, 4*B* and 4*C*.

Fig. 10.—Fifty-six-cell stage. Similar to the preceding, but showing the basal cell of the anterior arm of the cross divided and spindles in some of the cells derived from the second quartet. The cross is shown in heavy outline; there are three cells in each of the arms except the posterior one. The centre of the cross is here, and elsewhere, marked by a cross line, the "tip" cells of the arms, by stipples.

Fig. 11.—Irregular 81-cell stage; derived from preceding stage by division of the basal cell of the posterior arm, of eight cells of the third quartet, of eight cells of the second quartet, and of eight turret cells.

Fig. 12.—Eighty-five-cell stage; derived from the preceding by the completion of all divisions there indicated and by the subdivision of the basal and middle cells in the transverse arms of the cross.

Plate XXV.—Blastoderms, showing later stages of cleavage.

Fig. 13.—Another 85-cell stage, consisting of 72 ectomeres, 6 mesentomeres and 7 entomeres.

Fig. 14.—Stage with 111 cells; 98 ectomeres, 6 mesentomeres and 7 entomeres. This is a more advanced stage than the two following ones.

Fig. 15.—Stage with 89 cells; 76 ectomeres, 6 mesentomeres, 7 entomeres.

Fig. 16.—Stage with 104 cells; 91 ectomeres, 6 mesentomeres, and 7 entomeres.

Fig. 17.—Stage with 121 cells; 104 ectomeres, 10(?) mesentomeres and 7 entomeres.

Fig. 18.—Stage of about 320 cells. The ectomeres are very numerous and are somewhat depressed below the general level in the region anterior to the apical pole. The nuclei of the secondary macromeres, *4A*, *4B* and *4C*, are dividing.

Plate XXVI.—Blastoderms, from the time of formation of the apical invagination to the appearance of the primordia of definitive organs. All nuclei and cell boundaries, where shown, were drawn with the camera lucida, so that their number and location are fairly accurate.

Fig. 19.—Stage of approximately 512 cells. The apical invagination (*A.I.*) is a deep pit just anterior to the animal pole. The mesentoblast (*4d*) has given rise to the mesodermal bands (*Ms.*).

Fig. 20.—Stage slightly more advanced than the preceding, showing the apical invagination as a tubular ingrowth, with its opening near the anterior edge of the blastoderm; the nuclei of the secondary macromeres (*4A*, *4B* and *4C*) are dividing a second time.

Fig. 21.—Stage immediately after the flattening out of the apical invagination, only a trace of which is here shown. On each side of the latter is a group of cells, lying beneath the surface of the blastoderm, and represented with solid black nuclei, which are probably "larval mesoderm" cells (*L.M.*); the superficial group of cells in this region ultimately gives rise to the cerebral ganglion (*Cb.*), while the aggregation of cells lying between and in front of the mesodermal bands (*Ms.*) is the primordium of the shell gland. Two of the secondary macromeres (*4A* and *4C*) have, exceptionally, divided.

Fig. 22.—In this and the following figures all traces of the apical invagination have disappeared; in other respects this figure is similar to the preceding one.

Fig. 23.—Stage of about 1,000 cells, in which the shell gland is plainly visible as a disk of cells, slightly depressed in the middle, and in which the primordia of the cerebral (*Cb.*), buccal (*Bc.*), pleural (*Pl.*), and pedal (*Pd.*) ganglia and of the intestine (*In.*) are recognizable as groups of cells. The row of nuclei on the outer side of each cerebral ganglion probably represents the primordium of the velum, while the more deeply staining area connecting the two cerebral ganglia across the apical pole probably corresponds to the "cephalic neural plate" of annelids. The nuclei of the secondary macromere (*4B*) are dividing a third time, but the cell body remains undivided.

Fig. 24.—Stage in all regards similar to the preceding, except that the blastoderm has grown larger The nuclei in the macromeres have here reached their maximum size (cf. the nuclei of the same cèlls in figs. 7 and 10).

Plate XXVII.—Entire eggs, showing stages from the appearance of organ primordia to the completion of the overgrowth of the yolk.

Figs. 25 and 26.—Stages similar to the one shown in fig. 24. The primordia of different organs are indicated by the closely stippled areas, the stipples representing nuclei.

Fig. 27.—Stage in which the blastoderm has extended through the growth of its anterior portion, over about one-third of the yolk. The organ primordia are confined to a small area in the posterior margin of the blastoderm. The nuclei of the macromeres are dividing.

Fig. 28.—Stage in which the blastoderm has overgrown about one-half of the yolk. Primordia of the following organs are shown: Cerebral ganglia (*Cb.*), velum (*V.*), buccal ganglia (*Bc.*), pleural ganglia (*Pl.*), pedal ganglia (*Pd.*), otocysts (between pleural and pedal ganglia), intestine (*In.*), parietal ganglia (on each side of intestine), and shell gland.

Fig. 29.—Stage in which about two-thirds of the yolk has been overgrown. In addition to the organ primordia already named, the foot is also visible between the two pedal ganglia.

Fig. 30.—Final stages in the overgrowth of the yolk. The blastopore (*Bp.*) is a relatively small area of yolk at the vegetal pole, still uncovered by the blastoderm. The secondary macromeres (4*A*, 4*B* and 4*C*) lie in the lips of the blastopore, and while they contain many nuclei their cell bodies are still undivided. The velum has begun to extend forward around the anterior side of the blastopore, while the buccal ganglia (*Bc.*) lie in its lateral borders. All the organ primordia named above are plainly visible, and in addition the abdominal ganglion may be seen on the left of the intestine.

PLATE XXVIII.—Entire embryos, from the closure of the blastopore to the formation of the larva.

Fig. 31.—Embryo showing the blastopore very small. The margin of the shell gland has extended widely, while the area within this margin is covered by the embryonic shell (*Sh.*).

Fig. 32.—Stage showing the closure of the blastopore and the establishment of the pre-oral and post-oral velar bands The margin of the shell gland shows a deep notch posterior to the intestine, which grows more pronounced in later stages. The two cerebral ganglia are approaching each other in front of the blastopore. The primordium of the permanent kidney (*K.*) is recognizable.

Fig. 33.—Older stage, in which nearly one-half of the embryo is covered by the shell. The cerebral ganglia are united by a commissure in front of the mouth.

Fig. 34.—A stage in which about two-thirds of the embryo is covered by the shell.

Fig. 35.—Stage showing head vesicle (*H.V.*), larval heart (*L.H.*), mantle (*M.*), columellar muscle (*Cm.M.*), external kidneys (*Ex.K.*) and tentacles, (*T.*) in addition to the other organ primordia named in the description of figs. 28–30.

Fig. 36.—Later embryo, showing the formation of the mantle cavity, gill, velar lobes and the twisting of the nerve loop The primordia of all important organs are present at this stage.

NOTES ON SOME PACIFIC CIRRIPEDES.

BY HENRY A. PILSBRY.

The following notes on Japanese and Northwestern Pacific species of *Scalpellum*[1] are based upon material collected by the U. S. Fish Commission Str. *Albatross* in 1906, and are preliminary to an illustrated report to be published later. A new *Balanus*, the second to be made known of a peculiar group of forms living imbedded in sponges, is described from material presented to the Academy by Mr. C. R. Orcutt.

Of the "imperfectly calcified" species of *Scalpellum*, several are now known from Japanese waters, belonging to two slightly different groups, the group of *S. intermedium* and that of *S. japonicum*.

In the group of *S. intermedium* the small inframedian latus is narrowly triangular, widest at the base, with the umbo above and apical; the upper latus may be either triangular, biramose, or notched basally. Here belong the Japanese *S. nipponense* Pils., and from southern waters, *S. intermedium* Hoek and *S. laccadivicum* Annandale. All of these are very closely related, and may even prove to be varieties of a single species when fuller series of the growth stages come to light.

In the group of *S. japonicum* Hoek, the inframedian latus is broad above, narrow at the base, with the umbo basal or near the base. Some very interesting forms of *S. japonicum* were taken by the *Albatross* at Stations 4,972 and 4,967, off the east coast of Nippon. They show wide variation in the shape of the calcified portions of the upper and carinal latera. Two individuals from Station 4,972 diverge so widely from the type of *S. japonicum* that a subspecific name may be useful.

Scalpellum japonicum metapleurum n. subsp.

Differs from *S. japonicum* chiefly by the shape of the upper latus, which is calcified only in a band parallel to its tergal border.

Scalpellum gonionotum n. sp.

A species closely resembling *Scalpellum balanoides* Hoek, but larger, and differing by the *angular dorsal outline* of the capitulum and the shape of the carina, which is straight, with very narrow sides and a flat roof. There is a linear rostrum, not reaching to the base, or cov-

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[1] Published by permission of the Commissioner of Fisheries.

ered there by the rostral latera. The peduncle is closely covered with imbricating scales.

Length of capitulum 7, breadth 3.6 mm.

Albatross Station 4,901.

Scalpellum weltnerianum n. sp.

A species with fourteen loosely juxtaposed valves, regularly arched carina with apical umbo, rounded roof, in section like the letter U, and straight occludent border. There are very sparsely scattered hairs 2 to 3 mm. long, chiefly near the occludent margin. The paired plates have a sculpture of close radial riblets. Tergum erect and acute. Upper latus about twice as high as wide. Rostrum rather large, lozenge-shaped, with a median rib. Rostral latus quadrangular, as high as wide. Inframedian latus rather narrow, triangular, with acute apical umbo. Carinal latus with convex carinal and concave upper margins, the umbo apical, incurved. The carina extends in a narrow triangle between the carinal latera to the peduncle. Peduncle clothed with projecting scales curved in at their apices, arranged in six rows of about fifteen scales each.

Length of capitulum 11.5, breadth 5 mm.; length of peduncle about 5 mm.

Albatross Station 4,918, off Kyushu, in 361 fathoms, on a crinoid pinnule. August 13, 1906.

A very distinct species, shaped like *S. album*, but strongly sculptured.

Balanus orcutti n. sp. Plate XXIX, figs. 1–7.

A species closely related to *B. declivis* Darwin, living wholly imbedded in sponges.

Walls conical, with a small oval orifice and concave membranous base. The carina is double the length of the other plates, strongly arcuate, its projecting lower end tongue-shaped. The rostrum is slightly longer than the lateral plates. The radii and alæ are well sunken and smooth; the parietes marked with growth-lines and deep fine wrinkles, oblique to the growth-lines, and in places broken into long granules. The sheath is closely sculptured transversely with low ridges and covered with yellowish cuticle densely ciliated along the ridges. Below the sheath the plates are vertically ridged, especially the carina.

The scutum is triangular, densely sculptured with thread-like lamellæ parallel to the basal margin. The articular ridge is about half the length of the plate, wide and triangular. The adductor ridge is distinct but low. The cavities of the adductor and depressor muscles are deep.

The tergum is wide and triangular, the scutal and carinal margins straight. It is sculptured externally like the scutum; without a distinct spur, which is represented only by a slight wave in the basal margin. Internally there is a very short articular ridge and furrow; elsewhere the surface is irregularly roughened with short rugæ and some longitudinal wrinkles converging to the apex.

Height of the wall (to base of carina) 18 mm.; length of base 11, breadth 9.2 mm.

San Ysidro, Lower California. Type No. 1,783, A. N. S. P., collected and presented by C. R. Orcutt, 1889. There are also specimens from the same place and collector in coll. U. S. National Museum.

The barnacles live wholly imbedded in sponges and can be found only by breaking them up. *Balanus orcutti* differs from *B. declivis* Darwin[2] of the West Indies, by the peculiar sculpture of the external surface, which is obliquely corrugated or tuberculate in places, and by the shapes of the opercular valves. In *B. declivis* the scutum is wider, its greatest breadth contained twice in the length, while in *B. orcutti* the breadth is contained fully two and one-half times in the length. The tergum, on the other hand, is wider in *B. orcutti*, with a much less developed "spur," and a less wide inflected scutal area is seen in the interior view than Darwin figures for *B. declivis*. These characters show no noticeable variation in the series examined.

The specimens are dry, and the cirri and other internal parts have been destroyed.

EXPLANATION OF PLATE XXIX.

Fig. 1.—*Balanus orcutti*, carinal view of the wall.
Fig. 2.—Lateral view of the wall.
Fig. 3.—Rostral view of the wall.
Figs. 4, 5.—Interior and external views of the scutum.
Figs. 6, 7.—Interior and external views of the tergum.

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[2] *Monograph on the Cirripedia, Balanidæ*, p. 275. *B. declivis* has also been reported from Batjan, Moluccas, by Weltner, *Verz. recenten Cirripedenarten*, p. 270.

ON THE SYNONYMIC HISTORY OF THE GENERA CLAVA MARTYN, AND CERITHIUM BRUGUIÈRE.

BY WILLIAM HEALEY DALL.

The synonymic history of these genera is quite complicated, especially if one takes into consideration the minor subdivisions.

Most writers have hesitated to undertake revision of the Cerithiacea on account of the difficulties involved. During recent years the subject has been recalled to attention by the elucidation of the true dates of the volumes of Martyn's *Universal Conchologist* and by the publication of Part VII of M. Cossmann's *Essais de Paléoconchologie Comparée*, which included a review of the Cerithiacea.

The conclusions in regard to the validity of certain generic names established by Martyn, which resulted from my determination as to their correct date, has been dissented from by M. Cossmann in his *Essai*, and he supports his arguments by statements of fact which, if uncontroverted, would establish his case.

The difference is, in the main, caused by a different viewpoint as to the reformation of nomenclature, his arguments for which are supported by inaccurate citations.

In 1830 systematists considered it entirely proper to "ignore" little known names; to alter names which did not suit the Latinity or the taste of the person writing; to neglect more or less completely the early history of names; and to cite prelinnean and polynomial writers for systematic synonymy. These ideas, as we all know, were but slowly modified, since they appealed to the common preference for what is familiar, as well as to the indolence and carelessness of the hasty or amateur writer. As all know who have had occasion to use his very useful summaries, M. Cossmann has not, so far, entirely freed himself from these prepossessions, and has even on more than one occasion intimated that the acceptance of one or the other name of two in conflict should depend on the eminence of the author originating the name, rather than on the priority of publication; while his indignation at the resurrection of "obscure" names seems both sincere and profound.

One cannot but feel some sympathy with the regret that familiar (if erroneous) names must be eliminated from general use.

For some years I urged the maintenance of the first British Association rules, which required a diagnosis to validate a new genus or subgenus. But these views not being acceptable to the majority of zoologists, and the International Congresses having formulated a series of working rules in which this principle was not enforced, and believing that a stable nomenclature can only result from the general, impartial, rigidly exact enforcement of the rules adopted, I have proceeded in my work on that basis.

That it has resulted in necessary changes was the fault of the illogical and inaccurate methods of the early part of the nineteenth century, which M. Cossmann and those who sympathize with him seem to desire to perpetuate.

One cannot argue on such a question unless from a common standpoint, which being wanting, I have left unanswered numerous criticisms of my work by M. Cossmann, recognizing his right to his own standpoint and the futility of argument under the circumstances.

But if one admits perfect freedom in selection of principles, one does not necessarily waive the right to have the facts in the case accurately stated by the critics. In this direction M. Cossmann's writings leave much to be desired. Lest I should be supposed to acquiesce in them, I have thought it best to select a concrete case, that of M. Cossmann's treatment of the history of Martyn's genus *Clava*, afterwards named *Cerithium* by Bruguière, which M. Cossmann has had occasion to notice in his account of the Cerithiacea in the publication alluded to.

In order to clear up the subject it is necessary to enter into the history of the genus *Cerithium*. This name was first applied by Fabio Colonna in his treatise *De aquatilibus*[1] to a shell afterwards named *Cerithium adansonii* by Bruguière. The name was adopted by Adanson for a group containing Cerites and Turritellas,[2] one of which, *Le Cerite* (p. 155), he identified with Colonna's shell. These authors were prelinnean and, except historically, not entitled to be cited in synonymy.

In 1792 Bruguière adopted the name and for the first time introduced it into binomial nomenclature,[3] naming no type, but dividing the genus into three unnamed groups, the first of which corresponds to *Vertagus* Klein, the first species being *C. obeliscus* Bruguière.

In 1799 Lamarck published his *Prodrome*,[4] in which he cited as type *Murex aluco* Linné. Two years later, however, in his *Système*,[5] he

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[1] *De aquatilibus aliisque nonullis animalibus*, Roma, 1616, pp. 53, 57.

[2] *Sénégal*, pp. 152–160, 1757.

[3] *Encycl. Méth.*, I, pt. 2, 1792, p. 467. Not issued in 1789, as stated by Cossmann and various other authors.

[4] *Prodr. nouv. class.*, p. 73, 1799.

[5] *Syst. des an. s. vert.*, p. 85, 1801.

mentions as example *C. nodulosum* Bruguière, which was by the latter, as by Adanson, supposed to be Colonna's original species. Roissy[6] adopted the genus in Bruguière's sense; his first species was a *Vertagus* (Klein). In 1807 Link[7] followed Lamarck's *Prodrome* and put under *Cerithium* (Lam.) his species resembling *Vertagus* (Klein), beginning with *C. aluco*, which type was not then discriminated from the others, and gave to Bruguière's second group of true Cerites the name *Aluco*, with *Cerithium adansonii* Bruguière as his first species. Montfort in 1810[8] had also followed the lead of Lamarck in 1799 and figured *Murex vertagus* as the type of *Cerithium* s. s. after eliminating *Telescopium* and *Pyrazus* (=*herculea* Martyn). Schumacher[9] in 1817 has three groups under *Cerithium*, corresponding to *Pyrazus* Montfort (*C. palustre* Lam.), *Cerithium* Lamarck, 1801 (*C. nodulosum* Brug.), and *Cerithium* Lamarck, 1799 (*C. aluco* Linné). He also adopts Klein's name *Vertagus* with two groups, the first typified by *Murex vertagus* Linné, and the second by *Murex asper* Linné, which differs only by rougher sculpture.

In referring to species I have corrected the synonymy, which is often complicated, but refrain from inserting the details here.

To return to the parallel nomenclature, in 1753 Klein, who was one of the worst of the polynomialists, proposed the name *Vertagus*, his first "species" being *Murex vertagus* Linné. This name of course had no standing. Link in 1807[10] used *Vertagus* for a totally different group containing species of *Terebra*, and Schumacher's return[11] to Klein's type was necessarily too late to remedy matters.

Martyn's name *Clava* was first published[12] not later than 1784, as elsewhere proved beyond any doubt. The four species published in that year may be identified as follows:

1. *Clava rugata* Martyn = *Murex asper* Linné.
2. *Clava herculea* Martyn = *Cerithium ebeninum* Brug.
3. *Clava maculata* Martyn = *Cerithium clava* Brug.
4. *Clava rubus* Martyn = *Cerithium echinatum* Lam.

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[6] *Hist. nat. Moll.*, VI, p. 106, 1805.

[7] *Beschr. Rostock Samml.*, p. 130, 1807.

[8] *Conch. Syst.*, II, p. 511, 1810.

[9] *Essai*, pp. 223–4 and 227–8, 1817.

[10] *Beschr. Rostock Samml.*, p. 128, 1807.

[11] *Essai*, p. 227, 1817.

[12] *Universal Conchologist*, I, table, Nos. 12, 13. In the second series of forty plates, sometimes called by Martyn Vol. II, figs. 57 and 58 represent respectively *Clava maculata* and *C. rubus* Martyn. The species in Vol. III date only from 1786 and need not be considered in selecting a type, though of interest as showing that Martyn's conception of his genus *Clava* was practically the same as Bruguière's conception of his genus *Cerithium*, eight years later.

These are referable to the following groups:

3. *Cerithium* Lamarck, 1799; type *C. aluco* L. (+*Pseudovertagus* Vignal, 1904).
4. *Cerithium* Lamarck, 1801; type *C. nodulosum* Brug. (=*Aluco* Link, 1807).
2. *Pyrazus* Montfort, 1810; type *C. ebeninum* Brug.
1. *Vertagus* (Klein) Schumacher, 1817 (not of Link, 1807) = *Clava* Martyn, 1784+*Rhinoclavis* Swainson, 1840.

It thus appears that, whether we adopt the "first species" rule or the method of "elimination," Martyn's first species becomes his type. *Pseudovertagus* (*aluco*) is, in my opinion, generically distinct from *Clava* and much more nearly related to the true Cerites of Adanson and Lamarck (1801). This conclusion is essentially the same as that reached by Pilsbry.[13]

The date of Gmelin's volume is of general interest to those working in systematic Malacology, so that I have given the details; but for our present purpose it is sufficient to say that Martyn's work (the first 80 plates) is cited throughout Gmelin's volume, and some of his specific names are adopted by Gmelin.[14] This conclusively shows that, whatever the date of either work, Martyn precedes Gmelin, and *Clava* Gmelin, *non* Martyn, becomes a synonym.

M. Cossmann further suggests that a genus *Clavus* precedes and reduces *Clava* Martyn to synonymy. But in this case he has obviously forgotten the fact, patent in any Latin lexicon, that *Clava*, a club, is a feminine substantive not identical with the masculine *Clavus*, a nail. The two are as distinct as *Pica* and *Picus*.

In 1884[15] Jousseaume proposed to apply the name *Clava* to the group represented by Martyn's *Clava tessellata*, a species which is No. 97 in his third volume. This course is inadmissible, because *tessellata* is not one of the original species of 1784, but at earliest dates from 1786.

The name *Clava* in Martyn's sense appeared subsequently among the early writers only once. In the anonymous Museum Calonnianum it is used, practically as Martyn used it, for the whole group of *Cerithium* in the Lamarckian sense. But, as I have hitherto maintained that a work with no ostensible author or publisher is not entitled to be cited as valid in systematic synonymy, I do not consider that this incident

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[13] *Proc. Acad. Nat. Sci. Phila.* for 1901, p. 392.

[14] Such as *Buccinum scutulatum* (Martyn) Gmelin, and *Patella calyptra* (Martyn) Gmelin. See also pp. 3483, 3490, 3498, 3690, 3691, 3697, 3702, and 3712 (and many others) for citations by Gmelin of Martyn's figures.

[15] *Bull. Soc. Zool. de France*, IX, p. 23, 1884.

adds any strength to the case for the adoption of *Clava* Martyn as a systematic name.

Gmelin's use of the word *Clava* in a generic sense for a Cœlenterate animal, though cited by Cossmann as of 1789, is really not earlier than 1791, and until very recently has been regarded as of 1792.[16]

On the twenty-sixth page of part VI of Gmelin's work (p. 3056, No. 19) there is a reference to a paper of Braun, published in the tenth volume of the *Schriften der Gesellschaft Naturforschende Freunde zu Berlin,* page 58. This paper has been stated to have been issued in 1792, and if so the volume in which it is cited cannot be of earlier date.[17]

Lately M. Vignal, who has made a specialty of the Cerithiidæ, proposed the name[18] *Pseudovertagus* for forms allied to *C. aluco* Linné, which have an external appearance more or less like those of the type of *Murex vertagus* Linné, but want the strong spiral plication on the pillar. After examining the specimens in the Museum, I am of the opinion that this separation is absolutely justified. The fossil forms in Europe, according to M. Cossmann, are of this latter type, and so are most of the American species; but we have at least one species in the Chipola Oligocene which is unmistakably of the type of *C. vertagus,* so far as the plicate axis is concerned. There is also a recent species resembling *C. kochii* Philippi, at Barbados. The absence of the Indo-Pacific type from the European Tertiaries may therefore be due to its absence from that region faunally, and not to any ancestral character of the *Pseudovertagus.*

We are now in a position to review the facts above cited.

We may judge from the aggregate of the data that, disregarding prelinnean polynomialists, the first binomial author to recognize the

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[16] Gmelin's Vol. VI of his edition of the *Systema Naturæ* bears no date on the title.

[17] The paper referred to is M. Braun, Beitr. zur Gesch. d. Eingeweider-würmer. See Carus and Englemann, *Bibl. Zool.,* I, p. 362, where the date of Braun's paper is given as 1792. Also H. C. Bolton, *Cat. Sci. Periodicals,* second edition, p. 1023, where the date of Vol. X, above referred to, is given as 1792.

It is possible that Braun's paper was issued earlier in separate form, but in that case we should not expect that Gmelin would cite the page of the completed volume, instead of the page of the separate issue. Possibly some part of Vol. X may have appeared earlier than the date of the completed volume. Ant. Collin discusses the question in the *Zool. Anzeiger* for January, 1899, pp. 4, 5, and comes to the conclusion that at least a portion of Gmelin's part VI appeared between August 21, 1790, and May 14, 1791, probably in one of the early months of 1791. I have for some time followed Carus and Englemann and Bolton in using the date 1792 for this volume of Gmelin, instead of 1790 as used by Sherborn in the *Index Animalium* (p. 221), since the latter does not give detailed data in his preliminary bibliography; but after Collin's discussion, called to my attention by Dr. Stiles recently, it seems reasonable to compromise on 1791 as the most probable date.

[18] *Bull. Mus. Hist. Nat. Paris,* X, p. 358, 1904.

group commonly called *Cerithium* in nomenclature was Martyn, who named it *Clava*, having two species in his first publication, of which the first was a "*Vertagus*" and the second a *Pyrazus*.

The next author was Bruguière, who habilitated *Cerithium* Adanson, without mentioning a type and with limits, as M. Cossmann expresses it, which "ne répond à rien de bien précis." Lamarck's first effort to select a type fell on a species of *Pseudovertagus*.

In this[19] he was followed by Link (1807), Montfort (1810) and Cuvier (1817). Lamarck's second effort reverted to the antique type represented by *C. nodulosum*.

In this he was followed by Schumacher (1817), who included the *aluco* group under *Cerithium* (Lam.) proper, and separated the *Clava* group with plicate axis under the untenable name of *Vertagus*. Most modern authors have, in a general way, followed Schumacher.

Bruguière, Lamarck and Deshayes were familiar with Martyn's work, referred to it with high praise, and cited his names in synonymy; the loose practice of changing specific names to suit the fancy of the author, without reference to priority, being still in vogue.

M. Cossmann's criticisms have been made with such an air of confidence and so much particularity of detail, that the incautious reader might well suppose they were founded upon an accurate determination of the facts. Yet in the present case it has been shown that of three dates essential to a right decision, those of Martyn, Bruguière and Gmelin, as printed by M. Cossmann,[20] each and every one is wrong. Only because they are incorrect is he able to arrive at a decision different from mine, first published in 1892[21] and elaborated by Pilsbry in 1901.[22] Since an analysis of my previous paper on Martyn appeared in M. Cossmann's *Revue de Paléozoologie*, shortly after its publication, it seems difficult to account for the presence of the false date 1789 for Martyn's first volume in the last number of the *Essais*, and one would expect, after Sherborn and Woodward's elucidation of the dates of the several parts,[23] that a French author of M. Cossmann's standing would have informed himself of the dates of publication of the *Encyclopédie Méthodique* when they bore directly upon the subject he was discussing.

Whatever view may be taken of Martyn's work, nothing can prevent

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[19] *Vertagus* and *Pseudovertagus* being at that time not differentiated.

[20] *Essais de Paléoconch. Comp.*, VII, pp. 65, 84, 1907.

[21] *Trans. Wagner Inst.*, III, part II, p. 290, 1892.

[22] *Proc. Acad. Nat. Sci. Phila.* for 1901, p. 392.

[23] *Proc. Zool. Soc. London*, 1893, pp. 582–584.

the recognition of Lamarck's type of 1799 as the type of the genus *Cerithium,* provided one accepts the international code of rules governing zoological nomenclature.[24] The rejection of *Clava* Martyn would not alter this fact. But, in any case, this system of nomenclature of the *Cerithiidæ,* laboriously built up by M. Cossmann on an insufficient knowledge of the nomenclatorial history of the family, must submit to profound modifications before it can be approved by those who accept the international rules.

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[24] *Règles internationales de la nomenclature Zoologique adoptées par les Congrès Internationales de zoologie,* Paris, Rudeval, 1905, 8°, p. 57.

ORTHOPTERA OF THE FAMILIES TETTIGONIDÆ AND GRYLLIDÆ FROM SAPUCAY, PARAGUAY.

BY JAMES A. G. REHN.

This paper completes the study of the Sapucay collection of Orthoptera made by William T. Foster and now the property of Mr. Morgan Hebard. Five of the families of the order were treated in a recent paper in these *Proceedings*,[1] to which the reader is referred for the titles of previous papers on Sapucay Orthoptera. The asterisk is used here, as in the previous paper, to designate species not previously recorded from Sapucay.

In previous papers forty-one species of the two families here treated were recorded from Sapucay; thirty-six are here recorded, but of this number six are new species and twelve previously known species are recorded from the locality for the first time.

The author wishes to thank Mr. Hebard for the privilege of studying this valuable collection.

TETTIGONIDÆ.

PHANEROPTERINÆ.

ISOPHYA Brunner.

1878. *Isophya* Brunner, Monogr. der Phanеropt., pp. 13, 59.

Type.—*I. brasiliensis* Brunner.

Isophya borellii Giglio-Tos.

1894. *I[sophya] Borellii* Giglio-Tos, Bollett. Mus. Zool. Anat. Comp. Torino, IX, No. 184, p. 37. [Province of San Pedro and Asuncion, Paraguay; Santa Rosa, Salta, Argentina.]

March, 1905; two males, ten females.

These individuals are clearly referable to *borellii*, the males having the cercal tooth distinctly before the apex, the females having but the apical third of the dorsal margin of the ovipositor crenulate.

Isophya hamata Giglio-Tos.

1894. *I[sophya] hamata* Giglio-Tos, Bollett. Mus. Zool. Anat. Comp. Torino, IX, No. 184, p. 37. [Province of San Pedro, Asuncion and Colonia Risso on the Rio Apa, Paraguay.]

August, 1901; one male.

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[1] *Proc. Acad. Nat. Sci. Phila.*, 1907, pp. 151–192.

The apical cercal tooth and the more transverse plicate vein readily distinguish the males of this species from those of *borellii*. The range of this species is from Corumbá, Matto Grosso, Brazil, south to Sapucay.

HYPEROPHORA Brunner.

1878. *Hyperophora* Brunner, Monogr. der Phaneropt., pp. 16, 125.

Type.—*H. brasiliensis* Brunner.

Hyperophora brasiliensis Brunner.

1878. *H*[*yperophora*] *Brasiliensis* Brunner, Monogr. der Phaneropt., p. 126. [Brazil.]

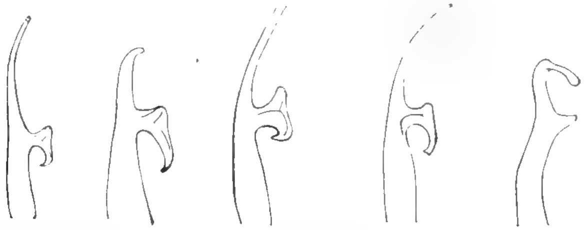
December, 1904, March, 1905; three males, two females.

There is considerable variation in these individuals in the depth of the coloration of the tegmina; in several specimens the green being very much richer and deeper than in the others. The male cercus of this species is represented by fig. 1.

This species ranges from Brazil to Buenos Ayres, Argentina.

***Hyperophora cerviformis** n. sp.

Type: ♂; Sapucay, Paraguay. February 27, 1905. (William Foster.) [Hebard Collection.]



Figs. 1–5.—Male cercus of species of *Hyperophora* (viewed from the dorsum). 1. *H. brasiliensis* Brunner. 2. *H. cerviformis* n. sp. 3. *H. major* Brunner. 4. *H. gracilis* n. sp. 5. *H. minor* Brunner. (× 8.)

Allied to *H. brasiliensis*, but differing in the slenderer form, the more elongate tegmina and the shorter cerci, which are moderately recurved distad, and with the proximal portion of the median process elongate and spined.

Size medium; form distinctly elongate, slender, compressed. Head short and deep, very considerably broader than the pronotum; occiput rounded; vertex moderately declivent, fastigium narrow, compressed, low, margins elevated, depressed mesad, at the extreme apex not touching the frontal fastigium which is trigonal; eyes ovate, prominent; antennæ rather thick, fragile, not perfect in the type, proximal joint about as broad as the eye. Pronotum with the disk subdeplanate, slightly sellate; lateral margins subparallel, acute, the width of the disk contained about once and a half in the length, cephalic margin moderately concave, caudal margin moderately arcuate, a distinct rectangulate impressed line mesad; lateral lobes distinctly longitudinal, the greatest depth, which is caudad, contained once and a half in the length, cephalic margin slightly sinuate oblique, ventral margin slightly emarginate over the coxæ and very slightly angulate caudad of this, caudal margin with a distinct rectangulate humeral sinus, otherwise rounded. Tegmina reaching about to the tips of the caudal femora, narrow, lanceolate, the greatest width contained about six and a half times in the length, costal field well rounded proximad, otherwise the margins taper almost imperceptibly to the rounded apex; discoidal vein with three rami which are connected by diagonal supplementary veins; anterior ulnar vein fusing slightly distad of the apical third and with two principal rami; tympanum distinctly longer than broad. Wings with apex acute, exceeding the tegmina by a length equal to that of the head and pronotum together. Terminal dorsal abdominal segment produced mesad into a subtrigonal process which is somewhat bullate; cerci, produced moderately tapering, apex blunt, somewhat depressed, narrowly recurved dorso-mesad, median process strongly produced in a proximal direction parallel with the shaft, acute, no development distad; subgenital plate with a rotundato-angulate emargination, lateral apical angles rather blunt, ventral surface with three subparallel carinæ. Cephalic femora but slightly shorter than the head and pronotum together; median femora twice as long as the pronotum. Caudal femora once and one-third the

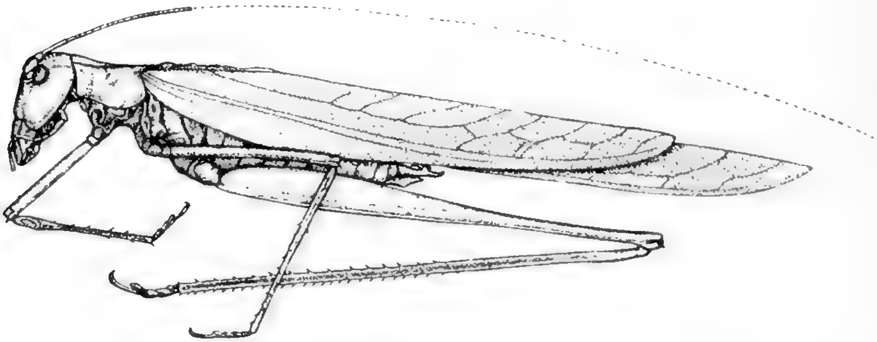


Fig. 6.—*Hyperophora cerviformis* n. sp. Lateral view of male type. (× 2½.)

length of the body, slender; caudal tibiæ slightly longer than the femora.

General color apple green turning to olive-yellow and naples yellow on the head, pronotum and limbs. Eyes prouts' brown, a weak narrow postocular line and the more distinct continuation of the same on the angle of the pronotum liver brown, the tympanum very broadly margined laterad with the same; tibiæ oil green, the caudal becoming olive-green distad.

Measurements.

Length of body,	17 mm.
Length of pronotum,	4 "
Length of tegmen,	27.5 "
Length of caudal femur,	22.7 "

The type is the only specimen seen by the author.

Hyperophora major Brunner.

1878. *H[yperophora] major* Brunner, Monogr. der Phaneropt., p. 126, tab. II, fig. 24. [Buenos Ayres, Argentina.]

March and May, 1902; two males, two females.

These specimens are slightly smaller than the measurements given for this form by Brunner, but as far as can be determined from his brief description they represent this species. The measurements of a Sapucay male and female are as follows:

	♂	♀
Length of body (exclusive of ovipositor),	20 mm.	22.5 mm.
Length of pronotum,	4.6 "	4.6 "
Length of tegmen,	29.5 "	30.5 "
Length of wing beyond tegmen,	6.5 "	6.1 "
Length of caudal femur,	24 "	24.5 "
Length of ovipositor (apex to ventral base),		5.5 "

The male cercus of this species is represented in fig. 3. This species has been recorded from Buenos Ayres and Santa Rosa, Salta, Argentina, and Urucum, Matto Grosso, Brazil.

***Hyperophora gracilis** n. sp.

Types: ♂ and ♀; Sapucay, Paraguay. February 27 (♀) and March 7 (♂), 1905. (William Foster.) [Hebard Collection.]

In a way this species connects certain previously known species of the genus, but in the form of the ovipositor it appears to be close to *H. angustipennis* Brunner, while the strongly lamellato-carinate ninth dorsal abdominal segment of the male is apparently peculiar to the new species. In possessing lateral lobes of the pronotum of equal depth and in having the mediastine vein by no means as well marked as in the *major-peruviana* group it occupies a rather intermediate position.

Size medium; form elongate, slender, somewhat compressed. Head distinctly broader than the pronotum, the occiput rounded, vertex declivent, fastigium narrow, longitudinally sulcate, apex blunt and in contact with the blunt apex of the facial fastigium; eyes subovate, strongly exserted; antennæ elongate, proximal joint as broad as the eye. Pronotum with the dorsum deplanate, slightly sellate; lateral margins subparallel, angulate, subcarinate, the breadth of the disk contained about once and a half in the length, cephalic margin very slightly emarginate, caudal margin arcuate, a distinct but low median carina present on the extreme caudal section of the disk, cephalad of this there is an indication of the same but no carina, rectangulate impressed pattern slightly caudad of the middle; lateral lobes with the greatest depth contained nearly twice in the length, caudal margin subsinuate with a faint trace of a supra-coxal emargination, humeral sinus distinct, rectangulate, the remainder of the caudal margin slightly arcuate and the ventro-caudal angle rather narrowly rounded. Tegmina exceeding the length of the body by about that of the pronotum, the greatest width contained about seven times in the length, margins approximating little, except in the apical fifth where the costal margin arches distinctly to the narrowly rounded apex; discoidal vein with four rami, all of which are distinctly sublongitudinal in their middle course, diagonal in the remainder; anterior ulnar vein with no distinct rami in the male, one to two in the female, the vein itself being connected by a short vein with the proximal rami of the discoidal vein. Wings exceeding the tegmina by nearly twice the length of the pronotum, the apex tapering and acute. Terminal dorsal abdominal segment of the male with a short acute process over the base of each cercus and a

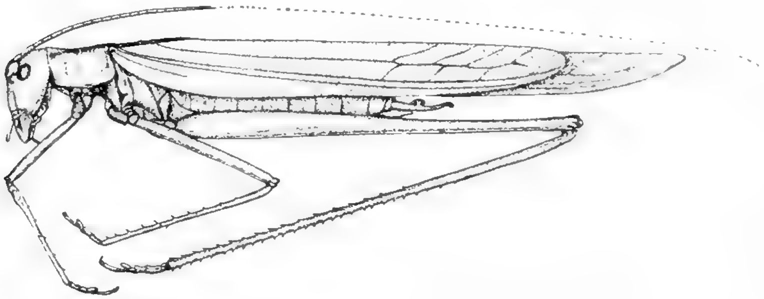


Fig. 7.—*Hyperophora gracilis* n. sp. Lateral view of male type. (× 2½.)

larger median trigonal process bearing a high rounded lamellate ridge; cerci elongate (see fig. 4), moderately robust in the proximal section, slender in the distal section which is strongly curved mesad with the apex blunt and somewhat recurved, median process on the distal side of its internal face with only a minute spine, the proximal side with a slender recurved appendage with a slightly expanded emarginato-truncate apex; subgenital plate moderately produced, apex rectangulate emarginate. Ovipositor of the female about half the length of the tegmina, slightly but regularly curved, rather broad, tapering very slightly except toward the immediate apex, dorsal margin slightly and ventral margin distinctly crenulate in the distal third; subgenital plate of the femora very slightly produced with a narrow median emargination. Cephalic femora as long as the pronotum and half of the head; median femora about a third the length of the tegmina. Caudal femora very slender, reaching to the apex of the tegmina.

Fig. 8.—*Hyperophora gracilis* n. sp. Lateral view of ovipositor. (× 3.)

General color apple green becoming greenish yellow on the proximal portion of the tegmina, pronotum and head; postocular line and angles of the pronotum brick red, the male tympanum marked laterad not very strongly with the same color; eyes chestnut; caudal tibiæ becoming purplish brown distad.

Measurements.

	♂	♀
Length of body,	21 mm.	—[2] mm.
Length of pronotum,	3.7 "	—[2] "
Length of tegmen,	23.8 "	25.5 "
Length of caudal femur,	21 "	22 "
Length of ovipositor,		11.5 "

Three paratypic males, taken in February and March, 1905, have also been examined. These specimens fully agree with the type in all essential characters. From these specimens it is seen that the male in some cases possesses at least a single ramus to the anterior ulnar vein of the tegmen.

Hyperophora minor Brunner.

1891. *Hyperophora minor* Brunner, Verhandl. K.-K. Zool.-bot. Gesell. Wien, XLI, p. 59. [Paraguay; Cordoba, Argentina.]

February and March, 1905; fourteen males, thirteen females.

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[2] The head and cephalic portion of the pronotum is missing in the female type.

The cercus of the male of this species is represented by fig. 5. There is an appreciable amount of variation in size in this species, the extremes of the present series measuring as follows:

	♂		♀	
Length of tegmen, . .	24 mm.	25.5 mm.	23.8 mm.	27 mm.
Length of caudal femur,	21.2 “	23 “	22 “	23.6 “
Length of ovipositor,			7.2 “	7.8 “

LIGOCATINUS Rehn.

1878. *Amaura* Brunner, Monogr. der Phaneropt., pp. 25, 247. (Not of Moller, 1842.)
1901. *Ligocatinus* Rehn, Canad. Entom., XXXIII, p. 272.

Type.—*Amaura spinata* Brunner.

Ligocatinus olivaceus (Brunner).

1891. *Amaura olivacea* Brunner, Verhandl. K.-K. Zool.-bot. Gesell. Wien XLI, p. 123. [Rio Grande do Sul, Brazil.]

February, 1903 and 1905; three females.

Terminal spines are present on the external dorsal margin of the cephalic tibiæ in all three specimens.[3]

HOMOTOICHA Brunner.

1891. *Homotoicha* Brunner, Verhandl. K.-K. Zool.-bot. Gesell. Wien, XLI, pp. 17, 124.

Type.—*H. minor* (Brunner).

Homotoicha fuscopunctata Caudell.

1906. *Homotoicha fuscopunctata* Caudell, Proc. U. S. Nat. Mus., XXX, p. 236. [Sapucay, Paraguay.]

March, 1905; one male.

This specimen has been examined by Caudell, who states there is no doubt in his mind but that it represents the male of his species. As the appendages are undescribed a few notes may be of interest.

Fig. 9.—*Homotoicha fuscopunctata* Caudell. Lateral view of apex of male abdomen. (× 5.)

Terminal dorsal abdominal segment with the apical margin broadly subtruncate. Cerci with the proximal third very stout, scabrous and bearing on the internal margin a lamellate ridge developed into a falciform process, curving dorsad, the base broad, apex acute and normally touching the base of the opposite cercus; median third of the cercus compressed; apex thickened, obliquely truncate and with a small spine placed in the middle of the truncation, beyond the proximal third the cerci are curved inward.

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[3] *Vide* Caudell, *Proc. U. S. Nat. Mus.*, XXX, p. 236.

Subgenital plate produced, tapering, bent considerably dorsad near the base, deeply and narrowly divided, short styles present.

CERAIA Brunner.

1891. *Ceraia* Brunner, Verhandl. K.-K. Zool.-bot. Gesell. Wien, XLI, pp. 18, 127.

Type.—*C. tibialis* Brunner.

Ceraia cornutoides Caudell.

1906. *Ceraia cornutoides* Caudell, Proc. U. S. Nat. Mus., XXX, p. 237. [Sapucay, Paraguay.]

January, 1903, March, 1905; two females.

SCAPHURA Kirby.

1825. *Scaphura* Kirby, Zool. Journ., I, p. 432.

Type.—*S. vigorsii* Kirby.

Scaphura nigra (Thunberg).

1824. *Gr[yllus] niger* Thunberg, Mém. l'Acad. Imp. des Sciences, St. Pétérsb., IX, p. 415. [Brazil.]

January and March, 1903 and 1905; one male, three females.

These specimens do not fully agree with any of the numerous color forms of this species, being closer to *vigorsii* Kirby and *chalybea* Marschall than to the others. From the former they differ in the absence of pale markings on the median femora and in the more brownish wings, these latter being distinctly red-brown with a preapical portion infuscate. From *chalybea* they differ in the chalybeous proximal portion of the antennæ comprising eight to thirteen joints, instead of only reaching the third. However they are closer to *chalybea* than to the type called *vigorsii* by Kirby.

I have provisionally considered all the nominal species as forms of *nigra*, which is the oldest name, the probability being that the various forms are geographic and restricted to definite areas. The variation noted in the four specimens in hand is slight, and from this one may infer that variation in one locality is generally no greater.

The resemblance of this species to a Sphegid wasp is very striking, as has already been noticed by Westwood, the similarity to species of the genus *Pepsis* being particularly true of the specimens examined.

GRAMMADERA Brunner.

1878. *Grammadera* Brunner, Monogr. der Phaneropt., pp. 27, 297.

Type.—*G. clara* Brunner.

***Grammadera albida** Brunner.

1878. *G[rammadera] albida* Brunner, Monogr. der Phaneropt., p. 298. [Brazil.]

November and December, 1904; two males, one female.

As the ovipositor was mutilated in the female type, I have described the appendages of the available female.

Ventral length of the ovipositor two and one-half times that of the disk of the pronotum, slightly falcate, greatest width immediately distad of the middle and contained about four times in the length, apex acute, both margins crenulate for about a third their length. Subgenital plate small, apex broadly emarginate.

***Grammadera rostrata** n. sp.

Type: ♀; Sapucay, Paraguay. February 10, 1905. (William Foster.) [Hebard Collection.]

Allied to *G. clara* and *albida*, differing from the former in the more arcuate ovipositor, the less quadrate lateral lobes of the pronotum and the slenderer limbs. From *G. albida* it differs in the smaller eyes, the more produced and subequal fastigium, the more distinctly disto-median insertion of the median vein and the less quadrate lateral lobes of the pronotum. From *G. hastata* Brunner and *pellucida* and *rosea* Giglio-Tos it is separated by a number of characters, the chief of which is the sulcate fastigium (not sulcate in *hastata*) and the emarginate subgenital plate (entire or rotundate in *pellucida* and *rosea*).

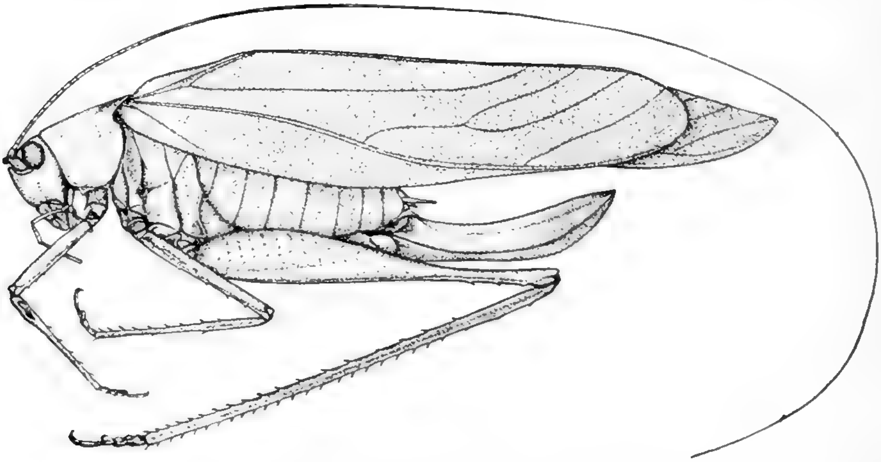

Fig. 10.—*Grammadera rostrata* n. sp. Lateral view of type. (× 2½.)

Size medium; form moderately elongate, distinctly compressed. Head with the occiput, vertex and fastigium on much the same plane, fastigium considerably produced, the margins slightly converging, the apex blunt and extending distinctly beyond the facial fastigium, reaching to the margin of the proximal antennal joint when that portion is in a vertical position, dorsum of the fastigium broadly but not very deeply sulcate; facial fastigium acute, distinctly separated from the fastigium of the vertex; eyes subglobose, prominent; antennæ about three times the length of the body (exclusive of the ovipositor), filiform, proximal joint rather large. Pronotum with the disk flattened only in the caudal section, the cephalic and median sections being rounded into the lateral lobes with a scarcely perceptible median angle, the greatest caudal width being continued about once and a half in the length, cephalic margin of the disk and lateral lobes truncate, caudal margin of the disk arcuate; lateral lobes about as long as deep, humeral sinus broad, shallow, the remainder of the caudal margin gently arcuate, cephalic section of the ventral margin sinuate with the ventro-cephalic angle obtuse. Tegmina about once and a half the length of the body (exclusive of the ovipositor), extending beyond the caudal femora by about the length of the pronotum, lanceolate, the greatest width contained nearly four and a half times in the length, costal margin very slightly arcuate, sutural margin straight in the distal three-fourths, apex rounded; median vein diverging two-fifths the length from the base and furcate with the rami reaching the sutural margin. Wings extending beyond the tegmina a distance nearly equal to the length of the pronotum. Supra-anal plate trigonal, acute; ovipositor about two-fifths the length of the tegmina and slightly more than half that of the caudal femora, moderately arcuate in the distal two-thirds, straight in the proximal third, the greatest width at about the distal third, dorsal margin not sinuate, ventral margin slightly sinuate in the proximal half, apex acute, distal half with the dorsal margin very slightly crenulate, ventral margin distinctly crenulate; subgenital plate short, slightly inflated, the margin with a broad shallow triangular emargination. Cephalic femora about equal to the pronotum in length, armed on the distal section of the ventro-cephalic margin with three spines; median femora slightly longer than the head and pronotum together, armed on the ventro-cephalic margin with three spines. Caudal femora equal to the body in length, considerably inflated distad, ventral margins armed with one or two spines near the apex; tibiæ exceeding the femora by near the length of the pronotum.

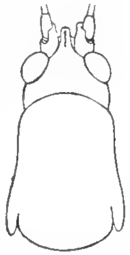

Fig. 11.—*Grammadera rostrata* n. sp. Dorsal view of head and pronotum. (× 4.)

General color maize yellow washed with greenish on the head, pronotum, pleura and limbs; a distinct gamboge yellow line extends from the apex of the fastigium to the caudal margin of the pronotum and is also indicated on the distal portion of the sutural margin of the tegmina; pronotum regularly sprinkled with red-brown dots; eyes vandyke brown; antennæ greenish proximad, yellowish, greenish and blackish distad. Tegmina and wings pale chromium green. Ovipositor with the distal two-fifths paris green, the apex and margins narrowly red-brown. Caudal femora ochraceous on the inflated portion, lined dorsad on the same and with distal section buffy, the whole speckled with red-brown as on the pronotum; caudal tibiæ greenish, much stronger distad.

Measurements.

Length of body (exclusive of ovipositor),	19	mm.
Length of pronotum,	5	"
Length of tegmen,	29.5	"
Length of caudal femur,	18.3	"
Length of ovipositor,	11.5	"

The type is unique.

***Grammadera forcipata** n. sp.

Type: ♂; Sapucay, Paraguay. February 27, 1905. (William Foster.) [Hebard Collection.]

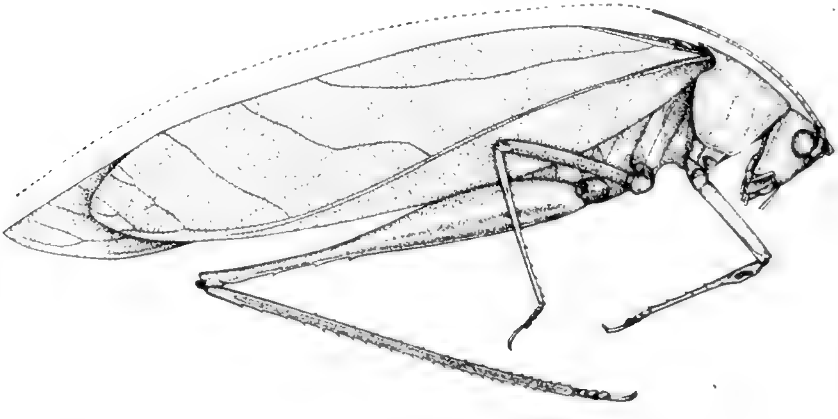

Fig. 12.—*Grammadera forcipata* n. sp. Lateral view of type. (× 3.)

Allied to *G. pellucida* Giglio-Tos, agreeing in the sulcate pronotum and the long slender incurved cerci, but differing in the absence of mucronations on the apex of the cerci, in the longer, strongly divided subgenital plate and the subequally broad as high lateral lobes of the pronotum. There is hardly any possibility of this species being the male of *G. rostrata* as the venation is much more irregular, the fastigium is longer and the limbs shorter and weaker.

Size medium; form considerably compressed. Head with the fastigium much narrower than the proximal joint of the antennæ, subequal, apex blunt, moderately sulcate dorsad, the apex when viewed laterad distinctly exceeding the margin of the proximal antennal joint when the latter is in a vertical position; facial fastigium produced into a slender projecting process directed dorso-cephalad and touching the ventral surface of the apex of the fastigium of the vertex; eyes subglobose, moderately prominent; antennæ slender, broken in the type. Pronotum with the disk as in *G. rostrata* except that the median section bears a distinct longitudinal sulcus more apparent caudad than cephalad, while a rectangulate impressed pattern is placed slightly caudad of the middle; lateral lobes as in *rostrata*. Tegmina about three and a half times as long as the combined length of the head and pronotum, moderately lanceolate, the greatest width contained nearly four times in the length; costal margin regularly but slightly arcuate, sutural margin straight except where it curves to the narrowly rounded apex; median vein diverging very slightly distad of the middle and reaching the sutural margin well before the apex, discoidal vein bearing three rami in the distal section; the whole venation is peculiar in character, the principal veins irregular and connected by numerous adventitious veins. Wings extending beyond the tegmina a distance about equal to the length of the cephalic femora, apex moderately acute. Terminal abdominal segment truncate; supra-anal plate hastate, slightly constricted mesad; cerci simple, tapering, apex acute, the distal section moderately incurved and also with a distinct dorsal curve; subgenital plate strongly produced, reaching about to the end of the cerci, bearing three converging ventral carinæ, narrowly incised distad with the lateral portions of the apex of the plate moderately long, sharp and tapering. Cephalic femora slightly shorter than the pronotum, unarmed ventrad; median femora slightly less than half the length of the caudal femora, unarmed ventrad. Caudal femora very slightly shorter than the body, not strongly inflated proximad, armed with several small spines on the ventro-lateral margin; caudal tibiæ exceeding the femora by nearly the length of the head.

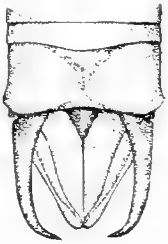

Fig. 13.—*Grammadera forcipata* n sp. Dorsal view of apex of male abdomen. (× 7.)

General color pale chromium green touched with yellowish on the abdomen and proximal portion of the tegmina and somewhat hoary on the pleura, coxæ and lateral lobes of the pronotum. Eyes hazel; tympanum of the tegmina with the principal veins strongly marked with bistre.

Measurements.

Length of body,	17 mm.
Length of pronotum,	4.9 "
Length of tegmen,	27 "
Length of caudal femur,	14.5 "

The type is the only specimen of this species seen by the author.

PHYLLOPTERA Serville.

1831. *Phylloptera* Serville, Ann. Sci. Nat., XXII, p. 142.

Type.—As designated by Kirby, *P. cassinæfolia.*

Phylloptera alliedea Caudell.

1906. *Phylloptera alliedea* Caudell, Proc. U. S. Nat. Mus., XXX, p. 238. [Sapucay, Paraguay.]

February, 1902 and 1905, May, 1902; two males, one female.

Phylloptera spinulosa Brunner.

1878. *Ph[ylioptera] spinulosa* Brunner, Monogr. der Phaneropt., p. 314. [Ypamena, São Paulo, Brazil.]

February, 1905; one male, one female.

The female individual has the tegmina with an ocellus as mentioned by Caudell. In neither specimen are the cephalic tibiæ sulcate dorsad.

The ovipositor of this species is very short and robust, the apex rectangulate, the distal half of the margins crenulate and the faces of the same portion tessellato-granulate. The ventral length of the ovipositor is six millimeters. Subgenital plate small, very strongly produced, divided to the base.

HYPERPHRONA Brunner.

1878. *Hyperphrona* Brunner, Monogr. der Phaneropt., pp. 28, 315.

Type.—*H. angusta* Brunner.

Hyperphrona signata n. sp.

Types: ♂ and ♀; Sapucay, Paraguay. December 19, 1904 (♂); February 24, 1905 (♀). (William Foster.) [Hebard Collection.]

Allied to *H. binotata* Brunner from the upper Amazon, agreeing with it in the coloration of the proximal joints of the antennæ, the proportions of the tegmina and the point of contact of the median vein, but differing in the absence of black from the remainder of the antennæ, the spiniform apex of the male cerci, the shorter ovipositor and the peculiar ocelliform marking of the margin of the tympanal field of the male tegmina.

Size rather small; form somewhat compressed. Head with the occiput very slightly rounded, vertex slightly declivent; fastigium trigonal, the margins slightly concave and the apex roundly tuberculate, the proximal portion having the margins roundly elevated and the middle sulcate, when viewed laterad the fastigium is seen to be strongly depressed mesad, with the apex somewhat elevated and not extending cephalad of the proximal joint of the antennæ; facial fastigium acute; eyes subglobose; antennæ half again as long as the greatest length, slender. Pronotum with the disk subdeplanate, laterad with the angles rounded and the greatest caudal width contained once and a half in the length, cephalic margin slightly emarginate, caudal margin strongly arcuate; lateral lobes slightly longer than deep, cephalic margin slightly sinuate, ventral margin rounded obtuse-angulate, caudal margin moderately arcuate with the humeral sinus moderately deep and broad. Tegmina slightly more than three times as long as the head and pronotum together, ovate-lanceolate, the greatest width contained about three and a third times in the length; costal and sutural margins regularly but not strongly arcuate, apex rounded; median vein diverging slightly proximad of the middle, simple or furcate,[4] reaching the sutural margin shortly proximad of the apex; anterior ulnar vein almost straight; tympanum of the male with the stridulating vein very stout. Wings extending beyond the tegmina a very short distance, narrowly rounded

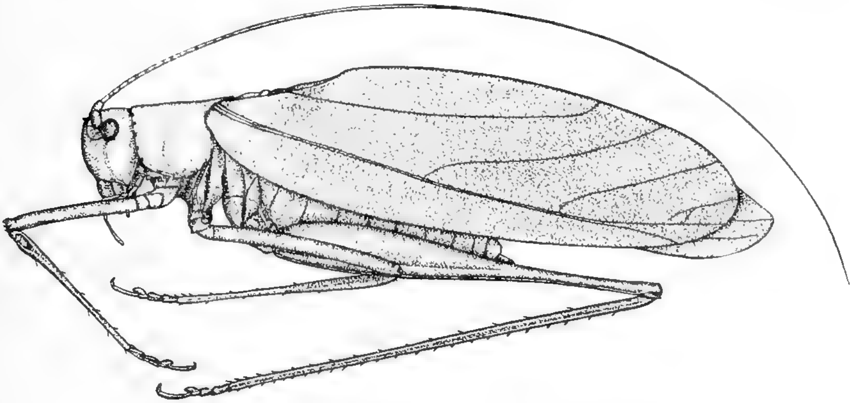

Fig. 14.—*Hyperphrona signata* n. sp. Lateral view of male type. (× 3.)

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[4] In the types furcate only on the left tegmen of the female.

at the apex. Terminal dorsal abdominal segment of the male with a very slight and broad median emargination; supra-anal plate reflexed, roughly semicircular; cerci stout at the base, short, tapering, the tips moderately hooked, acute; subgenital plate moderately produced, the apical portion much narrower than the base, apical margin truncate, false styles short and dentiform. Ovipositor about as long as the pronotum and half of the head, bent arcuate, broad, apex moderately acute, distal half of the dorsal margin distinctly crenulate, of the ventral margin obsoletely crenulate; subgenital plate small, rectangulate with the apex minutely rectangulate emarginate. Cephalic femora but little shorter than the head and pronotum together, unarmed; dorso-caudal margin of the tibiæ with four to five spines, one of which is placed at the distal extremity of the proximal inflation. Median femora equal to about half the length of the caudal femora, armed on the ventro-cephalic margin with two to three small, recumbent spines. Caudal femora slightly shorter than the length of the body, moderately inflated distad and with spines none or one on the ventro-cephalic margin; caudal tibiæ distinctly exceeding the femora.

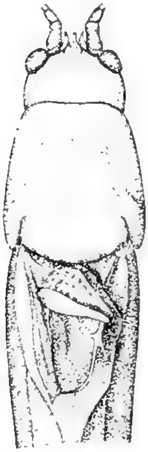

Fig. 15.—*Hyperphrona signata* n. sp. Dorsal view of head, pronotum and tympanum of male type. (× 5.)

General color buff-yellow becoming apple green on the tegmina, exposed portion of the wings and limbs. Eyes chestnut; antennæ very broadly and irregularly annulate with dragon's blood red. Pronotum with the disk regularly and the lateral lobes sparingly dotted with dragon's blood red, the margins being rather regularly checked with the same.

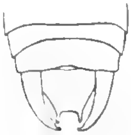

Fig. 16.—*Hyperphrona signata* n. sp. Dorsal view of apex of male abdomen. (× 6.)

Fig. 17.—*Hyperphrona signata* n. sp. Lateral view of ovipositor. (× 5.)

Tegmina sometimes[5] with an ochraceous premedian desiccated spot.

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[5] On the left tegmen of the female type.

margined on all but the caudal face with brown; tympanum of the male with an irregular median blotch of very pale greenish surrounded by a very irregular ring of liver brown; sutural margin narrowed touched mesad with liver brown.

Measurements.

	♂	♀
Length of body (exclusive of ovipositor),	17.3 mm.	18.3 mm.
Length of pronotum,	4.3 "	4.3 "
Length of tegmen,	23.2 "	21 "
Length of caudal femur,	17 "	16 "
Length of ovipositor,		5.5 "

A series of four male and six female paratypic individuals have also been examined. The months represented in the series are December, 1904, and January, February and March, 1905.

In size there is an appreciable amount of variation, in addition to which there also appears to be two forms irrespective of sex, one with the tegmina short as in the female type, the other with the tegmina longer and correspondingly slenderer as in the male type. The series also shows that the forking of the median vein is purely a variation not even individual, one tegmen in a number of specimens having the unbranched type, the other the reverse. The female type is the only specimen with the premedian tegminal spot, while the tympanal spot of the male with its surrounding ring is also seen to vary greatly in depth, though always present in that sex. In a number of specimens the tegmina are distinctly yellow proximad, and in one male the whole tegmina are of that color.

TURPILIA Stål.

***Turpilia paraguayensis** n. sp.

Types: ♂ and ♀; March 12 (♀) and 21 (♂), 1905. (William Foster.) [Hebard Collection.]

Closely allied to *T. mexicana* Brunner from Oaxaca and *T. linearis* Rehn from Costa Rica. From *mexicana* it differs in the general smaller size, the spined dorsal margin of the median femora and the acute subgenital plate of the femora. From *linearis* it differs in the lateral lobes of the pronotum being as long as deep, the tegmina slightly shorter and the cerci with a distinct apical spine.

Size moderately large; form elongate. Head with the occiput slightly rounded; fastigium strongly compressed, narrowly sulcate, apex blunt, separated from the blunt apex of the acute angulate facial fastigium by a very slight space; eyes large, subglobose, moderately prominent; antennæ probably exceeding the tips of the wings (slightly defective in the types), filiform. Pronotum with the disk strongly deplanate, slightly expanding in width caudad, the greatest caudal width contained slightly less than once and a half in the length; cephalic margin truncate, caudal margin arcuate, lateral angles distinct but narrowly rounded, a fine impressed longitudinal median line present on the disk; lateral lobes about as long as deep, ventro-cephalic angle very broadly rounded, humeral sulcus marked but shallowly, the caudal margin ventrad of this with a rounded obtuse angle from which the ventro-caudal margin is diagonally subtruncate. Tegmina elongate lanceolate, about four times as long as the combined length of the head and pronotum, the greatest width contained nearly five times in the length; costal and sutural margins slightly approximating, the apex rounded; discoidal vein with two rami in the distal section, both of which reach the apical margin; median vein diverging two-fifths the distance from the base, furcate. Wings extending beyond the tegmina a distance very nearly equal to the length of the pronotum, immediate apex rectangulate. Terminal dorsal abdominal segment of the male broadly and shallowly emarginate mesad and also on the lateral faces; cerci short, stout at the base, tapering, with the immediate apex sharply narrowed, hooked and spiniform, internal margin slightly before the middle provided with a thick, blunt, peg-like process; subgenital plate of the male produced, narrowed with a median ventral carina and lateral thickened rods which extend to the base of the short, slender styles, narrow distad margin of the plate with a rounded V-shaped emargination. Ovipositor as long as the head and half of

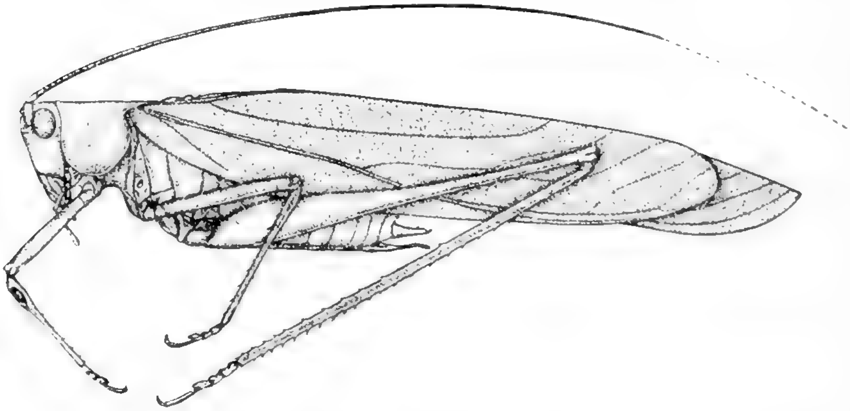

Fig. 18.—*Turpilia paraguayensis* n. sp. Lateral view of male type. (× 2½.)

the pronotum, considerably bent proximad, very slightly curved distad, the greatest width mesad and contained two and one-half times in the length, dorsal margin nearly straight and entirely crenulate, ventral margin considerably arcuate and crenulate in the distal fourth, apex slightly narrowed, rounded; subgenital plate of the female produced trigonal with slightly concave sides, apex narrowly truncate. Cephalic femora about equal to the pronotum in length, unarmed ventrad; the proximal inflation of the tibiæ supplied with a distal spine on the caudal margin. Median femora as long as the head and pronotum together, unarmed ventrad. Caudal femora about equal to the body in length, moderately inflated proximad, ventro-lateral margin with three to five spines distad, internal margin with six to seven spines; caudal tibiæ slightly longer than the femora.

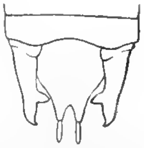

Fig. 19.—*Turpilia paraguayensis* n. sp. Dorsal view of apex of male abdomen. (× 6.)

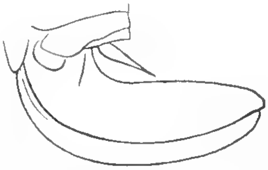

Fig. 20.—*Turpilia paraguayensis* n. sp. Lateral view of ovipositor. (× 5.)

General color dull greenish-yellow, the tegmina and wings apple green. Head with the eyes chestnut, antennæ with all except the two proximal joints vinaceous-cinnamon; pronotum with the caudal section of the disk apple green, the lateral angles sometimes marked with vinaceous; tegmina with the anal vein and sutural margin more or less distinctly marked with buff-pink; tibial foramina marked with dark brown, distal extremities of the tibiæ and the tarsi ochraceous buff; ovipositor orange-rufous.

Measurements.

	♂	♀
Length of body,	20 mm.	22.7 mm.
Length of pronotum,	5 "	5.5 "
Length of tegmen,	31 "	31.2 "
Length of caudal femur,	20.8 "	21.8 "
Length of ovipositor,		6.5 "

A paratypic series of five males and five females, taken in March, 1903, have also been examined and found to differ in no important characters from the type.

MICROCENTRUM Scudder.

***Microcentrum lanceolatum** (Burmeister).

1838. *Ph[ylloptera] lanceolata* Burmeister, Handb. der Entom., II, Abth. II, pt. I, p. 692. [Brazil.]

March, 1905; one female.

This individual is rather smaller than the Brazilian or Surinam material measured by Brunner,[6] but otherwise it is perfectly typical of the species.

Measurements.

Length of pronotum,	6.5 mm.
Length of tegmen,	42 "
Greatest width of tegmen,	13.5 "
Length of caudal femur,	22.2 "
Length of ovipositor,	6 "

This species has been recorded from Villa Rica, Paraguay, and Urucum, Matto Grosso, Brazil, by Giglio-Tos.

PSEUDOPHYLLINÆ.

DASYSCELUS Brunner.

1895. *Dasyscelus* Brunner, Monogr. der Pseudophyll., pp. 15, 118.

Type.—*D. atrifrons* Brunner.

Dasyscelus normalis Brunner.

1895. *Dasyscelus normalis* Brunner, Monogr. der Pseudophyll., p. 119. [Uruguay; Buenos Ayres.]

November, December and January, 1903 and 1905, April, 1903; six males, twelve females.

This species appears to have as a synonym *D. demigratus* Brunner, over which *normalis* has line priority. The differences cited are in the color of the face and in the length of the tegmina and limbs. The former of these characters is at once discredited by the fact that two types, one with a black face and the other with a pale face, are present in this series, the two extremes being connected by a number of intermediates. The length of the limbs varies with the general size and the present series shows more difference in size in the extremes than the typical measurements of *normalis* and *demigratus*, although the Sapucay individuals average larger than Brunner's material, which came in part at least from Buenos Ayres. The original localities given for *demigratus* are "Gabun, Buenos Ayres," but the former is unquestionably erroneous.

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[6] *Monogr. der Phaneropt.*, p. 336.

CONOCEPHALINÆ.

LAMNICEPS Bolivar.

1903. *Lamniceps* Bolivar, Revista Chilena de Hist. Nat., VII, núm. 3, p. 144

Type.—*L. giglio-tosi* Bolivar.

***Lamniceps giglio-tosi** Bolivar.

1903. *Lamniceps Giglio-Tosi* Bolivar, Revista Chilena de Hist. Nat., VII, núm. 3, p. 145. [Central Paraguay.]

November and December, 1904, February, 1905; four females.

These individuals are perfectly typical of Bolivar's genus and species, which is clearly, as stated by him, intermediate in position between *Copiphora* and *Lirometopum.*

One specimen is slightly smaller than the others, but otherwise no differences are noted.

The description of *Copiophora borellii* Giglio-Tos[7] appears to be that of a form closely related to this species.

CONOCEPHALOIDES Perkins.[8]

1899. *Conocephaloides* Perkins, Fauna Hawaiiensis, Orth., p. 13.

Type.—*C. hawaiiensis* Perkins = *Conocephalus remotus* Walker.

***Conocephaloides ichneumoneus** (Bolivar).

1884. *Conocephalus ichneumoneus* Bolivar, Artópod. Viaje al Pacífico, Neuropt. y Ortópt., p. 90, lám. 2, fig. 10. [Apiahy, Brazil.]

December, 1904; two females.

This specimen fully agrees with Bolivar's description, except that the pronotum and tegmina are very slightly longer and the ovipositor slightly shorter.

The type locality in the State of São Paulo and this record constitute the known localities for the species.

***Conocephaloides pichinchæ** (Bolivar).

1881. *Conocephalus Pichinchæ* Bolivar, Anales Soc. Españ. Hist. Nat., X, p. 498. [Pichincha, Ecuador.]

November, 1904; one male.

This individual is referred here with considerable doubt, but it is clearly related to this species and *guttatus*, with a number of which

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[7] *Bollett. Mus. Zool. Anat. Comp. Torino,* IX, No. 184, p. 40. [Luque, Paraguay.]

[8] The author is compelled with considerable reluctance to adopt this name, based on an aberrant form of the genus, in preference to the familiar application of *Conocephalus* Thunberg. After examining the literature involved it is evident, as has been shown by Kirby (*Synonym. Catal. Orthopt.*, II, pp. 241, 274 and 279), that Thunberg's *hemipterus* is identical with *Gryllus conocephalus* Linnæus, which by the rule of tautonomy is the type of *Conocephalus* Thunberg. The latter genus, however, is not cancelled by the fact that it is based on a specific name, as Kirby so treats it, but instead it replaces *Anisoptera* Latreille and *Xiphidion* Serville.

latter species it has been compared. From the original description of *pichinchæ* it differs in its apparently broader tegmina, its unarmed cephalic femora and slightly longer caudal femora. The tibiæ bear the very apparent distal blackish-fuscous markings originally described.

Conocephaloides pustulatus (Redtenbacher).

1891. *Conocephalus pustulatus* Redtenbacher, Verhandl. K.-K. Zool.-botan. Gesell. Wien, XLI, p. 395. [Theresopolis, Brazil.]

November and December, 1904, January, 1905; seven males, five females.

This series shows a moderate amount of variation in size, chiefly in the length of the tegmina. Both color phases are in the series at hand, the green, however, predominating.

Kirby has recently[9] applied the name *exaltatus* Walker[10] to this species, but Walker's description does not agree in several details with the material before us and Redtenbacher's diagnosis perfectly characterizes the species. In consequence we prefer to use Redtenbacher's name for the Paraguayan and south Brazilian form until its relationship to Walker's species is more clearly understood.

***Conocephaloides maxillosus** (Fabricius).

1794. *Locusta maxillosa* Fabricius, Entom. Syst., II, p. 37. [America.]

March, 1905; one female.

The range of this species to the south now appears to be limited by southern Brazil (Rio Janeiro, Theresopolis), Paraguay and Bolivia.

***Conocephaloides maculosus** (Redtenbacher).

1891. *Conocephalus maculosus* Redtenbacher, Verhandl. K.-K. Zool.-bot. Gesell. Wien, XLI, p. 396. [Lages, Santa Catharina, Brazil.]

December, 1904; one male.

This individual differs somewhat in its measurements from the original female type, but such differences may be sexual, and as far as can otherwise be determined from the original description it represents this species. The measurements may be of interest:

Length of body, ...	27.5 mm.
Length of pronotum.	8.1 "
Length of tegmen.	37.5 "
Length of caudal femur, ...	21.5 "

***Conocephaloides saturatus** (Griffini).

1891. *Conocephalus infuscatus* Redtenbacher (not of Scudder, 1875), Verhandl. K.-K. Zool.-bot. Gesell. Wien, XLI, p. 398. [Medellin; St. Vincent, Lesser Antilles; Cuba; Venezuela; Surinam; Cayenne; Brazil; Rio Grande and Theresopolis, Brazil; Peru.]

1899. *Conocephalus saturatus* Griffini, Miscell. Entom., VII, p. 5.

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[9] *Synon. Catal. Orth.*, II, p. 243.

[10] *Catal. Derm. Salt. Brit. Mus.*, II, p. 311. [Venezuela.]

March, 1905; three females.

In these specimens the length of the tegmina varies from 33 to 38 millimeters, the caudal femora from 24 to 25.5 and the ovipositor from 34 to 34.5. The ovipositor is appreciably longer than the measurements given by Redtenbacher (26–28 mm.), but otherwise the specimens are perfectly typical.

***Conocephaloides brachypterus** (Redtenbacher).

1891. *Conocephalus brachypterus* Redtenbacher, Verhandl. K.-K. Zool.-bot. Gesell. Wien, XLI, p. 400. [Brazil.]

February, 1903; one female.

This individual has several spines on each of the cephalic and median femora, but otherwise it fully agrees with the original description.

***Conocephaloides rugosicollis** (Bolivar).

1881. *Conocephalus rugosicollis* Bolivar, Anales Soc. Españ. Hist. Nat., X, p. 496. [Huasco, Chile.]

November and December, 1904, January, February and March, 1905; seven males, six females.

As far as can be determined from the several published descriptions of this species the Paraguayan series before us is referable to *rugosicollis.* In the degree of contiguity of the vertex and frontal fastigium there is, however, considerable variation, ranging from individuals with the two distinctly touching to others in which they are slightly but appreciably separated. In no other character, however, can the material be separated, and the majority of the series is rather intermediate between the two.

The figure of the tegmen given by Redtenbacher[11] is not exactly as seen in the Paraguayan specimens, as the obliquely truncate apex of the tegmen is not sinuate in the latter series.

As the female of this species has never been described a few notes may be of interest.

Ovipositor less than half the length of the tegmina, slightly bent proximad, straight otherwise, thick distad, the greatest width at about a fourth the length from the apex, latter acute; subgenital plate with a deep median sinuate V-shaped emargination.

Measurements.

Length of body (exclusive of ovipositor),	31	mm.
Length of pronotum,	7.9	"
Length of tegmen,	41	"
Length of caudal femur,	24.2	"
Length of ovipositor,	18.3	"

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[11] *Verhandl. K.-K. Zool.-bot. Gesell. Wien,* XLI, taf. III, fig. 44.

AGRÆCIA Serville.

1831. *Agræcia* Serville, Ann. Sci. Nat., XXII, p. 152.

Type.—*Locusta punctata* Serville.

***Agræcia maculata** Redtenbacher.

1891. *Agræcia maculata* Redtenbacher, Verhandl. K.-K. Zool.-bot. Gesell. Wien, XLI, p. 455, taf. IV, fig. 63. [Theresopolis, Brazil.]

November and December, 1904; nine males, eleven females.

These individuals are perfectly typical of the species except for their smaller size. Considerable variation in size is noticed in the female sex, but no specimen is as large as the measurements given by Redtenbacher.

The cerci of the male are short, stout and with the apex abruptly tapering; subgenital plate with the apex broad, truncate and with considerable sized lateral false styles.

The measurements of an average male and the extremes of the female sex are here given:

	♂	♀	♀
Length of body,	26 mm.	28.5 mm.	33.5 mm.
Length of pronotum,	7 “	7 “	7.6 “
Length of tegmen,	31 “	30.5 “	36.5 “
Length of caudal femur,	16.5 “	17.2 “	18.5 “
Length of ovipositor,		14.5 “	15.7 “

XIPHELIMUM Caudell.

1906. *Xiphelimum* Caudell, Proc. U. S. Nat. Mus., XXX, p. 241.

Type. *X. amplipennis* Caudell.

Xiphelimum amplipennis Caudell.

1906. *Xiphelimum amplipennis* Caudell, Proc. U. S. Nat. Mus., XXX, p. 241. [Sapucay, Paraguay.]

March, 1905; seven males.

These specimens fully agree with the original description of this beautiful species.

CONOCEPHALUS Thunberg.[12]

1815. *Conocephalus* Thunberg, Mém. l'Acad. Imp. Sci. St. Pétérsb., V, pp. 214, 271.

Type by tautonomy *C. hemipterus* Thunberg = *Locusta conocephalus* Linnæus.

1831. *Xiphidion* Serville, Ann. Sci. Nat., XXII, p. 159.

Conocephalus longipes (Redtenbacher).

1891. *Xiphidium longipes* Redtenbacher, Verhandl. K.-K. Zool.-bot. Gesell. Wien, XLI, p. 505, taf. IV, fig. 81. [Buenos Ayres, Argentina; Montevideo, Uruguay; Rio Grande do Sul and Santa Catharina, Brazil; Peru(?).]

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[12] See note on page — under *Conocephaloides*.

March, 1905; one male.

This specimen has been compared with a pair from Carcarañá, Argentina.

Conocephalus saltator (Saussure).

1859. *Xiphidium saltator* Saussure, Revue et Magasin de Zoologie, 2e ser XI, p. 208. [Guiana.]

March, 1905; one male, four females.

The ovipositor is practically straight in all the females and about thirteen millimeters in length.

The species ranges from Cuba to Montevideo, Uruguay.

Conocephalus strictoides (Caudell).

1906. *Xiphidium strictoides* Caudell, Proc. U. S. Nat. Mus., XXX, p. 242. [Sapucay, Paraguay.]

April, 1902; one female.

This specimen has the tegmina, caudal femora and ovipositor somewhat smaller than in the type measurements, but in all other characters the individual agrees perfectly with the original description, except that the dorsum of the abdomen is marked in purplish brown with a pattern resembling that of *C. strictum*.

GRYLLACRINÆ.

CAMPTONOTUS Uhler.

1864. *Camptonotus* Uhler, Proc. Entom. Soc. Phila., II, p. 548.

Type.—*C. scudderi* Uhler (= *Gryllacris carolinensis* Gerstaecker).

***Camptonotus australis** n. sp.

Types: ♂ and ♀; Sapucay, Paraguay. November 10 (♂) and December 19 (♀), 1905. (William Foster.) [Hebard Collection.]

Allied to *C. carolinensis* (Gerstaecker) and *affinis* Rehn, but differing from both in the very robust caudal femora and the heavy, more regularly arcuate and less attenuate ovipositor.

Size medium; form as usual in the genus; surface glabous. Head with the occiput well arched, longitudinally and transversely; vertex very broad and evenly rounding into the front; face somewhat flattened; eyes elongate reniform; antennæ about four times as long as the body. Pronotum with the dorsal length slightly shorter than the greatest width, the dorsal outline when viewed laterad slightly convex; cephalic margin of the disk truncate, caudal margin very broadly and shallowly triangular emarginate; lateral lobes broadly rounding into the disk, longer than deep, ventral margin truncate, ventro-cephalic angle obliquely rounded, ventro-caudal angle obliquely subtruncate. Mesonotum and metanotum with their caudal margins very slightly arcuate. Abdomen somewhat compressed; terminal dorsal abdominal segment of the male moderately inflated, the apical margin rotundate emarginate, a median longitudinal carina present on the distal half; male cerci simple, terete, acute, the length about equal to that of the terminal abdominal segment; subgenital plate of the male short, apical margin obtuse-angulate emarginate; ovipositor nearly equal to half the length of the body, regularly arcuate, moderately stout proximad and regularly tapering to the acute apex; subgenital plate of the female broad trigonal, apex narrowly and shallowly emarginate. Cephalic and median limbs moderately robust. Caudal femora nearly two and a half times the length of the pronotum, strongly inflated, the greatest width contained nearly two and a half times in the length, ventro-lateral margin with three to four spines, internal margin armed distad with two spines; tibiæ not exceeding the femora in length.

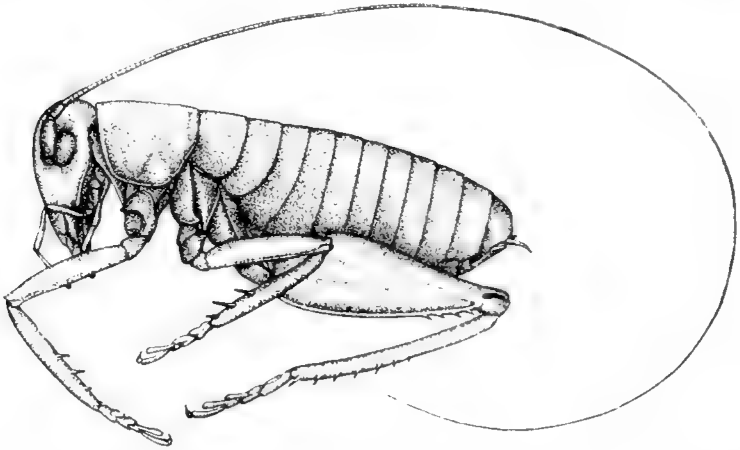

Fig. 21.—*Camptonotus australis* n. sp. Lateral view of male type. (× 4.)

Fig. 22.—*Camptonotus australis* n. sp. Lateral view of ovipositor. (× 5.)

General color ochraceous becoming buffy on the limbs, particularly the caudal tibiæ which also have a faint wash of green distad. Eyes bistre.

Measurements.

Length of body	13.5 mm.	16 mm.
Length of pronotum	3.2 "	3.3 "
Length of caudal femur	7.3 "	8.9 "
Length of ovipositor		7 "

A paratypic series of four males and three females, taken November, 1904, have also been examined. Aside from a considerable amount of variation in size no differences worthy of note are apparent.

GRYLLIDÆ.

GRYLLOTALPINÆ.

SCAPTERISCUS Scudder.

Scapteriscus camerani Giglio-Tos.

1894. *S[capteriscus] Camerani* Giglio-Tos, Bollett. Mus. Zool. Anat. Comp. Torino, IX, No. 184, p. 45, plate figs. 13 and 16. [Province of San Pedro, Asuncion, Paraguay.]

January, 1903; one female.

This individual is slightly smaller than the original measurements for the same sex, but otherwise is perfectly typical.

GRYLLINÆ.

GRYLLUS Linnæus.

Gryllus assimilis (Fabricius).

1775. *Acheta assimilis* Fabricius, Syst. Entom., p. 280. [Jamaica.]

February, 1905; one male, three females.

These specimens are much paler than Mexican individuals of this species, three of them being especially light in color.

Gryllus argentinus Saussure.

1874. *Gryllus Argentinus* Saussure, Miss. Scientif. au Mex. et l'Amér. Cent., Orth., p. 399. [Southern Brazil; Argentine Republic; the north of Patagonia; Buenos Ayres; Bahia Blanca; Rio Negro of Patagonia.]

July, 1902, February and March, 1905; two males, two females.

These specimens agree very well with an authentic pair of this species from Buenos Ayres and Rio Grande do Sul, Brazil, received from Dr. Saussure.

ENEOPTERINÆ.

ENEOPTERA Burmeister.

1838. *Eneoptera* Burmeister, Handb. d. Entom., II, Abth. II, pt. I, p..736.

Type.—*Acheta brasiliensis* Fabricius (= *Gryllus surinamensis* De Geer).

Eneoptera surinamensis (De Geer).

1773. *Gryllus Surinamensis* De Geer, Mém. Ins., III, p. 519, pl. 43, fig. 1 [Surinam.]

March, 1905; three males, two females.

THE ANATOMY OF CALIFORNIAN HALIOTIDÆ.[1]

BY CLAYTON F. PALMER.

The past few years have witnessed great additions to our knowledge of the anatomy of mollusks, and in this phylum probably no group has received more attention than the prosobranchs. And it is equally true that while the bibliography relating to this last named division has assumed large proportions the results are often of a conflicting nature. Even the comparatively limited family of the Haliotidæ have received their share of consideration, and unfortunately a proportionate amount of confusion as well. It is thus apparent that the anatomy of *Haliotis* merits more study, especially on account of the position this mollusk occupies among archaic forms. Something over a year ago, while studying in the zoology department of Stanford University, Dr. Harold Heath suggested to me that the anatomy of *Haliotis* deserved further investigation. The western coast of North America is the habitat of several species of this mollusk, and two of these are readily procurable from the university. Therefore material was never lacking, and as it was of relatively giant size the following results are believed to be correct.

The material consisted of specimens of *Haliotis rufescens* Swn. and *H. cracherodii* Leach, the red and black abalone respectively. These were taken of various sizes and were examined both by gross dissection and in section. So far as I know, no anatomical details have ever been published concerning any species of *Haliotis* found in this part of the world. Hence the following may serve to corroborate, to some extent, certain facts relating to the genus, and to correct certain misstatements as well.

Upon opening the mantle cavity of *Haliotis*, one first sees the two well developed ctenidia of the distinct bilamellate type, the left being somewhat the larger. Near their bases and against the ventral wall of the rectum may be seen the papilla-like openings of the right and left ureters (text fig. A, *RU*, *LU*); the right aperture generally has the

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[1] The present paper was completed over four years ago, and was intended to form a division of a more extended work relating to the anatomy of various mollusks from the western coast of the United States. Owing to other duties it is impossible to carry out the proposed plan, at least within the near future, and the results in their original form are herewith presented.

more tumid lips of the two. The left duct leads directly into the main cavity of the excretory organ, while the one of the other side opens into a kind of vestibule, which in turn communicates with the main body of the organ.

The *left kidney* in *Haliotis* (fig. 1, Pl. XXX, *LK*) has become greatly reduced and highly modified; it is now known generally as the papillary sac, a term applied to homologous organs in other members of the group. It lies against the left side of the rectum (*R*), and extends backward and to a certain extent over the anterior and left surface of the pericardial wall (*P*). With the exception of its right or inner side, where it is contiguous with the rectum, its walls are produced into well developed papillæ.

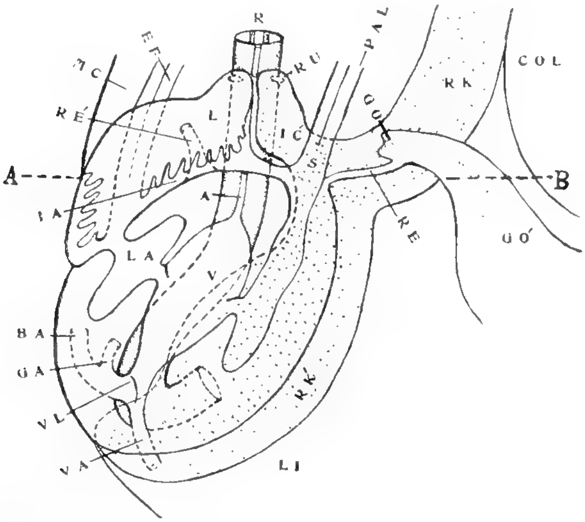

Fig. A.—Diagram showing relations of nephridia, pericardium, gonoduct, etc. For lettering see explanation of plate.

Just what functions are sustained by this organ is not clear, though several theories have been advanced. Pelseneer ('96) believes it is phagocytic in character. Its walls and papillæ are richly supplied with the purest blood; the organ seems to be the principal excuse for the existence of the peculiar inter-auricular sinus (fig. A, *IA*) described by other writers for this genus. This blood sinus connects the right and left auricles, coursing along the outer edge of the wall separating the pericardium and left kidney. In sections a connection may be traced between the wall of the papillary sac and the basibranchial sinus. Its blood supply is similar therefore to that in European species of *Haliotis*, as described by Perrier ('89), Wegmann '(84) and other workers. Whatever function is served by the papillæ, it is very evident, judging from their appearance, that they are actively secretory by nature.

The *right kidney* (fig. A, *RK, RK'*) is the principal excretory organ in *Haliotis*. It is well developed and occupies, in the species under discussion, a position very similar to that described for the European species, *H. tuberculata* and *H. glabra* (Haller). From the small chamber (*IC'*) immediately behind the lobe (*RU*), serving as a mouth to the ureter, there is a species of vestibule opening posteriorly into larger cavities at the right (*RK*) and left (*RK'*). The junction of these is under the forward inner corner of the pericardium (*P*), the vestibule (*IC'*) corresponding in position to the papillary sac. The last named organ and the vestibule of the right kidney are separated by the rectum, which is supported between them by a thin dorsal and ventral partition, shown to some extent in fig. 3, Pl. XXX, although this section is too far posterior to indicate clearly their true relations.

Bouvier ('88) recorded an inter-renal communication in *Ampullaria*, but this is emphatically denied by Pelseneer ('96). Haller has reported such a state of affairs in *Haliotis* "*glabra*" and *Trochus* "*gibberosus*," but very little acceptance has been accorded to the statement. Communication may possibly exist in certain mollusca, but it is doubtful if such a connection is present in the genus *Haliotis*. By referring to figs. 1, 3, 5 it will be seen that, in addition to the close contact of the two nephridia as just explained, they are in close proximity at the bottom of the chamber (*IC*). However, a careful examination of several series of sections through these regions gives no hint of any definite connection.

From its junction with the vestibule the cavity of the posterior part of the kidney (*RK'*) extends beneath the pericardium and around its inner and posterior surface. The lumen of the anterior portion (*RK*) is directed forward toward the columellar muscle. Near the latter it enlarges considerably in a dorso-ventral direction, and becomes in shape and size like an almond seed in specimens of average size. The outlines of the walls of the kidney itself correspond closely with the cavities just described, and accordingly are similar in all essential regards to the species described by Wegmann ('84), Totzaur ('02) and others.

The tissue of the right kidney is nowhere very thick; it is disposed more as an intervisceral packing material. The division (*RK'*) in the region of the pericardial cavity is a curved mass of spongy tissue, lying under and about the inner side of the pericardium and ending immediately behind its postero-lateral corner. The intestinal lobe (*RK*) is somewhat strap-shaped and extends well forward toward the head. In color the right kidney is of a grayish brown tint, varying to a buff shade. Histologically the tissue consists of minute pouches, or acini, which open into small channels, these into larger ones, and so on to the main ducts. The cells are of the usual cubical form, and are crowded with pigmented waste products of granular appearance. I have seen nothing in my material that seems to warrant any further discussion of the tissue, which has been well described by others.

The *reproductive system* in *Haliotis* is interesting, among other things, because of the lateness of its development, and the rapidity of the same when once begun. Careful microscopical examination of small specimens reveals at best only the slightest development or not even a trace of a germinal epithelium. Even in specimens 3 cm. long the latter is demonstrated with difficulty. In average-sized individuals, and larger, the gonad is well developed, especially at the height of the breeding season, which occurs early in the year. The testis is of a cream color, the ovary a slaty green. There is practically no difference in size between the glands of the two sexes, very nearly the entire surface of the main visceral mass being covered by the organ.

In small specimens of *H. cracherodii*, of about 2 cm. in length, the whole of the visceral mass to the right of the pericardium, except one small area (a portion of the stomach), is of a brownish color. This is due to the extensive liver, which forms the horn-shaped portion of the visceral mass, extending along the right posterior curve of the columellar muscle. At the left of the cæcum the stomach is in contact with the body wall, and projecting through the liver forms the i regular whitish area noted above. Examined externally specimens fully 5 cm. in length show no changes from the condition just described. From this time forward, however, the development of sexual products commences to manifest itself. The first outward indication is a grayish tinge at the tip of the horn (of the visceral mass), which gradually extends itself over the remainder of the liver. Individuals 6, or at most 7, cm. in length possess a grayish coating entirely investing the horn. This thickens, and in specimens 8 cm. long there is a well established gonad extending to some extent over the main visceral mass. As may be supposed, the thickest part is at the tip of the horn, where it measures about 3 mm. in depth. The males and females of this size exhibit practically no difference in gonad coloration.

Sections through the gonad of males and females between 7 and 8 cm. long revealed sperms or ova that while immature are in well advanced stages of development. The ova were of oval form, and the heads of the sperms were bacillus-shaped. Even under very high powers no filaments could be detected, though they may probably have been destroyed by reagents. The material, it should be added, was collected early in October, while the breeding season does not begin until some time in January or February. From the above it is evident that *H. cracherodii* does not commence to breed until it is more than 9 cm. in length, and it is certain that sexual activity begins at a somewhat earlier period with the males than the females.

In large specimens the gonad may attain as much as half an inch in thickness along the posterior border of the columellar muscle. And the cavity, only potentially present in early stages, becomes now very clearly defined and of considerable size. Tracing it posteriorly and then to the left one may discover the funnel-shaped gonoduct (*GO'*, figs. 2, 3, 4, 5, text fig. A). It bends somewhat to the left and narrows to a flattened tube from 3 to 6 mm. in diameter. This opens into the cavity of the kidney, at the left border of the gonad, and the mouth is provided with a flexible valve-like flap, which may serve to prevent the entrance of any substances from the kidney. I have found ripe eggs and sperms in the gonoducts of specimens taken the last of December. Perrier ('89) states that the gonoduct of *Haliotis* is closed except at the breeding season, but this is certainly not the case in the two species studied by me. In all stages the duct has been open and there was a free passage from the gonad to the kidney. There was no organic obstruction even in specimens 2 cm. long. Fleure ('02) found ova in the pericardial cavity of *H. tuberculata*, but this is probably an accidental occurrence, since in the western species the sex products pass from the kidney directly to the exterior.

The *renopericardial canals* of prosobranchs have of late been the subject of much controversy, and at the present time the results of various authors are decidedly conflicting. Working upon the European species Wegmann ('84), Perrier ('89) and Erlanger ('92), besides other investigators, found a left renopericardial canal only. Fleure ('02) examined the same species very carefully, but curiously could find no left canal, though he did demonstrate the existence of a right canal. About the same time Totzaur ('02) found both canals, but neither of these investigators has given us any figures nor a detailed account of these much discussed organs. Some time previous to the reports of the above named authors, Haller stated that he had found both canals in *H. glabra*, and was thus, so far as I am aware, the first to report such a state of affairs for any species of *Haliotidæ*.

Haliotis undoubtedly possesses two renopericardial canals. I have been able to demonstrate their presence, in the two species under discussion in this paper, both macroscopically and microscopically. They may be seen readily in material from upwards of 0.5 cm. in length (the smallest specimens I had) to that over 13 cm. long.

For a study of these canals it will be well to commence with a consideration of sections through specimens about 1.5 cm. long. The first five figures should give one a fairly clear idea of the relations of the renopericardial canals, pericardium, kidneys and gonoduct.[2] Neither of the canals is very long, and both may be regarded as funnel-like outgrowths of the pericardium. The left canal (*RE*) is, however, much the wider, and can be followed far more readily in material properly prepared.

The left renopericardial canal originates as a wide tube opening into the pericardial cavity somewhat ventral to the point where the rectum pierces the front wall of the same. Fig. 2 (*RE′*) shows the mouth of this duct at the left lower corner of the pericardium, and that of the right canal (*RE*) at the opposite corner. The former takes an oblique course along the side and floor of the papillary sac (*LK*), into which it opens between the papillæ. Throughout practically its entire extent it is lined with epithelial cells of moderate height apparently totally devoid of cilia.

The right renopericardial canal (*RE*) is a more slender duct, extending towards the gonoduct (*GO*) from the inner, forward angle of the pericardium. Its inner opening is relatively narrow and is situated immediately beneath the right branchial sinus (fig. 2, *S*). At the right of the pallial sinus (a branch of the branchial sinus) it may be seen entering the side of the gonoduct (fig. 3). In fig. 5, which is six sections farther forwards, the gonoduct may be seen opening freely into the cavity of the kidney at the point *GO*. In this connection it is to be noted that the ventral wall of the gonoduct is very thin and extends for some distance over the cavity of the kidney, unsupported by anything except the body wall above it. The right renopericardial canal in specimens of this size (1.5 cm.) discharges into the left side of the gonoduct, very close to the mouth of the latter—more so, in fact, than is shown at *GO* in fig. A.

An examination of large specimens of *Haliotis* by gross dissection did not at first appear to confirm the results given above. According-

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[2] The sections shown in figs. 1, 2, 3, 4, 5 of Pl. XXX were made parallel with the line A–B of fig. A.

ingly similar sections were made through the same region in individuals of both species, and neglecting individual variation the series showed some interesting relations of organs decidedly unlike those just noted. From the study of specimens of smaller size it was found that between 1.5 and 3 cm. in length the renopericardial canal and gonoduct undergo a considerable amount of displacement. By referring to fig. 4, representing a section through an individual 3 cm. long, it will be seen that *the right renopericardial canal and gonoduct have their apertures facing each other.* Material of this size gave very satisfactory results with both species, and a study of sections of animals from 1.5–3 cm. long made it readily possible to trace where these organs go in assuming the adult condition.

In individuals 1.5 cm. long the renopericardial canal, which opens into the gonoduct near its end, gradually shifts forward to open by the latter by a common lipped mouth. From this stage on the common mouth of the canal and duct appears to change its position very little, if at all. At the same time the gonoduct, in some inexplicable way, forms for itself a second outlet into the kidney, a short distance away from the original mouth. It is this last named opening that is shown in fig. 4, and the one that in the adult serves for the discharge of the sex products.

The above statements are interesting not only in themselves, but they appear to me to explain certain other statements lately made. Tobler ('01) reported a second communication between the gonoduct and kidney in *Parmophorus,* and was followed by Totzaur ('02) with the statement that he had found a similar state of affairs in *Haliotis.* Neither of these investigators gives the point any explanation; nevertheless I believe both cases may come under the above interpretation.

Blood System.—In the following discussion of the organs of circulation an attempt has been made to explain certain apparently incorrect statements regarding this genus. Generally speaking the broader features of the system are already known. The work of Milne Edwards ('47), Lacaze Duthiers and especially Wegmann ('84) have done much to advance our knowledge along this line. Briefly reviewing their work in the light of the California species, it may be said that the heart is situated on the left posterior side of the visceral mass, a little behind the mantle cavity. The two auricles open into the ventricle, pierced by the rectum, and ventricular valves prevent the backward flow of blood. A small anterior aorta (fig. D, *Ao*) supplies blood to a portion of the mantle on the left side. The first part of its course is upon the dorsal wall of the rectum.

The lower posterior end of the ventricle originates the short common aorta, which at its first branch bears a membranous valve. The visceral aorta, arising posteriorly, bends beneath the posterior end of the visceral mass, supplying blood to the stomach, liver, gonad and that portion of the right kidney immediately behind the pericardium. The main artery continues anteriorly, coursing along in the wall of the body just above the epipodium. It soon develops the genital aorta, which proceeds towards the columellar muscle, giving off branches to the alimentary canal, right kidney, liver and gonad. It continues along the horn-shaped portion of the visceral mass, branching freely through the liver and gonad.

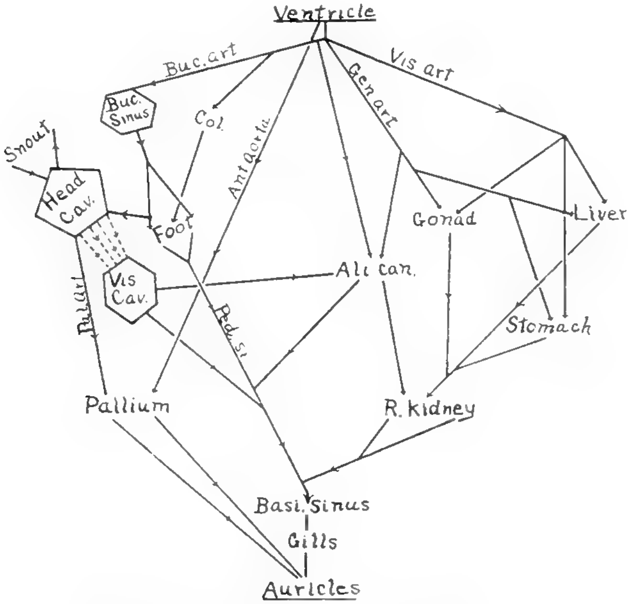

Fig. B.—Diagram of *Haliotis* circulation.

The main or buccal aorta bends in a gentle curve to the buccal mass, developing, as it courses forward, branches to the viscera. The radula and its sheath lie freely in its lumen (figs. C, D, *BAo*), and more anteriorly it originates a branch of moderate size, which, owing to the fact that it supplies the great adductor muscle, may be known as the columellar artery (fig. D, *Co*). Reaching the head, the buccal aorta increases in calibre to envelop the buccal mass, thus forming the buccal sinus. Ventrally this sinus passes into the junction of the two pedal arteries (fig. D, *Lpa*), with which, by three short canals, the sinus about the pleuro-pedal ganglia is brought into connection. The foot is thus supplied by the above-mentioned vessels and by the neural arteries surrounding the ventral nerve cords. The fact that so important a portion of the nervous system literally floats in a blood sinus gives an excellent clue to this portion of the system in *Haliotis*. By referring to fig. C it will be seen that the blood, having once gained the sinus about the pleuro-pedal ganglia, is free to work its way about the intestines, and to some extent the remainder of the viscera. The path is not so unobstructed as one might imagine from the figure, but even though a considerable amount of connective tissue does surround the gut, it is nevertheless penetrated by numerous fairly well defined channels.

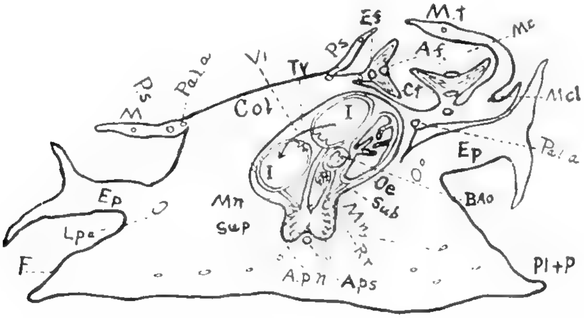

Fig. C.—Section passing through front end of columellar muscle and pleuro-pedal ganglia. *Aps*, anterior pedal sinus; *Apn*, nerves to front end of foot; *Lpa*, lateral pedal artery; *Mn*, mantle nerves; *Œ*, œsophagus; *Pal.a*, pallial artery; *Pl+p*, pleuro-pedal ganglia; *Ps*, pallial sinus; *Rr*, radula muscle; *Sub*, *Sup*, sub- and supra-intestinal nerve. For explanation of other letters see plate.

Following back along the cerebro-pleural and pedal connectives the blood finds its path readily into the head cavity. This surrounds the buccal cavity and lies between its wall and that of the head. In it the cerebral ganglia are situated, together with the salivary and sugar glands. It is somewhat indefinitely bounded, but it may be said that it extends posteriorly beyond the hinder border of the sugar glands. Its wall is of a spongy nature, permitting the blood to ooze out of the head cavity into the visceral cavity. The latter is a true hæmocele, as reported by Woodward for *Pleurotomaria*. At the left upper and posterior end of the head cavity there arises, by two or three roots, the main pallial artery. Passing along the left side of the neck in the body wall (fig. C, *Pal.a*), it turns somewhat to the left and enters the extreme left edge of the mantle. Sending a branch anteriorly it bends sharply posteriorly and follows the mantle border around the visceral mass and up the right side. The sections show (figs. C, D, *Pal.a*) this vessel on both sides of the body. The artery becomes difficult to trace at the forward left side of the mantle which borders the columellar muscle. This is the vessel which Milne Edwards and Wegmann describe as a vein, but this is certainly an error, as it does not connect with the visceral cavity, but with that of the head.

The foot of *Haliotis* varies somewhat from that of the Old World species so far as the circulation is concerned. The single lateral pedal artery of each side of the epipodium in *H. rufescens* (figs. C, D, *Lpa*) is curiously enough represented in *H. tuberculata*, according to Wegmann, by two arteries, termed by him the superior pedal and inferior external pedal arteries. The foot is pierced freely by blood sinuses, and injections pass with ease throughout its entire extent even from arteries into veins or *vice versa.* It is therefore readily seen that the blood of the foot is collected into a large median sinus, of which two sections may be seen in fig. D, *PS*. At the front end of the foot this makes a gentle bend upward immediately behind the pleuro-pedal ganglia, and turning to the left along that side of the columellar muscle proceeds posteriorly. Throughout the remainder of its course, this sinus is partially imbedded in the anterior lobe of the right kidney (fig. D, *PS*), which it drains while *en route* to the basi-branchial sinus. Its lumen is of more than average size and may be readily followed. It is therefore with questioning that one considers Wegmann's statement to the effect that anteriorly this sinus in *H. tuberculata* empties into the visceral cavity. Can there be such a radical difference between two

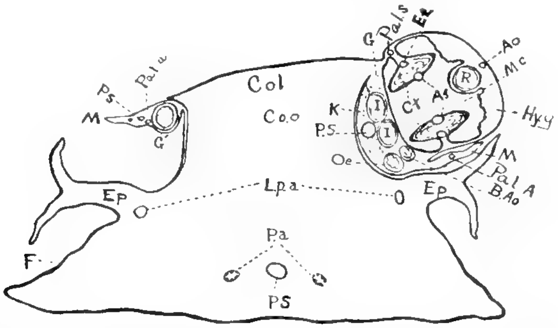

Fig. D.—Transverse section through middle of columellar muscle of *H. rufescens.* *Ao*, anterior aorta; *Co*, columellar muscle; *G*, G^1, gonad; *K*, anterior portion of right kidney. For other letters see explanation of plate.

species of the same genus? Here again it is interesting to note that *Pleurotomaria* and *Haliotis rufescens* agree, although Woodward, who had very little material, was not entirely sure of his ground.

The basi-branchial sinus (Pl. XXX, fig. 6, *Si*) is in reality but the branchial end of the median pedal sinus, that receives also a few veins (*NV*) from the right kidney. It is provided with a membranous valve (*V*), which, like the aortic valve, has not been hitherto described, so far as I am able to learn. The former suggests a like structure found in the Cephalopoda that likewise prevents a backward flow of blood from the ctenidia. Reaching these last-named organs through the afferent sinuses (*Af*, *Af′*) the blood is collected by the efferent vessels (figs. C, D, *Ef*), and with that of the pallial sinuses passes to the auricles, together with blood brought by several minor veins. Here, as in *H. tuberculata* and some other prosobranchs, there is a well-developed sinus connecting the two auricles.

Though difficult to demonstrate, it appears that the main venous sinus, mentioned in the preceding paragraph, also partially drains the visceral cavity and portions of the intestines. The kidney, especially the anterior portion, probably aids to a considerable extent in the operation. But the larger part of the blood passing through this organ is that distributed to the viscera, etc., by the visceral and genital arteries. This is carried to the right kidney by a prominent sinus that is seen lying at the border of the liver immediately behind the columellar muscle, and above the genital artery. The blood is distributed through the tissue of the kidney by means of a meshwork of fine vessels. In conclusion it may be said that the blood from the papillary sac drains into the basi-branchial sinus.

BIBLIOGRAPHY.

BOUVIER, E. L. Étude sur l'Organization des Ampullaires. Mém. publ. par la Société Philomathique.

ERLANGER, R. 1892. On the Paired Nephridia of Prosobranchs. *Quart. Jour. Mic. Sci.*, Vol. 33.

FLEURE, H. J. 1902. Notes on the Relations of the Kidney in *Haliotis tuberculata*. *Ibid.*, Vol. 46.

HALLER, B. 1885. Beiträge zur Kenntnis der Niere die Prosobranchier. *Morph. Jahrb.*, Bd. 11.

——. 1894. Studien uber Docoglosse und Rhipidoglosse Prosobranchier, etc. Leipzig.

LANKESTER, E. R. 1881. On the Originally Bilateral Character of the Renal Organs of Prosobranchs, etc. *Ann. Mag. Nat. Hist.*, (5), Vol. 7.

PELSENEER, P. 1898. Recherches morpholog. et phylog. sur les Mollusques archaic. *Mém. l'Acad. roy. des sci. de Belgique*, T. 57.

THIELE, J. 1897. Beitrage zur Kenntnis der Mollusken. *Zeit. f. w. Zool.*, Bd. 62.

Tobler, M. 1901. Zur Anatomie von Parmophorus intermedius Reeve. *Jen. Zeit. f. Naturw.*, Bd. 36.

Totzauer, R. J. 1902. Nieren- und Gonadverhältnisse von Haliotis. *Zool. Anz.*, Bd. 25.

Wegmann, H. 1884. Contrib. à l'histoire naturelle des Haliotides. *Arch. Zool. expér.* (2), T. 11.

Woodward, M. F. 1901. The Anatomy of Pleurotomaria berichii. *Quart. Jour. Mic. Sci.*, Vol. 44.

Explanation of Figures.

The following letters have been used in the explanation of the figures:

A, anterior aorta.
AO, main aorta.
BA, buccal aorta.
COL, columellar muscle.
EF, left efferent branchial sinus.
GA, genital aorta.
GO', gonoduct.
GO, gonoduct opening into right kidney.
I, intestine.
IA, blood sinus of left kidney.
IC', vestibule of right kidney.
LI, liver.
LU, left ureter.
PAL, right pallial sinus.
R, rectum.
RE, *RE'*, renopericardial canals.
RK, *RK'*, kidney lobes.
RU, right ureter.
VL, aortic valve.

Explanation of Plate XXX.

Fig. 1.—Section through both kidneys of specimen of *Haliotis rufescens*, 1.5 cm. long, viewed posteriorly. *HY*, hypobranchial gland; *IC*, right kidney cavity; *RD*, end of radula; *ST*, stomach.

Fig. 2.—Portion of *H. rufescens* showing pericardium, left kidney, sinus and gonoduct. *COL*, columellar muscle; *G*, gonad.

Fig. 3.—Seventh section anterior to fig. 1. *E*, right efferent branchial sinus; *P'*, right pallial sinus.

Fig. 4.—Section through right renopericardial canal and gonoduct of *H. cracherodii*, 3 cm. long.

Fig. 5.—Sixth section anterior to that shown in fig. 3, showing opening of gonoduct into right kidney.

Fig. 6.—*H. rufescens*, dorsal wall of mantle reflected and basi-branchial sinus opened. *Af*, *Af'*, right and left afferent branchial sinuses; *HyG*, hypobranchial gland; *LCt*, left ctenidium; *LU*, left ureter; *MC*, mantle cavity; *NV*, veins from right kidney; *R*, rectum; *Si*, branchial sinus; *V*, valve.

NOTES ON THE CIRRIPEDE GENUS MEGALASMA.

BY HENRY A. PILSBRY.

The genus *Megalasma* was instituted by Dr. P. P. C. Hoek[1] for a pentaspidian barnacle dredged by the *Challenger* in the Philippine Archipelago, which was said to differ from *Pœcilasma* by having the umbo of the scutum situated on the occludent margin above the basal angle, whereas in *Pœcilasma* the umbo is at the basal angle, as in all other *Lepadinæ*.

In my work on the cirripedes of the U. S. National Museum,[2] I had occasion to show that *Pœcilasma*, as understood by Hoek and Gruvel, consists of two series of species, (1) those with the sides of the carina narrow (= *Pœcilasma* Darwin), and (2) those with the sides notably widened towards the base. Moreover, this second group differs from *Megalasma* only by having the base of the scutum nearly at a right angle with the occludent border, while in the type of *Megalasma* the basal margin has rotated through an arc of about 90°, bringing it in line with the lower part of the occludent margin. The position of the umbo is morphologically the same in *Megalasma* and *Pœcilasma*—that is, at the base of the occludent margin proper, where this joins the peduncular margin. The alleged elevation of the umbo on the occludent margin in *Megalasma* does not exist. It is merely apparent on account of the continuity of the occludent and peduncular margins, as shown in fig. 2*a*, where the umbo is at *u*, the margin of the peduncular orifice at *po*. In my opinion, therefore, the genus *Pœcilasma* should be restricted to species like those included by Darwin, while all forms with the sides of the carina wide and the internal plate well developed must be transferred to *Megalasma*. The mere change in the shape of the scutum at the borders of the peduncular foramen is insufficient for the separation of genera.

Megalasma, in the limits here assigned, is distinguished from *Pœcilasma* by the structure of the carina, which has wide sides near the base, and a well-developed oblique plate or septum within the base, bridging across the cavity of the carina, and terminating above in two projections or teeth. The species of *Pœcilasma* chiefly live upon the cara-

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[1] *Challenger Report*, VIII, Cirripedia, p. 50, 1883.

[2] *Bulletin of the U. S. Nat. Mus.*, No. 60, p. 82, 1907.

paces of crabs, while *Megalasma* has been found mainly on sea-urchin spines and upon other cirripedes.

Megalasma carinodentatum Weltner[3] was described from a single example, and derived its name from the projection or tooth on the roof of the carina. This projection, however, may very likely be pathologic, consequent upon an injury at the end of the carina when half grown.

COMPARISON OF M. BELLUM AND M. MINUS.

M. bellum (Pils.)[4] is closely related to *M. minus* Annandale.[5] The receipt of specimens of the latter, which I owe to the courtesy of Dr. N. Annandale, of the Indian Museum, enables me to compare the two species more thoroughly than has hitherto been possible, since the published figures show only the external aspect of the capitulum, and the internal features have not been described or figured.

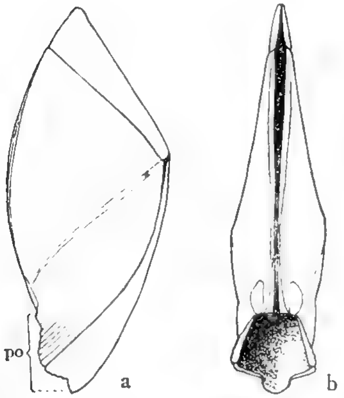

Fig. 1.—*Megalasma minus* Annand. *a*, lateral, and *b*, ventral view, × 7½. *po*, margin of the peduncular orifice.

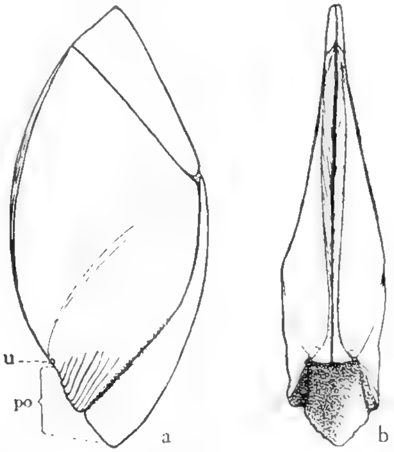

Fig. 2.—*M. bellum* Pils. *a*, lateral, and *b*, ventral view, × 4. *u*, umbo of the scutum.

Megalasma minus and *M. bellum* are alike in general shape and in sculpture, but differ in size and in various details of the scuta and

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[3] *Sitzungs-berichte der Gesellschaft naturforschender Freunde zu Berlin*, Jahrg. 1894, p. 84.

[4] *Pœcilasma bellum* Pilsbry, *Bulletin of the Bureau of Fisheries*, XXVI, p. 183, pl. IV, fig. 6 (June 29, 1907). This paper was prepared in 1905, hence before I knew of the existence of *M. minus*.

[5] *Megalasma striatum* subsp. *minus* Annandale, *Annals and Magazine of Natural History*, ser. 7, XVII, p. 399 (April, 1906); Illustrations of the Zoology of the Royal Indian Marine Survey Ship *Investigator*, Entomostraca, pl. I, fig. 8 (1907).

carina. *M. minus* is slightly narrower than *M. bellum* throughout. The dimensions of the type were not given by Dr. Annandale in his original account, but the name implies that it is smaller than *M. striatum*, which has a capitulum 11 mm. long. The figure of his type, subsequently published, is said to be enlarged six diameters, which would make the capitulum about 9 mm. long. The largest specimen I have seen, a ♀ bearing a large mass of eggs, measures 6.5 mm. in length of capitulum. *M. bellum* attains a much greater size. The type is 14.5 mm. long, and I have seen a great number of specimens from many localities with capitula from 12 to 15 mm. long.

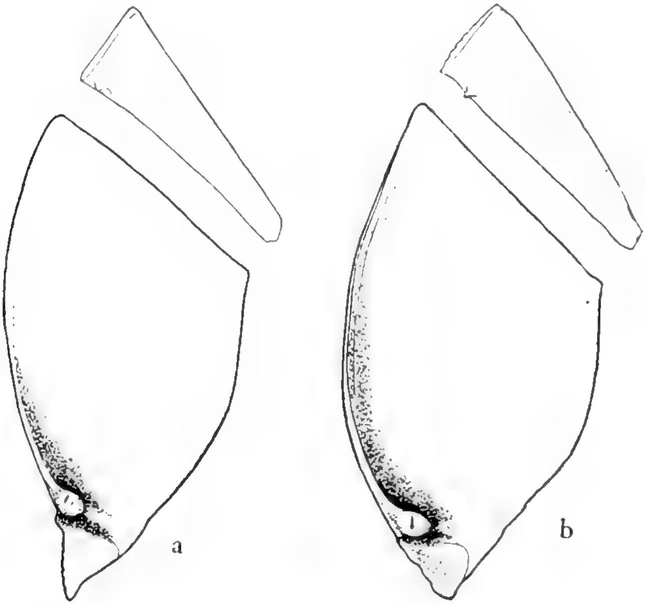

Fig. 3.—*a*, internal view of the left scutum and tergum of *M. minus*, × 10, and *b*, *M. bellum*, × 5.

The lateral borders of the peduncular foramen, in a lateral view of the capitulum, are nearly straight in *M. bellum* (fig. 2, *po*), but in *M. minus* these margins arch outwards more or less strongly (fig. 1, *po*).

The primitive valves, visible at the umbones, are convex, densely cellular in both species, irregularly trapezoidal in outline, with subparallel occludent and dorsal borders, the latter much the shorter. The anterior (basal) end is squarely truncate, the posterior end oblique. In *M. minus* the primitive valves measure 0.66 mm. long, 0.25 wide (pl.31, fig. 9). In *M. bellum* the valves are a little wider, measuring 0.75 x 0.3 mm. In both species a ridge or angle close to the occludent border of the scutum defines a narrow and nearly flat ventral area; and towards the base a smooth sunken area separates the primitive valves and the sculptured portions of the scuta, as shown in figs. 1*b*, 2*b*.

The scuta, when removed, are seen to differ in various respects. The occludent border is more bowed in *M. bellum*, and the basal portion, below the umbonal tooth, is wider than in *M. minus*. In both species the umbonal tooth is stout and high in both valves. There is no socket in the carinal margin for the reception of the tooth of the carina, such as Hoek described and figured in *M. striatum* (see fig. 3).

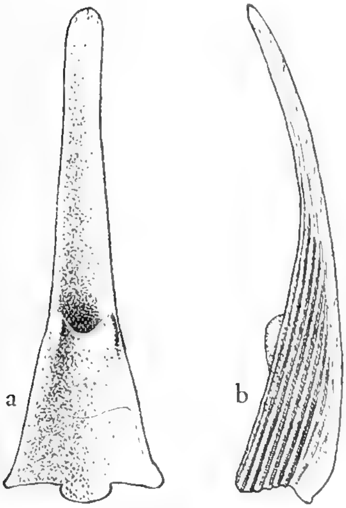

Fig. 4.—*M. minus*, carina in ventral and lateral views.

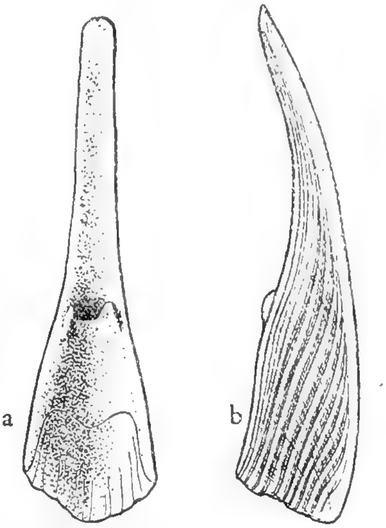

Fig. 5.—*M. bellum*, carina in ventral and lateral views.

The carina in *M. minus* (fig. 4) has much narrower sides, which are more expanded at the baso-lateral angles. The basal margin has a rounded median projection, and the articulating teeth are larger. In *M. bellum* (fig. 5) the basal margin is simply arcuate. In other respects the carinæ are similar. The shape of the base of the carina affects the shape of the peduncular foramen, as viewed from the ventral side (see figs. 1*b* and 2*b*). The difference of shape is equally pronounced if *M. minus* is compared with young specimens of *M. bellum*, of equal size. In *M. minus* the basal angles of the carina are more produced, and spread apart farther than in *M. bellum*. The septum across the cavity is situated higher than in species of the subgenus *Glyptelasma,* but otherwise the carina is very similar to that of *G. subcarinatum,* etc. The carina of *M. minus* illustrated (fig. 4) is 4.8 mm. long; that of *M. bellum* (fig. 5) is 7.8 mm. long. The terga are similar in general shape in *M. minus, M. bellum* and *M. carinodentatum.* In the former two there is a small acute tooth on the scutal margin, near the occludent end. In *M. striatum* the terga are much higher, and are pointed at the carinal end.

The peduncle is slightly longer in *M. bellum* than in *M. minus,* though it is very short in both species.

In *M. bellum* the first cirrus has rami of 8 segments, the outer ramus broader, with the segments conspicuously convex and profusely spinose on both marigns. The inner face is also profusely spinose. It is very like the first cirrus of *M. striatum* as figured by Hoek.[6] The inner ramus is narrower, only the distal segments projecting laterally. The posterior margins and inner face of each segment is spinose. The other cirri are slender, with 16 to 19 segments. Except the basal and distal segments, they have four pairs of large and one pair of small spines on the anterior border of each segment, and a tuft of three or four unequal small spines at the distal posterior angle of each segment (fig. 7, 10th and 11th segments of cirrus V).

Fig. 6.—*M. minus,* 7th and 8th segments of cirrus V.[7]

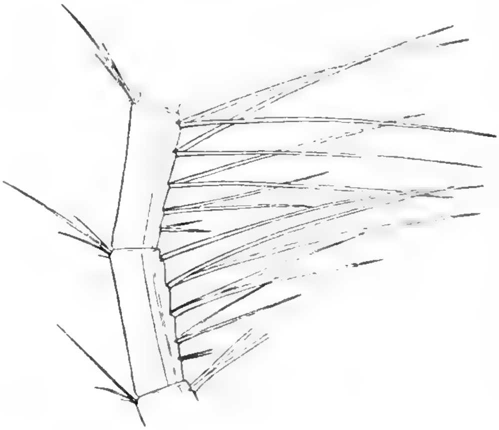

Fig. 7.—*M. bellum,* 10th and 11th segments of cirrus V.

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[6] *Challenger Report,* VIII, Cirripedia, pl. 2, fig. 9.

[7] In this figure the cirri of *M. minus* are represented on a larger scale than those of *M. bellum.* They are actually very much smaller.

In *M. minus* the first cirri are formed about as in *M. bellum.* The other cirri are comparatively more slender, with only three pairs of long spines on the front margin of each segment, and a fourth very minute pair below them. The posterior distal angle of each segment has one long spine, a shorter one, and usually one or two minute spines (fig. 6, 7th and 8th segments of cirrus V).

The cirri of *M. bellum* resemble those of *M. striatum* and *M. carinatum,* while those of *M. minus* are like the cirri of *M. gracile* as described by Hoek. It will be understood that in comparisons of the cirri the intermediate segments are described, unless otherwise stated. The distal and proximal segments generally have fewer pairs of spines on the front margin. The second cirrus usually has additional spines, variously arranged.

In *M. minus* the mandible (pl. 31, figs. 7, 8) has four acute teeth, counting the lower point. The space between the upper and second teeth is double that separating the other teeth. Below the lower tooth there is a slender spine representing the lower point developed in most species of *Megalasma* and *Pœcilasma,* and shown enlarged in fig. 8. Both upper and lower borders of the mandible have delicate spiny fringes, the spinules in part arranged in pairs. The two mandibles are alike in the example dissected.

The maxilla (pl. 31, fig. 6) has a deep notch below the upper pair of arge spines. Below the notch the edge projects and is closely spinose, as usual. The upper and lower borders are delicately fringed.

In *M. bellum* the mandibles (pl. 31, figs. 1, 2, 3, 4) resemble those of *M. minus,* except in having the lower point split into two teeth (figs. 3, 4) on one side of the individual examined, there being therefore five teeth in all. The other mandible of the same individual has the lower point split into four narrow teeth (figs. 1, 2). Part of the spines on the surface, near the lower points, stand in groups of two or three, as shown in the detail figs. 2 and 4. They also are in groups on the upper edge of the mandible, but elsewhere stand singly. The surface spines are drawn with camera in figs. 2, 4 and 8, but in the other figures only the general effect is given.

The maxilla (pl. 31, fig. 5) resembles that of *M. minus,* except for the somewhat greater protrusion of the lower part of the spinose edge.

The hermaphrodite form of *M. bellum* has a long penis, sparsely hairy, with a more profuse bunch of hairs at the distal end.

The individual of *M. minus* dissected contained a large egg-mass. The eggs are ovate-piriform, 0.23 mm. long (pl. 31, fig. 10).

It will be seen from the above descriptions and figures that while related, *M. minus* and *M. bellum* differ in many details of structure, the scuta, carina, cirri and mandibles all being diverse in the two forms, which must be held specifically distinct. *M. striatum* Hoek is related to *M. bellum* by the cirri and mandibles, but differs in the terga and the sculpture of the bases of scuta and carina, etc. It differs from *M. minus* by the same characters of the plates, and also by the armature of the cirri and to some extent in the mandibles.

Megalasma gracile and M. gracilius.

Megalasma gracile (Hoek) was originally described (as *Pœcilasma gracile*) from a Challenger station off Sydney, New South Wales. I have elsewhere called attention to the doubt attaching to material from this station, owing to the mixture therein of molluscan species otherwise known only from the Atlantic, with others known to be Australian.[8] That *Megalasma gracile* was really from the Australian station is rendered more probable by the discovery of several specimens in the Indian Ocean by the Indian Marine Survey, as recorded by Dr. Annandale.[9] The western Atlantic *M. g. gracilius* may prove to be identical with Hoek's form, yet in view of the wide geographic separation, and of several minor differences in the plates, I have thought best to segregate it as a subspecies. This course is likely to prove less injurious to science than an inconsiderate lumping of forms from widely separated areas, without actual comparison of specimens. Dr. Hoek has written well on this topic.[10]

The cirri of *M. gracilius* differ somewhat from those of *M. gracile* as described by Hoek.[11] He states that the posterior pair of cirri have segments "bearing as a rule four pairs of spines, the lowest pair of which is very minute, the second pair minute."

In *M. gracilius* the posterior cirri have five or six pairs of spines, the lower pair minute, on the 6th to 10th segments; beyond that point there are four pairs, then decreasing to three, and finally one or two on the outermost segments. Cirri iii to vi are practically alike. Cirrus ii has many additional spines, partly disposed in a row parallel to that on the anterior border, partly arising along the distal border of each segment. The inner ramus is much the longer, composed of 15 segments, the outer having 13 segments.

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[8] *Bull. U. S. Nat. Mus.*, No. 60, p. 89.

[9] *Records of the Indian Museum*, I, pt. 1, p. 81.

[10] *Challenger Report*, VIII, Cirripedia, p. 145.

[11] *Challenger Report*, Cirripedia, p. 47.

The mandible of *M. gracilius* is similar to Hoek's figure of that of *M. gracile*, the lower point being minutely bifid.

KEY TO SPECIES OF MEGALASMA.

a.—Peduncular margins of scutum and carina continuous with the occludent margin, in the same direction, the umbo of the scutum therefore above the basal angle of the plate. Indo-Pacific province, ... (*Megalasma s. str*).

b.—A peduncular area on each side defined by a semicircular ridge on the bases of scutum and carina; roof of the carina very wide; width of scutum about two-thirds its length; tergum triangular, the occludent margin about half the length of the scutal. Capitulum 11 mm. long. Philippine Archipelago. . . . . *M. striatum* Hoek.

b′.—Peduncular area defined by a semicircular groove; width of scutum slightly more than half its length; tergum quadrangular, the occludent margin about one-fourth as long as the scutal margin. Capitulum 6.5 mm. long. Indian Ocean, ... *M. carinodentatum* Weltner.

b″.—No distinctly defined peduncular area on the bases of scuta and carina; scutum nearly twice as long as wide; occludent margin of tergum about one-third the length of the scutal margin.

c.—Basal margin of carina straight with a rounded median projection, the sides narrower than in *P. bellum*; lateral margins of the peduncular orifice arched forward. Capitulum 6.5 to 9 mm. long. Segments of the cirri with 3 pairs of large spines, 1 pair of very small ones. Andaman Sea. . . . *M. minus* Annandale.

c′.—Basal margin of carina convex, deeply arched, the sides wide; lateral borders of the peduncular orifice straight. Capitulum 12 to 15 mm. long. Segments of cirri with 4 pairs of long spines, 1 pair of small ones. Hawaiian Islands, ... *M. bellum* Pilsbry.

a′.—Peduncular or basal margin of scutum making about a right angle with the occludent margin, the umbo of the scutum at the baso-ventral angle of the plate, . (subgenus *Glyptelasma* Pilsbry).

b.—Umbo of the carina projecting beak-like below the base of the scutum, and making an angle with it.

c.—Basal margin of carina as long as the basal margin of the scutum; internal basal plate long, lozenge-shaped; sides wide in the lower half.

d.—Peduncle about one-third the length of the capitulum; basal margin of scutum half the width of carina near its base. Capitulum 7 mm. long. Off Australia; Indian Ocean, . . . *M. gracile* Hoek.

d'.—Peduncle extremely short; basal margin of scutum about equal to the width of the carina; posterior cirri with more numerous spines. Capitulum 11 to 12.7 mm. long. Off eastern United States, *M. g. gracilius* Pilsbry.

c'.—Basal margin of carina shorter than that of the scutum; internal plate short, wider than long; sides wide in the lower third. Capitulum 19 mm. long. Off eastern United States, ... *M. annandalei* Pilsbry.

b'.—Umbo of the carina not produced below the basal margin of the scutum.

c.—Occludent margin of scutum nearly straight; carina with rather narrow sides, abruptly spreading and auriculate at the base, the basal margin a straight line. Capitulum 15.5 mm. long. Off eastern United States, *M. rectum* Pilsbry.

c'.—Occludent margin arched; carina with wide sides and a large internal basal plate, its basal margin V-shaped, as seen from below.

d.—Length of capitulum three times its breadth, the base narrow; scutum almost smooth. Length 14 mm. Off Culebra and Ascension Islands, *M. carinatum* Hoek.

d'.—Length of capitulum twice its breadth; scutum sculptured with spaced concentric grooves and fine radial impressions. Capitulum 16 to 25 mm. long. Off eastern United States, *M. subcarinatum* Pilsbry.

EXPLANATION OF PLATE XXXI.

Figs. 1–4.—*Megalasma bellum* (Pils.). Mandibles and more enlarged lower points of same.

Fig. 5.—*M. bellum*. Maxilla.

Fig. 6.—*M. minus* Annand. Maxilla.

Figs. 7, 8.—*M. minus*. Mandible and its lower point more enlarged.

Fig. 9.—*M. minus*. Outline of primitive shell and adjacent margin of the scutum.

Fig. 10.—*M. minus*. Group of ova.

OCTOBER 1.

ARTHUR ERWIN BROWN, D.Sc., Vice-President, in the Chair.

Fifteen persons present.

The Secretaries, Librarian and Curators reported on the work of the summer.

The Publication Committee reported that papers under the following titles had been presented for publication since the last meeting:

"Notes on the Leaf Hairs of Lesquerella," by E. G. Vanatta (May 23).

"Notes on Serranidæ," by Henry W. Fowler (May 25).

"Orthoptera from Northern Florida," by James A. G. Rehn and Morgan Hebard (June 12).

"Bertramia bufonis, a new Sporozoan Parasite of Bufo lentiginosus," by Helen Dean King (June 12).

"Moundville Revisited," by Clarence B. Moore (July 11).

"Crystal River Revisited," by Clarence B. Moore (July 11).

"Mounds of the Lower Chattahoochee and Lower Flint Rivers," by Clarence B. Moore (July 11).

"Notes on the Ten Thousand Islands, Florida," by Clarence B. Moore (July 11).

"The Embryology of Fulgur: A Study of the Influence of Yolk on Development," by Edwin G. Conklin (July 12).

"Notes on some Pacific Cirripedes," by Henry A. Pilsbry (July 16).

"The Anatomy of California Haliotidæ," by Clayton F. Palmer (July 23).

"On the Synonymic History of the Genera Clava Martyn and Cerithium Bruguière," by William Healy Dall (July 26).

"Orthoptera of the Families Tettigonidæ and Gryllidæ from Sapucay, Paraguay," by James A. G. Rehn (August 14).

"Notes on the Cirripede Genus Megalasma," by Henry A. Pilsbry (September 25).

"A Collection of Fishes from Victoria, Australia," by Henry W. Fowler (October 1).

The four papers by Mr. Clarence B. Moore will constitute the third number of Volume XIII of the JOURNAL of the Academy.

The deaths of Joseph E. Gillingham, 1906, and Angelo Heilprin, July 17, 1907, members, and of Sir Joseph Fayrer, M.D., a correspondent, were announced.

OCTOBER 15.

ARTHUR ERWIN BROWN, D.Sc., Vice-President, in the Chair.

Sixty-six persons present.

The death of Anna T. Jeanes, a member, September 24, 1907, was announced.

DR. HENRY LEFFMAN made a speculative communication on life in other worlds, considering some of the data on which the assumption of life elsewhere might be based. (No abstract.)

Dr. F. Creighton Wellman and Edgar T. Wherry were elected members.

The following was ordered printed:

A COLLECTION OF FISHES FROM VICTORIA AUSTRALIA.

BY HENRY W. FOWLER.

The Academy has recently received through the Conchological Department a collection of marine fishes from Victoria, Australia. This collection was made by Mrs. Agnes F. Kenyon, of Melbourne, and though reported in full in this paper, embraces a few specimens secured in the southern Pacific which are listed in footnotes. Evidently most all the others were obtained along the coast of Victoria. The entire collection has been presented by the Conchological Department to the Academy. Some of the specimens are in bad preservation.

SCYLIORHINIDÆ.

Catulus analis (Ogilby).

Four egg-cases agreeing with Dr. Waite's figures. Besides these there are egg-cases of other sharks which I am unable to identify, and which probably belong to the genera *Heterodontus, Scyliorhinus* and *Crossorhinus.*

DASYATIDÆ.

Trygonoptera testacea Müller and Henle.

A tail with 2 spines and small dorsal agrees with Müller and Henle's figure. Two other large spines, the larger 10½ inches long, probably belong to some species of *Dasyatis.* Another tail with a well-developed dorsal fin close in front of the spine belongs probably to *Myliobatis.*

CHIMÆRIDÆ.

PSYCHICHTHYS subgen. nov.

Type *Hydrolagus waitei* sp. nov.

Differs from subgenus *Hydrolagus* Gill, in the entire or undivided dorsal.

(Ψυχὴ, ghost; ἰχθύς, fish; with reference to the vernacular given to these fishes in Australian seas.)

Hydrolagus waitei sp. nov. Fig. 1.

Head about 5; depth about 5⅔; snout 1⅕ in head; eye 6¼; width of mouth 3; maxillary 3¼; interorbital space 3¾; pectoral about 1¼.

Body elongate, well compressed, and tapering from head into a long slender tail, though not filamentous. Greatest depth falls about origin of pectoral.

Head large, compressed, its width about 2⅙, and its depth nearly equal to its length. Upper profile of head rather evenly convex, and well inclined to base of dorsal spine, depression above eye probably due to shrinkage. Lower profile of head forming a broad triangle at lower symphysis of mandible. Snout long, broad, its greatest width about 1⅔ in its length. Eye small, rounded, high, or near upper profile of head, and a trifle behind middle of its length. Mouth broad, transverse, inferior. Lips thick and fleshy. Teeth evidently damaged. At present upper jaw with 2 small approximated flat triangular laminæ, and posteriorly along each side of upper jaw a broad and also long lamina extending far back. On each of these upper plates are 2 series of slightly elongated obsolete asperous patches and well separated. Mandible consisting of 2 trenchant strong plates, division or approximation at symphysis, and their edges entire. Maxillary covered above more or less by skin of preorbital region, and its distal extremity falls about half an eye-diameter anterior to front margin of eye.

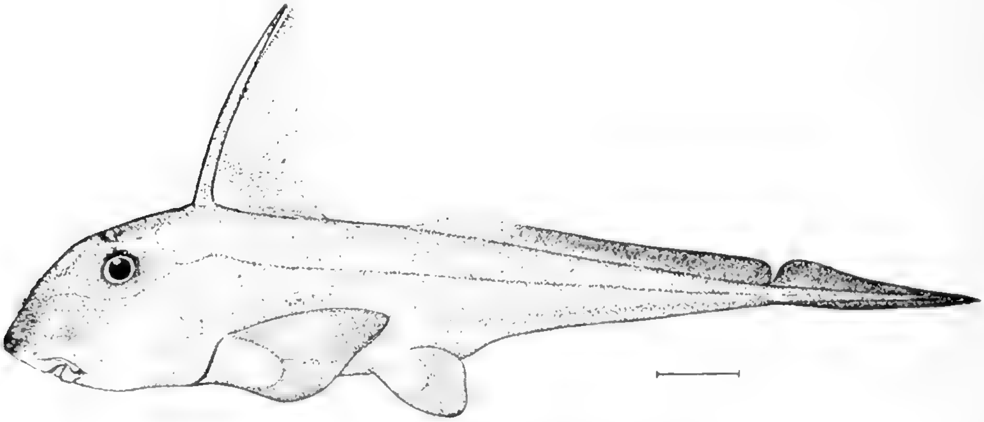

Fig. 1.—*Hydrolagus waitei* Fowler. (Type.)

Gill-openings small, inferior, below origin of pectoral and forming a fold over isthmus well in advance of latter.

First dorsal inserted a trifle before origin of pectoral, and furnished with a long strong spine, well compressed, its anterior edge sharply trenchant, and its length a little greater than head, possibly an eye-diameter more. Posterior margins of dorsal spine with rather broad low trenchant keels, somewhat of spinescent form, and about 30 in number. Origin of second dorsal (damaged) begins apparently a little after origin of ventrals and extends back as a low, though also apparently entire, rayed fin to caudal, where it is entirely separated. It appeared to be about of even height throughout its length. Caudal encircles tail, rather high above at first, or this about equal to eye-diameter, and its length equal to dorsal spine. It gradually tapers to end of tail above, though below is lowest anteriorly. Pectoral large, broad, and apparently only reaching ventral. Ventral much smaller than pectoral, and inserted apparently but slightly if any before tip of latter, though apparently well before tip of depressed dorsal spine.

Color entirely faded in dried example to dull brownish.

Length about 12 inches.

Type, No. 33,119, A. N. S. P. Victoria.

This species resembles *Chimæra ogilbyi* Waite, *Rep. Thetis*, 1898, p. 41, Pl. 11. It differs however in the dorsal spine being trenchant along its anterior edge, serrated along its posterior edges and equal to, or a trifle longer than, the head. Other differences may be seen in the shorter snout, shorter pectoral, shorter caudal and apparently more posterior insertion of the second dorsal. However these differences may be accepted only provisionally, as it has been necessary to restore the accompanying figure to some extent. The length of the dorsal spine and tail are however undoubtedly points of difference. This species differs from *Hydrolagus colliei* (Bennett) in the longer dorsal spine, entire second dorsal and smaller eye. It is possible *Chimæra ogilbyi* is also a *Hydrolagus,* though the caudal is long, its tail could hardly be considered filamentous like that of *Chimæra monstrosa* Linnæus. It resembles *Chimæra monstrosa* var. *australis* Hector, *Trans. Proc. New Zeal. Inst.*, XXXIV, 1901 (1902), p. 239, Pl. 14, from New Zealand, but differs in the shorter tail and absence of the anal.

(Named for Dr. Edgar R. Waite for his many excellent contributions to Australian ichthyology.)

CHEILOBRANCHIDÆ.

Cheilobranchus rufus (Macleay).

One example agreeing with Dr. Waite's figure in *Rec. Austr. Mus.*, VI, No. 3, 1906, p. 195, Pl. 36, fig. 1.

MYRIDÆ.

Muræenichthys devisi sp. nov. Fig 2.

Head about 10 (end of tail damaged); depth at thorax $3\frac{1}{2}$ in head;

width of head $5\frac{1}{4}$; snout $4\frac{1}{4}$; gape 3; maxillary $2\frac{1}{2}$; eye $3\frac{1}{4}$ in snout; interorbital space 2.

Body long, slender, compressed, and edges apparently convex. Greatest depth at thorax, and otherwise trunk of about equal depth throughout. Tail long, slender, more or less compressed and tapering. Head and trunk $1\frac{1}{2}$ in tail (damaged).

Head small, compressed, attenuated, and swelling into a rather deep thorax. Jaws long, slender, and with upper a little more convexly elevated than lower. Snout long, slender, its tip projecting well beyond mandible, and its sides rather steep. Eye large, a trifle longer than deep, its center falling about last fourth in space between tip of snout and corner of mouth, and its lower margin close to edge of mouth. Maxillary concealed, though projecting a little beyond posterior corner of mouth. Mouth large, gape long. Jaws slender, rather narrow and furnished with rather large teeth. In upper jaw along edges teeth biserial, and on vomer uniserial. Teeth in mandible at first biserial a short distance from symphysis, and then uniserial, though of somewhat irregular size. Teeth in upper jaw not quite so irregular in size. Anterior nostril in a small tube near tip of snout, and posterior a rather large pore on lower external margin of upper lip just below front of eye. Interorbital space rather narrow and convexly elevated.

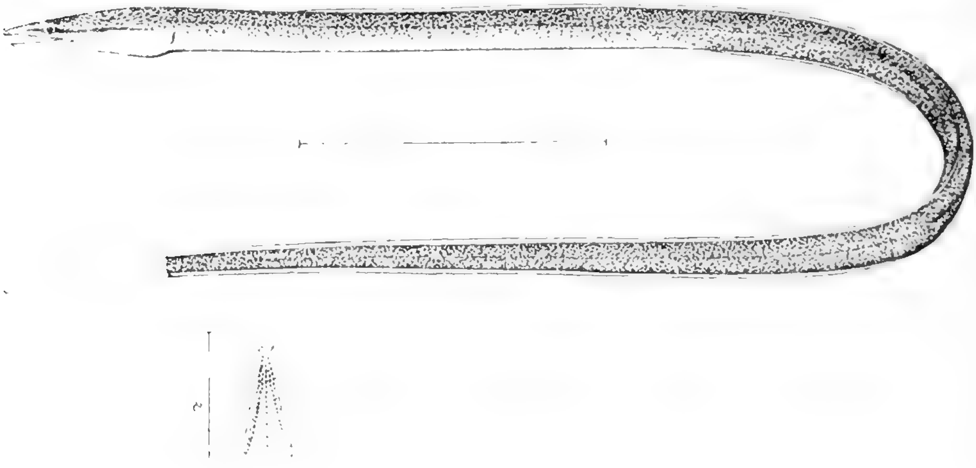

Fig. 2.—*Murænichthys derisi* Fowler. (Type.)

Gill-opening small and a little low.

Skin naked and smooth, without any scales. A few rather large pores on supper surface of head. Lateral line apparently continuous, and rather superior along side of trunk.

Vertical fins only developed, low, dorsal and anal probably continuous ? (damaged) around caudal. Dorsal inserted about first fourth of space between gill-opening and vent. No pectoral.

Color of dried alcoholic largely faded brownish, upper surface all mottled or specked with deeper brownish to dusky. Lower surface of head and all of abdomen to vent pale immaculate brown. Tail all specked like upper surface of trunk. Vertical fins all pale brownish.

Length $5\frac{7}{8}$ inches ? (caudal damaged).

Type, No. 33,120, A. N. S. P. Victoria.

This species is closely related to *Murænichthys breviceps* Günther, *Ann. Mag. Nat. Hist.*, (4), XVII, 1876, p. 401, from Tasmania. It differs in the more anterior insertion of the dorsal fin.

(Named for Dr. Charles W. De Vis, who has contributed to the ichthyology of Australia.)

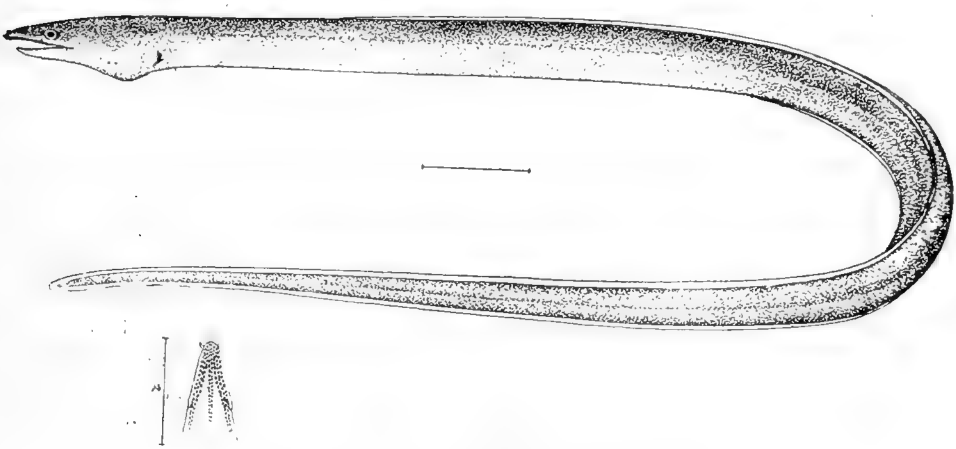

Fig. 3.—*Murænichthys ogilbyi* Fowler. (Type.)

Murænichthys ogilbyi sp. nov. Fig. 3.

Head about $11\frac{3}{4}$; depth at thorax $2\frac{1}{4}$ in head; width of head $3\frac{1}{2}$; snout $4\frac{1}{3}$; gape $2\frac{7}{8}$; maxillary 2; eye $2\frac{1}{8}$ in snout; interorbital space 2.

Body very long, slender, well compressed, and edges rather convexly rounded. Greatest depth at thorax, and otherwise trunk of about more or less equal depth. Tail long, slender, compressed and tapering. Head and trunk $1\frac{2}{3}$ in tail.

Head small, compressed, attenuated, and swelling into a rather deep thorax. Jaws long, slender, and with equally convex surfaces above and below. Snout long, slender, its tip projecting well beyond mandible, and sides not steep. Eye a trifle longer than deep, its center falling about last fourth in space between tip of snout and corner of mouth, and its lower margin close to edge of mouth. Maxillary slender, concealed, and projecting about an eye-diameter beyond posterior margin of eye. Mouth large, gape long. Jaws narrow and furnished with rather large and more or less equal teeth, above along edges at first triserial, or for a space about $\frac{3}{4}$ length of snout, and then biserial. Vomerine teeth biserial. Mandibular teeth at first, or about first fifth of length of mandible, triserial, and then biserial, though becoming irregular posteriorly. Anterior nostril evidently in a short fleshy tube near end of snout. Posterior nostril opening in a fold of upper lip about opposite anterior margin of eye. Interorbital space rather narrow and convexly elevated.

Gill-opening small and a little low.

Skin naked and apparently smooth, without any scales. A few pores on snout and head above. Lateral line apparently continuous, superior along side of trunk.

Vertical fins only developed, low, dorsal and anal continuous evidently around caudal? (damaged), and former inserted about first $\frac{2}{7}$ in space between gill-opening and vent.

Color of dried alcoholic dark uniform brown, lower surface, including head, lighter. Under a lens upper surface seen covered entirely with minute dusky dots. Iris brownish. Vertical fins dull brownish.

Length 13$\frac{5}{8}$ inches.

Type, No. 33,121, A. N. S. P. Victoria.

This species differs from the last chiefly in the biserial vomerine teeth, triserial teeth in the upper jaw, and more posterior insertion of the dorsal. From *M. breviceps* it differs in its triserial upper teeth. Like *Murænichthys nicholsæ* Waite, *Rec. Austr. Mus.*, V, No. 3, 1904, p. 142, Pl. 17, fig. 1, from Lord Howe Island, this species has a sac under the throat. It differs however in the more anterior insertion of the dorsal.

(Named for Dr. J. Douglass Ogilby, who has contributed much to Australian ichthyology.)

EXOCŒTIDÆ.

Exocœtus volitans Linnæus.

One small example agreeing with my Hawaiian material.

ATHERINIDÆ.

Atherina presbyteroides Richardson.

Head $4\frac{2}{5}$; depth about $6\frac{1}{4}$?; D. IX–I, i, 10, i; A. I, i, 12, i; P. i, 10; scales from gill-opening to base of caudal (guessed according to pockets) at 45?; about 9? scales in a vertical series up from origin of ventral; width of head $1\frac{7}{8}$ in its length; pectoral $1\frac{1}{3}$; snout $3\frac{3}{4}$ in head measured from tip of upper jaw; eye $2\frac{4}{5}$; maxillary $2\frac{1}{2}$; interorbital space $3\frac{1}{3}$. Belly apparently not swollen. Snout short, obtuse as seen from above. Eye large, high, a trifle anterior. Mandible protruding and rami elevated a little inside mouth. Maxillary reaching a trifle beyond front margin of eye, without teeth. Teeth in narrow bands in jaws and a short narrow band across vomer. Interorbital space flat. Ridge of preopercle nearly forming a right angle. Scales large, cycloid, narrowly exposed in longitudinal series and loosely adherent. Head and base of caudal scaly, otherwise fins naked. Spinous dorsal inserted nearer tip of snout than base of caudal or a short space behind origin of ventral, and spines all rather slender, flexible and second longest. Rayed dorsal inserted nearer origin of ventral than base of caudal or a little behind origin of anal, and first rays longest. Rayed anal similar to last. Pectoral reaches about $1\frac{1}{3}$ to origin of spinous dorsal. Ventral inserted a little nearer origin of pectoral than that of anal. Vent about opposite base of last dorsal spine. Color in alcohol faded brownish generally. A silvery band about 2 or 3 scales distant from dorsal ridge of back from shoulder to base of caudal, rather narrow after rayed dorsal and anal and bounded by a narrow leaden line along its upper margin. Sides of head and iris silvery. Fins plain pale brown. Length about 2 inches (caudal damaged).

This differs a little from the original account in the possession of an additional anal ray and the depth of the body being a little less than the length of the head.

MACRORHAMPHOSIDÆ.[1]

Macrorhamphosus scolopax elevatus (Waite).

A small example agrees with young Italian examples of *M. scolopax*. Depth of body $2\frac{1}{2}$ in space between posterior margin of eye and base of caudal, and dorsal spine about $2\frac{2}{5}$ in latter. Eye about 3 in snout.

LIMICULINA subgen. nov.

Type *Centriscus humerosus* Richardson.

Differs from subgenus *Macrorhamphosus* Lacépède in the more

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[1] *Fistularia petimba* (Lacépède) from Fiji.

posterior vertical fins, so that origin of spinous dorsal is close before base of last dorsal ray, and in having the beak directed upwards.

(*Limicula*, an old name for the godwit, with reference to the upturned beak.)

Macrorhamphosus humerosus (Richardson).

One example.

SYNGNATHIDÆ.[2]

CASTELNAUINA subgen. nov.

Type *Solenognathus spinosissimus* Günther.

Differs from subgenus *Solegnathus* Swainson in having the rings with small low spines along their edges.

(Named for Count Francis de Castelnau, who studied the fishes of Victoria.)

Solegnathus spinosissimus (Günther).

Two examples.

Phyllopteryx tæniopterus (Lacépède).

Four examples from Portland, Victoria.

Phyllopteryx elongatus Castelnau.

Two small examples appear to agree with Castelnau's account, and though the sexes are undetermined the greatest depth of the body is about half the length of the snout. The spines on the snout are laterally superior. Cutaneous appendages and end of tail black. Portland, Victoria.

MACLEAYINA subgen. nov.

Type *Hippocampus bleekeri* sp. nov.

Differs from subgenus *Hippocampus* Rafinesque in the long dorsal the rays being about 28 to 31, while in the latter they are about 12 to 20.

(Named for Hon. William Macleay, the distinguished Australian zoologist.)

Hippocampus bleekeri sp. nov. Fig. 1.

Head $1\frac{3}{5}$ in trunk, measured to gill-opening; depth of trunk 2 in its length; width of trunk $5\frac{1}{5}$; trunk $2\frac{1}{8}$ in tail; D. 28; A. 5; P. 15; rings 12 + 48; depth of head, at coronet, $1\frac{3}{5}$ in its length; width of head $2\frac{2}{3}$; snout 2; eye $8\frac{1}{2}$; base of dorsal $1\frac{1}{2}$; interorbital space $1\frac{1}{3}$ in eye.

Body elongate, moderately deep, trunk comparatively short and

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[2] *Syngnathus semistriatus* (Kaup) and *Stigmatophora nigra* Kaup. Two specimens representing these Australian species are listed from Fiji.

well compressed. Tail very long, slender, quadrangular and tapering in a long point.

Head moderately large, deep and compressed. Snout long, slender, of more or less even depth throughout, and its greatest width about

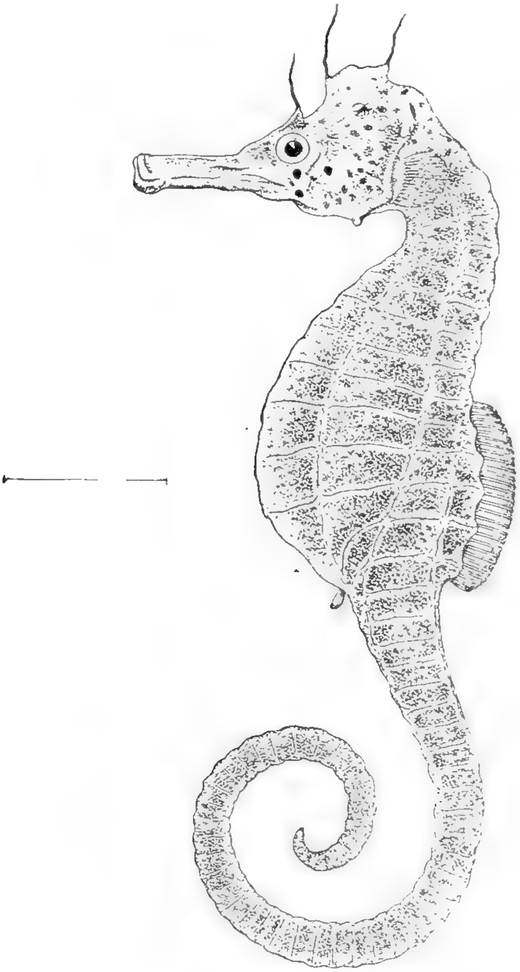

Fig. 4.—*Hippocampus bleekeri* Fowler. (Type.)

equal to greatest distal depth of muzzle. Eye small, high, a trifle longer than deep, and its center falling slightly behind middle in length of head. Mouth terminal, small, superior, and with thin jaws slightly protruding above and below. Nostrils small, close to middle of front rim of orbit. Interorbital space narrow, forming an isosceles triangle, angle formed about $\frac{2}{3}$ an eye-diameter anterior to eye.

Gill-opening about 2 in eye, vertical, and laterally superior on nape near nuchal keel.

Coronet high, its upper surface slightly concave, with 2 lateral tubercles, and an elevated prominence springing from ridge in front. Below latter, on each side of head, a round tubercle. A slight trenchant keel at front of interorbital space longitudinally, and each side of triangle separated from this though gradually springing up into a high slender bony process above posterior margin of eye. A blunt postorbital tubercle near eye. Shoulder-girdle with 3 large round tubercles. A few fine radiating striæ on opercle. From each supraorbital process a rather long slender cutaneous filament, 1 from anterior process of coronet and 1 from each posterior process. Body-rings mostly with concave surfaces, without spines, though ridges rather minutely asperous and forming slight tubercles on those on trunk more or less, though none distinctly enlarged at intervals. On tail ridges are more or less obsolete, except those forming longitudinal edges.

Fins rather small, with simple rays. Dorsal with long base, beginning on posterior portion of ninth ring, and then extending on to third caudal ring near its posterior margin. Anal small, short, in first ring of tail. Pectoral with a moderately broad base, rays rather short. Vent a little before anal.

Color in alcohol brown, more or less uniform, or darker mottlings within each square evidently result of preservation. Opercular region with some round blackish spots. However upper surface of tail is marked by about a dozen transverse saddles, most distinct on dorsal surface. Dorsal rather dusky.

Length, measured from tip of coronet to tip of extended tail, 9 inches.

Type, No. 33,122, A. N. S. P. Victoria.

Also another example in poor preservation. It has about 28 dorsal rays, and has a similar long tail and comparatively moderately deep trunk. Still smaller examples agree, though 2 at present are whitish with minute brownish dots, visible only under a lens.

This species is related to *Hippocampus abdominalis* Lesson, but differs at once in the longer snout and more contracted depth. Bleeker has roughly figured the present species as *H. abdominalis* in *Verh. Kon. Ak. Wetensch.*, Amsterdam (Visch. Van Diemensl.), II, 1855, p. 28, Pl., fig. 4, from Tasmania.

(Named for Dr. Pieter van Bleeker, who studied the fishes of Tasmania.)

Hippocampus agnesæ sp. nov. Fig. 5.

Head 2 in trunk, measured to gill-opening; depth of trunk $1\frac{1}{5}$ in its length; width of trunk $3\frac{4}{5}$; trunk about 2 in tail; D. 29; A. 3?; P. 17; rings 12 + 47; depth of head, at coronet, $1\frac{3}{7}$ in its length; width of head $2\frac{1}{5}$; snout $2\frac{2}{3}$; eye $5\frac{3}{5}$; base of dorsal $1\frac{1}{10}$; interorbital space $1\frac{2}{3}$ in eye.

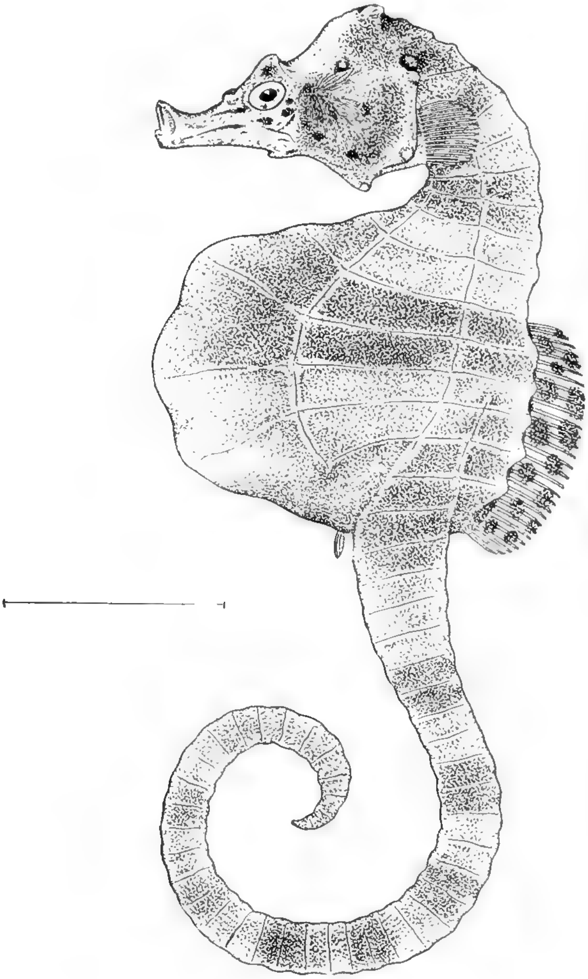

Fig. 5.—*Hippocampus agnesæ* Fowler. (Type.)

Body long, very deep, trunk very short and deeply compressed. Abdomen in front forming a deep trenchant keel, undulate as seen in profile. Tail very long, compressed at first or with its width a trifle less than its depth, then soon becoming quadrangular, and tapering rather suddenly into a strong point.

Head small, deep and compressed. Snout short, robust, its least depth about midway in its length, and its greatest width about 1⅙ in greatest distal depth of muzzle. Eye small, a trifle longer than deep, and its center falling a trifle before middle in length of head. Mouth moderately small, terminal, superior, and with rather thin jaws slightly protruding above and below. Nostrils small, together, close to middle of front rim of eye. Interorbital space narrow, concave, forming an isosceles triangle, with angle about ⅔ an eye-diameter anterior to eye.

Gill-opening about ⅗ of eye, vertical, and laterally superior on nape near nuchal keel.

Coronet moderately elevated, forming a trenchant keel, which is very slightly convex in profile and with a slight level space posteriorly at summit. Ridge of coronet on each side anteriorly with a slight tubercle and posterior edge with a slight tubercle also at each side. Below former, on each side of head, a large elevated tubercle. A trenchant and slightly elevated keel at front of interorbital angle, and each side of triangle separated from this though gradually springing up into a high broad bony process above posterior margin of eye. A very obsolete postorbital tubercle near eye. Shoulder-girdle with 3 large rounded tubercles. Opercle with many fine radiating striæ. Head without any filaments. Body-rings mostly with concave surfaces, without spines, though ridges slightly asperous and forming slight tubercles on those on trunk more or less, though none distinctly enlarged at intervals. On tail ridges become more or less obsolete, especially towards tip, though those forming longitudinal edges distinct.

Fins rather small, with simple rays. Dorsal with long base, beginning on middle of tenth ring, though appearing in profile close to its anterior edge, and then extending on to fourth caudal ring, towards its posterior margin. Anal small, short, just before ridge of third ring on tail. Pectoral with a broad base and rays all rather short. Vent a little before anal.

Color in alcohol faded dull brownish, head and ridges of rings all pale. Lower side of head with some few brownish spots, all a little smaller than pupil. Fifth, sixth and seventh, tenth, eleventh and twelfth of body-rings, and third and fourth, ninth and tenth, thirteenth and fourteenth, seventeenth and eighteenth, twentieth, twenty-first and twenty-second, and most likely beyond on tail, all deeper brown than general color. Dorsal brownish, spotted distinctly with dusky, edge of fin apparently not darker than elsewhere.

Length, measured from tip of snout to tip of extended tail, about 7? inches.

Type, No. 33,123, A. N. S. P. Victoria.

Also another example with same data, a trifle smaller but agreeing in most all particulars.

This species is related to *Hippocampus abdominalis* Lesson from New Zealand, but differs in the much shorter snout and absence of tentacles.

(Named for Mrs. Agnes F. Kenyon who collected the type.)

APOGONIDÆ.

Mionorus ramsayi sp. nov. Fig. 6.

Head $2\frac{1}{3}$; depth $2\frac{1}{8}$; D. VII–I, 7, i; A. II, 7, i; P. i, 12; V. I, 5; scales 26 in lateral line to base of caudal and 3 more on latter; 3 scales between origin of spinous dorsal and lateral line; 3 scales between origin of second dorsal and lateral line; 7 scales in a vertical series between origin of spinous anal and lateral line; width of head $2\frac{1}{4}$ in its length; depth of head at posterior margin of eye $1\frac{1}{5}$; mandible $1\frac{3}{4}$; third dorsal spine $1\frac{1}{3}$; spine of rayed dorsal 2; least depth of caudal peduncle $2\frac{1}{5}$; second anal spine $2\frac{1}{10}$; first branched anal ray (damaged) $1\frac{3}{5}$; pectoral $1\frac{1}{3}$; ventral $1\frac{1}{8}$; ventral spine 2; snout $4\frac{1}{2}$ in head measured from tip of upper jaw; eye 3; maxillary $1\frac{3}{4}$; interorbital space $3\frac{1}{4}$.

Body deep, well compressed, greatest depth at origin of spinous dorsal, back elevated, edges of body apparently rounded, upper profile anteriorly more inclined than lower, which is also a little more convex. Caudal peduncle compressed, rather deep, and its least depth about $1\frac{1}{4}$ in its length.

Head large, very deep, well compressed, slightly convergent below, lower profile a little convex and a trifle more inclined than upper, which is straight. Snout short, its length 2 in its width, and surface convex. Eye large, circular, close to upper profile and falling about first third in head. Mouth large, well inclined, and mandible slightly protruding in front. Maxillary long, well inclined, slightly curved up, and reaching beyond posterior margin of pupil slightly, though not quite to posterior margin of eye. Distal expansion of maxillary nearly equals diameter of pupil. Teeth in bands in jaws, small, short, simple and rather even. Small teeth on vomer and palatines. Nostrils together on side of snout above. Interorbital space depressed or flattened. Ridge and margin of preopercle slightly uneven, though not serrated and former inclined a little posteriorly. Opercle without spine.

Gill-opening extending forward opposite anterior margin of pupil. Gill-rakers slender, pointed, about equal to diameter of pupil, and 2? + 8? in number. Filaments rather short, apparently a little shorter? than rakers. Isthmus forms a long narrow slender trenchant keel.

Scales large, conspicuously ctenoid, and in series above lateral line parallel with its course, and below in horizontal series. Head scaly, about 2 series on cheek (according to pockets), and scales on opercles large. Between bases of ventrals a series of 2 large scales and its length a trifle over a third of fin. Base of ventral scaly in axilla. A few scales on base of caudal, and other fins all naked. Lateral line and its course concurrent with dorsal profile. Tubes simple, and extending well over scales.

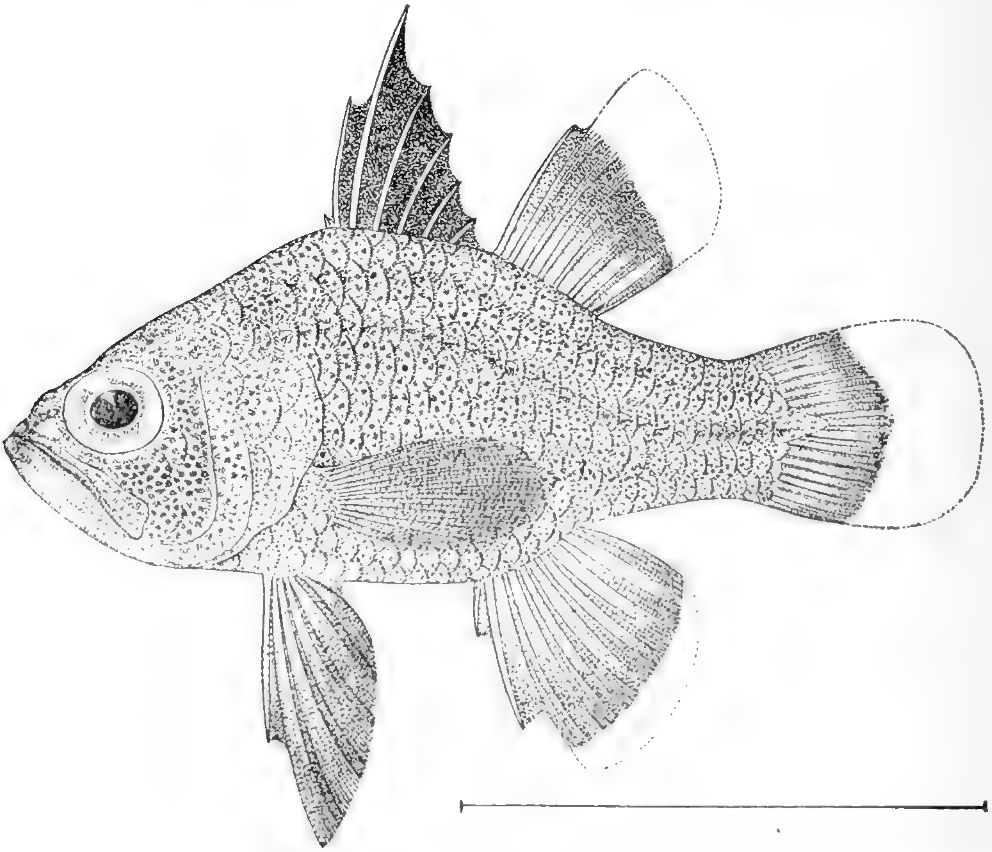

Fig. 6.—*Mionorus ramsayi* Fowler. (Type.)

Origin of spinous dorsal about opposite posterior margin of opercle or much nearer tip of snout than base of caudal, third spine longest, first shortest, and last much shorter than second. Rayed dorsal with its origin about midway between posterior margin of eye and base of caudal, and anterior rays highest. Rayed anal similar, and depressed fin reaching base of caudal. Second anal ray longer, and origin of spinous anal a little nearer posterior margin of eye than base of caudal. Caudal (damaged) probably rounded? Pectoral long, reaching a little beyond origin of rayed anal or a trifle more than half way to base of caudal, and upper median rays longest. Ventral inserted a trifle before origin of pectoral and reaching a little beyond tip of depressed pectoral, first ray longest. Vent close in front of anal.

Color faded in alcohol largely dull brown, scales everywhere minutely and obscurely specked or dotted with slightly darker. Iris slaty. Fins all pale brown. Spinous dorsal and ventrals blackish, especially so distally.

Length $1\frac{3}{4}$ inches (caudal damaged).

Type, No. 33,124, A. N. S. P. Victoria.

This species resembles *Apogonichthys darnleyensis* Alleyne and Macleay, but differs in the absence of minute serræ on the edges of the preopercle, and coloration. From *Apogonichthys adspersus* Castelnau it differs in fewer scales and more dorsal spines. From *Apogonichthys longicauda* De Vis, from Queensland, it differs in having the second dorsal spine much longer than the first, proportions of head and depth and coloration.

(Named for Dr. E. Pierson Ramsay, the well-known Australian naturalist.)

ENOPLOSIDÆ.

Enoplosus armatus (White). "Old Wife."

One example from Sorrento, on the coast of Victoria.

HÆMULIDÆ.

Terapon cuvieri (Bleeker).

One young.

POMACENTRIDÆ.

Tetradrachmum aruanum (Linnæus).

One example.

LABRIDÆ.

Lepidaplois richardsoni sp. nov. Fig. 7.

Head $3\frac{1}{4}$; depth $2\frac{3}{4}$; D. XII, 11; A. III, 10, i; P. i, 16; V. I, 5; scales

31 in lateral line to base of caudal and 3 more out on latter; 7 scales obliquely back from origin of spinous dorsal to lateral line; 6 scales obliquely back from origin of rayed dorsal to lateral line; 12 scales in a vertical series between origin of spinous anal and lateral line; width of head about 2 in its length; depth of head at posterior margin of eye about $1\frac{2}{7}$; snout 3; eye $3\frac{3}{4}$; maxillary $2\frac{1}{2}$; interorbital space $3\frac{1}{2}$; first dorsal spine $5\frac{4}{5}$; twelfth dorsal spine 3; third dorsal ray about $2\frac{1}{5}$; third anal spine nearly 3; fourth anal ray $2\frac{3}{4}$; least depth of caudal peduncle $1\frac{3}{5}$; caudal about $1\frac{2}{5}$; pectoral (damaged) $1\frac{2}{5}$?; ventral (damaged) about $1\frac{2}{5}$?

Body well compressed, comparatively short and deep, with greatest depth about midway in entire length of fish, edges convexly rounded, and profiles similar. Predorsal region converging a little above, but its edge not trenchant. Caudal peduncle deep, compressed, and its length about $\frac{4}{7}$ its least depth.

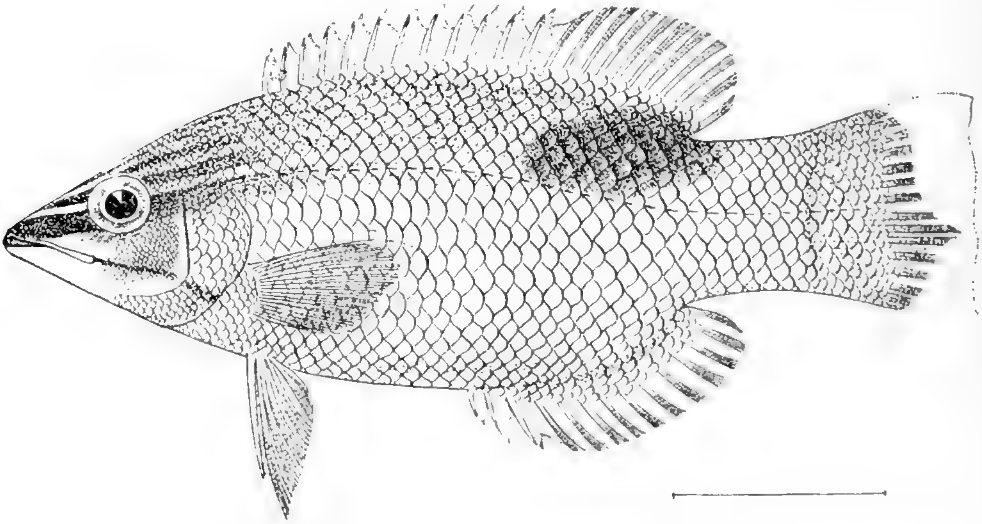

Fig. 7.—*Lepidaplois richardsoni* Fowler. (Type.)

Head moderately small, well compressed, and profiles each nearly straight, or sloping down in front till about midway in depth of head, so that muzzle is somewhat attenuated. Snout rather conical, its width at base about $1\frac{1}{6}$ in its length. Eye a trifle longer than deep, high or close to upper profile, and its center falling a trifle anterior in length of head. Mouth narrow, rather long, and jaws of about equal length in front. Maxillary long, well concealed above or only its lower portion rather narrowly exposed, and reaching a trifle beyond front margin of eye. Teeth in jaws strong, uniserial, conic, and with 4 canines in front of each jaw slightly directed forwards. Of upper canines all are of about uniform size, though of lower 2 median are a little smaller than outer. Lips thin and little fleshy. Nostrils close together near upper front margin of eye, and anterior a trifle larger. Interorbital space moderately broad, depressed and but slightly elevated convexly. Preorbital moderately broad, its least width about 2 in horizontal diameter of eye. Posterior margin of preopercle nearly straight and very slightly inclined forward, its edge very finely serrated.

Gill-opening extending forward about opposite middle of eye.

Scales large, cycloid, broadly exposed, and becoming smaller towards edges of body, on head and bases of fins. On costal region and middle of side of trunk scales largest. Of head muzzle and interorbital space naked. Preorbital and infraorbital with a number of short flutings of tubes radiating from lower margin of eye. Scales on opercle a little larger than elsewhere on head, and those on cheek in 9 series. Along bases of vertical fins scales rather large, and but slightly reduced on base of caudal. Lateral line continuous, rather high, concurrent with dorsal profile, then dropping down on side of caudal peduncle till about midway in depth of latter, and continued well out on base of latter. Tubes slender or rather attenuated, persisting to posterior edge of scale, and usually simple or only very slightly ramified or arborescent.

Origin of spinous dorsal nearer origin of rayed dorsal than tip of snout, or a little behind that of pectoral, and anterior spines graduated up till about midway in length of fin, after which they are more or less subequal with last longest. Margin of spinous dorsal deeply notched between tip of each spine, and membrane forming a slight cutaneous flap projecting slightly after though close behind tip of each. Rayed dorsal much shorter than spinous, insertion of fin about midway between origin of spinous fin and base of caudal, radii all more or less subequally high, except last few which are shorter, and posterior edge of fin rounded. Anal spines graduated up from first which is shortest, origin of fin a little before that of soft dorsal, and margin notched with slight flaps like those of spinous dorsal. Rayed anal similar to rayed dorsal, and inserted very slightly anterior to origin of latter. Caudal (damaged) apparently truncate, with corners pointed? Pectoral (damaged) apparently rounded, with upper rays longest. Origin of ventral about opposite that of pectoral, with spine about $\frac{5}{7}$ in length of fin, and entire length of latter reaching about $\frac{3}{4}$ to origin of spinous anal. Vent evidently close in front of latter.

Color of dried skin faded very pale brown generally, back and upper surface of head scarcely darker. On membrane of spinous dorsal between first and second rays and extending apparently a little over second spine a deep brown blotch a little smaller than eye. On back below bases of posterior dorsal rays and upper surface of caudal peduncle anteriorly, a blackish-brown blotch, very conspicuous, and extending horizontally forward to lateral line till about opposite origin of rayed dorsal. From anterior side of tip of snout to eye, then continued back from posterior margin of latter a little inferiorly along upper side of head and fading out on front of back below lateral line, a deep brown band, its width about equal to half a vertical eye-diameter. From upper surface of tip of snout a band is given off on each side, including nostrils where a lower ramification extends to eye, and is continued from upper posterior margin of latter parallel with one below, fading out on front of back. This band is also nearly as broad as one below and equally distinct. Rest of upper surface of head with several still narrower and slightly wavy bands or streaks of same color, though a little indistinct. From end of maxillary a narrow deep brown streak extends back over cheek below, passing over angle or corner of preopercle towards lower base of pectoral. Fins otherwise than noted all pale uniform brownish. Iris dusky.

Length about $4\frac{1}{2}$ inches (caudal damaged).

Type, No. 33,125, A. N. S. P. Victoria.

This species is closely related to *Lepidaplois bilunulatus* (Lacépède) as figured under *Cossyphus bilunulatus* Bleeker, *Atlas Ichth.*, I, 1862, p. 160, Pl. 38, fig. 3, from Amboyna. It differs however from Bleeker's fish in having about 5 longitudinal dark bands converging on the upper half of the head, and a much narrower streak extending back from the maxillary to the corner of the preopercle. There are also no posterior canines such as Bleeker shows. From *Lepidaplois albotæniatus* (Valenciennes) as figured by Jordan and Evermann, *Bull. U. S. Fish Comm.*, XXIII, pt. 1, 1903 (1905), p. 278, Pl. 24, it differs in having broader bands above the inferior orbital one.

(Named for Sir John Richardson, among the most accurate of the early writers on Australian fishes.)

Coris dorsomacula sp. nov. Fig. 8.

Head about $3\frac{2}{3}$; depth about $3\frac{2}{3}$; D. IX, 12; A. III, 12; P. I, 11; V. I, 5; scales 5 in lateral line to base of caudal and 4 more on latter (with tubes); 4 scales obliquely back from origin of spinous dorsal to lateral line; 4 scales obliquely back from origin of rayed dorsal to lateral line; 17 scales in a vertical series between origin of spinous anal and lateral line; 7 scales from middle of upper surface of caudal peduncle obliquely back down to lateral line; 7 scales from middle of lower surface of caudal peduncle obliquely forward to lateral line; width of head probably about 2 in its length; depth of head at posterior margin of eye about $1\frac{1}{2}$; snout, measured from tip of upper jaw, 3; eye 4; maxillary 4; interorbital space about $4\frac{1}{5}$; first dorsal spine $4\frac{1}{3}$; ninth dorsal spine $2\frac{2}{3}$; fourth dorsal ray nearly 2; third anal spine about $4\frac{1}{4}$; first anal ray about $2\frac{1}{3}$; eleventh anal ray 2; least depth of caudal peduncle about $1\frac{7}{8}$; pectoral about $1\frac{2}{7}$; ventral $1\frac{2}{3}$.

Body well compressed, elongate, contour rather fusiform with similarly convex profiles, greatest depth about midway in its length, and edges rather narrowly convex, though apparently not trenchant. Caudal peduncle rather deep, well compressed, and its least depth about equal to its length.

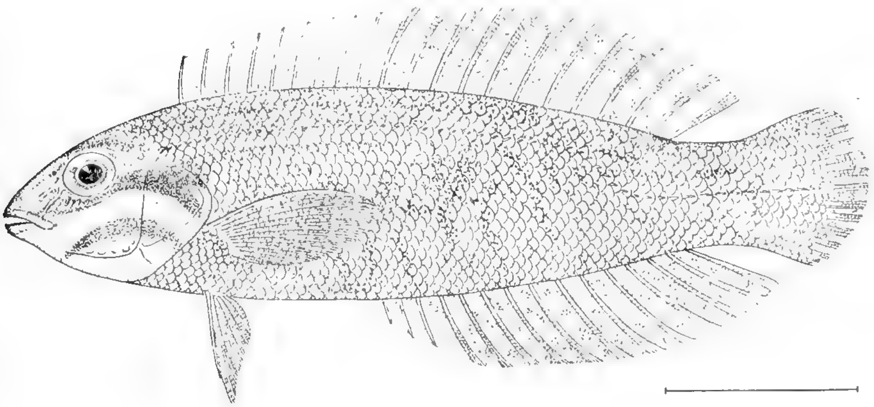

Fig. 8.—*Coris dorsomacula* Fowler. (Type.)

Head moderately small, compressed, sides apparently flattened, and upper profile a little more convexly inclined than lower. Muzzle conic, attenuated. Snout rather long, its surface convex, and its width equal to its length, inclusive of upper jaw. Mouth horizontal, falling a little below center in depth of head, and rather small. Teeth conic, uniserial, and becoming enlarged anteriorly in jaws, where they form 4 rather large canines both above and below, median 2 of each series a little larger than others. Anteriorly teeth are all directed a little forwards, especially enlarged canines. Lips apparently rather thin.

Nostrils superior on side of snout near upper anterior margin of eye, and posterior much larger than anterior. Interorbital space depressed or slightly flattened, only sides a little elevated. Width of preorbital about $\frac{4}{5}$ of eye. Posterior margin of preopercle inclined very slightly forward.

Gill-opening moderate.

Scales rather large, thin, disposed in longitudinal series parallel with lateral line, becoming slightly smaller towards edges of body, on breast, predorsal region and base of caudal. Head, and all fins, except base of caudal, naked. Lateral line superior, concurrent with the dorsal profile of back till below posterior portion of rayed dorsal when it descends till midway on side of caudal peduncle, and then extending straight to base of caudal. Tubes simple, large, and on anterior or elevated portion of lateral line all bent up, though all extending rather close to margins of scales. On side of caudal peduncle tubes are horizontal. On preorbital and limb of preopercle are some short radiating flutings. A series of pores along infraorbital.

Origin of spinous dorsal about midway between tip of upper jaw and base of first dorsal ray or apparently a trifle before origin of pectoral. spines slender, firm and graduated up from first which is shortest, and margin of fin apparently entire. Origin of rayed dorsal a little nearer posterior margin of eye than base of last dorsal ray, and anterior rays a little shorter than last, and margin of fin a little convex. Origin of spinous anal about midway between tip of snout and base of caudal or about opposite origin of pectoral, spines small, slender, firm and graduated from first to third, which latter is longest and margin of fin entire. Rayed anal similar to rayed dorsal, except posterior rays seem a little longer than anterior. Caudal (damaged) probably with posterior margin convex? Pectoral moderate, upper rays longest. Ventral inserted about opposite origin of pectoral, though apparently not quite reaching vent. Ventral spine slender, about $\frac{5}{7}$ length of fin. Vent close in front of anal.

Color when dried in alcohol faded largely dull brownish. A pale or dull grayish streak extends from lower preorbital region up to lower margin of eye, then back from latter towards shoulder, though giving off a branch towards base of pectoral. From under surface of mandible at its articulation extends back convexly over cheek, crossing posterior margin of preopercle just above its angle, and finally decurves over lower portion of opercle. A pale streak along lateral line for greater part of its course superiorly, and paler or lighter anteriorly. Trunk with pale and darker vermiculations, especially contrasted on costal region. Rayed vertical fins all with traces of dusky blotches or spots, though now obscure. A jet-black blotch at bases of last dorsal rays. Iris brownish.

Length $4\frac{5}{8}$ inches (caudal damaged).

Type, No. 33,126, A. N. S. P. Victoria.

This species is very closely related to *Coris venusta* Vaillant and Sauvage from Honolulu, but differs in the jet-black blotch at the bases of the last two dorsal rays. It approaches most closely the figure of *Hemicoris remidius* Jenkins, *Bull. U. S. Fish Comm.*, XIX, 1899 (1900), p. 49, fig. 5, also from Honolulu, which is thought identical with *Coris venusta*.

(*Dorsum*, back; *macula*, spot; with reference to the black spot at the bases of the last dorsal rays.)

MONACANTHIDÆ.[3]

Brachaluteres trossulus (Richardson).

One small example.

Osbeckia scripta (Gmelin).

One young.

DIODONTIDÆ.

Diodon blochii Castelnau.

One example.

OSTRACIIDÆ.[4]

Aracana aurita (Shaw).

One large example.

Aracana flavigastra (Gray).

Four specimens agreeing with Richardson's figure.

Aracana ornata (Gray).

Two fine examples.

TETRODONTIDÆ.[5]

Spheroides richei (Fréminville).

One example with 3 dark or blackish saddles over the back.

Tetrodon nigropunctatus Schneider.

One example of deep chocolate-brown color and fins all with pale creamy tints. Spines over body of moderate length.

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[3] *Chætodon lunula* (Lacépède) from the Hawaiian Islands.

[4] *Ostracion concatenatus* Bloch, *Ostracion lentiginosus* Schneider and *Ostracion cornutus* Linnæus from "South Sea Islands."

[5] *Remora remora* (Linnæus) from New Zealand.

TRICHONOTIDÆ.

LESUEURINA gen. nov.

Type *Lesueurella platycephalus* sp. nov.

Differs from *Hemerocœtes* Valenciennes in the absence of the spine at the anterior termination of each maxillary, the insertion of the dorsal posterior to that of the anal, and the protruding mandible.

(Named for Charles Alexandre Le Sueur, the first to study the fishes in the collection of the Academy of Natural Sciences of Philadelphia.)

Lesueurina platycephala sp. nov. Fig. 9.

Head $4\frac{1}{3}$; depth 7; D. 32; A. 37; P. 16; V. I, 5; 42 scales in lateral line to base of caudal; 5 scales obliquely back from origin of dorsal to lateral line; 8 scales obliquely up behind from origin of anal to lateral line; width of head $1\frac{2}{5}$ in its length; depth of head 2; twenty-ninth dorsal ray about 3; thirty-third anal ray $2\frac{2}{3}$; pectoral (damaged) about 1; ventral (damaged) $1\frac{7}{8}$; least depth of caudal peduncle $3\frac{1}{4}$; snout $4\frac{2}{3}$ in head measured from tip of upper jaw; eye 6; maxillary $2\frac{2}{5}$; interorbital space 5.

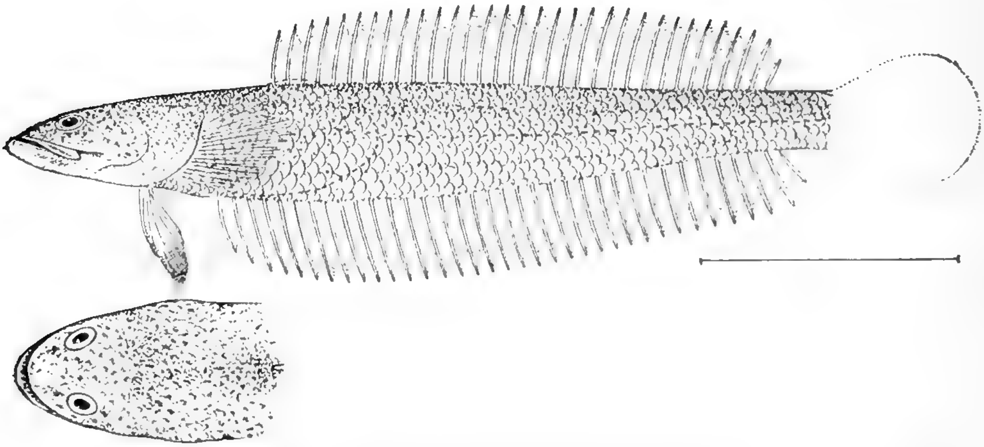

Fig. 9.—*Lesueurina platycephala* Fowler. (Type.)

Body elongate, well compressed, and becoming depressed anteriorly, so that greatest width which is at posterior margin of preopercle is a little more than greatest depth of body. Greatest depth of body towards end of depressed pectoral, and trunk sloping back gradually from this point to least depth of caudal peduncle with similar straight profiles. Predorsal region broadly convex. Caudal peduncle well compressed, deep and short.

Head broad, depressed, in lateral profile appearing attenuated, and when viewed above its greatest width at posterior margin of preopercle or about last third of its length. Anterior profile as seen from above convex, though rather narrowly constricted. Snout broad, short, its anterior profile broadly convex as seen from above, and its length $1\frac{2}{5}$ in its width at front margins of orbits. Eye small, superior, a little longer than deep though rounded, and its center falling about first fourth in space between tip of snout and posterior margin of opercle. Mouth large, broad, and mandible projecting well beyond tip of upper jaw in front. As seen below mandible is broadly convex around front profile, or its width about $1\frac{1}{6}$ in its length. Maxillary narrow, reaching back till opposite posterior margin of eye, and its distal extremity slender or forming a point below. Rather narrow bands of small slender pointed teeth in jaws. Similar teeth in two widely separated short narrow bands or series on each side of vomer in front, each of these close behind band in jaw. On each side of roof of mouth also a similar band or series to those on vomer, though a little further from band around edge of jaw. Roof of mouth otherwise edentulous. Tongue rather large, broad, depressed, rounded in front and apparently little free. Nostrils (damaged) apparently similar, close together directly in front of eye. Interorbital space narrow and flattened. Top of head posterior to eyes broad, very slightly convex to nearly flat, and from upper sides rather converging below to branchiostegal region, though at this point, and across isthmus, rather broadly depressed. Posterior margin of preopercle entire and convex. Preorbital and infraorbitals rather roughly rugose.

Gill-openings large and extending well forward. Gill-rakers not now evident and filaments also probably dried. Isthmus rather narrowly triangular, and with lower surface forming a short trenchant keel.

Scales large, distributed over most of head and all of trunk, and on latter forming longitudinal series parallel with lateral line. Scales on head rather small, and extending down on cheek and opercle. On trunk scales on predorsal region and belly are smaller than elsewhere. Scales all thin, broadly exposed, with entire margins and without corrugations of any kind. No scales on fins (caudal damaged and therefore not determined). Lateral line continuous, a little superior at first or till after tip of pectoral, then midway along side of trunk to middle of base of caudal, and composed of long and rather well exposed tubes.

Dorsal long, its insertion well behind that of anal or near first third in entire length of fish, and first rays graduated up, after which they are all more or less equal, or only last 1 or 2 graduated down a little shorter. Anal inserted about last $\frac{2}{5}$ in space between origins of ventral and dorsal. Caudal (damaged) probably slightly convex? Pectoral (damaged) reaching a little beyond origin of dorsal, upper median rays evidently longest, margin of fin rounded and bases of lower rays extending well forward towards base of ventral. Ventral inserted at last fourth in length of head, and reaching a trifle beyond origin of anal. Vent close in front of anal.

Color in alcohol of dry example faded pale brownish more or less generally. Back a trifle darker in tint than lower surface, and over upper surface of head and predorsal region especially sprinkled with small deeper or darker brownish specks or dots. Lower surface of head and belly at least immaculate. Fins all dull brownish. Iris pale yellowish-brown.

Length (without damaged caudal) about $3\frac{1}{16}$ inches.

Type, No. 33,127, A. N. S. P. Victoria.

Only the above example.

(*Πλατύς*, broad; *κεφαλή*, head.)

CALLIONYMIDÆ.

Callionymus papilio Günther.

Two examples.

URANOSCOPIDÆ.

Kathetostoma læve (Schneider).

A head is most likely this species.

BLENNIIDÆ.

Cristiceps australis Valenciennes.

One example.

Blennius victoriæ sp. nov. Fig. 10.

Head $3\frac{1}{2}$; depth about 4; D. XV, 16; A. II, 19; P. 14; V. 2; width of head $1\frac{3}{5}$ in its length; depth of head $1\frac{1}{5}$; snout nearly 3; eye 4; maxillary $2\frac{1}{3}$; interorbital space $1\frac{3}{4}$; first dorsal spine $2\frac{1}{3}$; eighth dorsal ray $2\frac{1}{4}$; first anal ray about 4; eighteenth anal ray $2\frac{2}{3}$; least depth of caudal peduncle $3\frac{1}{3}$; caudal $1\frac{2}{3}$; ninth pectoral ray $1\frac{1}{5}$; length of ventral $1\frac{3}{4}$.

Body elongate, well compressed, so that towards edges of back or dorsal, and lower surface of trunk posterior to vent or towards anals, it is decidedly convergent. Anterior upper profile slightly elevated convexly, so that greatest depth falls at this point. Caudal peduncle compressed, and its length as measured to base of last dorsal ray $\frac{4}{5}$ its least depth.

Head large, deep, or with greatest depth of entire body falling at origin of ventral, and upper profile at first very steeply inclined up from tip of snout till above front of eye, and then slightly inclined to origin of dorsal. Snout rather broadly convex over surface, so that its width is a little greater than its length. Eye large, circular, close to upper profile, and placed about first third in head. Mouth large, low, with gape reaching about opposite middle of eye. Lips broad, upper more so than lower. Teeth uniserial, slender, pointed, close-set, equal, and each jaw, both above and below posteriorly, with an enlarged canine slightly recurved posteriorly. Maxillary more or less concealed posteriorly. Preorbital moderately broad, its least width about $1\frac{1}{2}$ in eye. Nostrils small, close together near middle of front rim of eye, and of about equal size. Interorbital space narrow, its width about $2\frac{3}{4}$ in eye, and very slightly concave. Median line of cranium slightly trenchant, or with a slight keel.

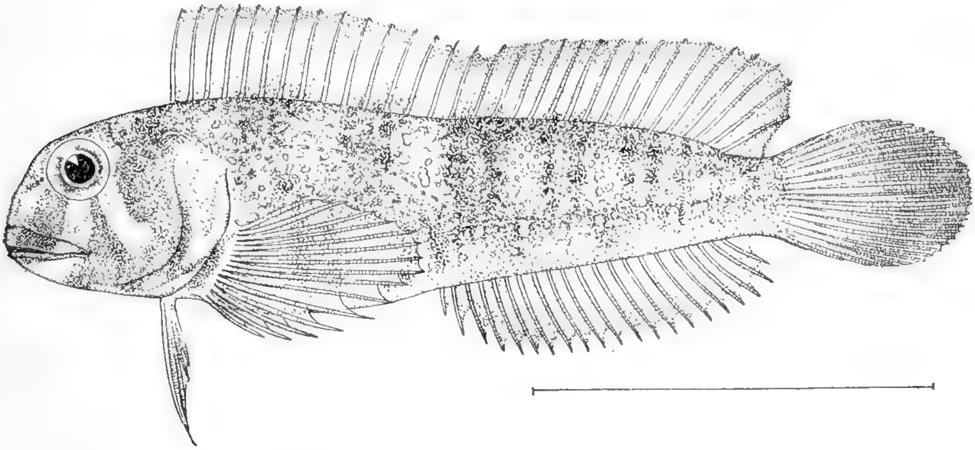

Fig. 10.—*Blennius victoriæ* Fowler. (Type.)

Gill-opening large, lateral, and with membrane as a fold over broad isthmus, this point about midway in length of head.

Skin naked and apparently smooth. Lateral line of simple tubes, superior at first or for about first $\frac{4}{9}$ in length of trunk, then sloping down till about lower $\frac{2}{5}$ in depth of trunk at that point. About 20 tubes, each opening in a pore, in anterior curved portion of lateral line, and about 9 tubes continued back in a straight series anteriorly.

Origin of spinous dorsal nearly midway between origin of pectoral and posterior margin of eye, spines all more or less subequal with flexible tips, and edge of fin emarginate. Origin of rayed dorsal a little nearer that of spinous fin than base of last dorsal ray, rays a little higher than spines, edge entire, and fins continuous with spinous portion. Anal preceded by 2 spines scarcely distinguishable from rays, second a little longer than first, and origin of latter about opposite origin of rayed dorsal. Anal rays rather shorter anteriorly or with longest posteriorly, and margin of fin notched. Caudal with median rays longest, and fin rounded. Pectoral broad, lower rays with free tips and median rays longest, and reaching vent. Ventral jugular, falling about opposite last $\frac{2}{7}$ in length of head, with a long slender spine flexible at tip reaching about $1\frac{3}{4}$ to origin of spinous anal. Ventral rays large, long and thick. Vent close in front of anal.

Color in alcohol rather dark brown generally, lower surface scarcely paler. About 7 pairs of broad deep brown or dusky vertical bars from dorsal profile, and somewhat reflected on bases of dorsals. Each dark bar is really a double vertical series of several blackish spots, and below lateral line they become obsolete. On side of trunk between dark vertical bars are very pale small yellowish to grayish spots, these obscure and rather irregular. In pale areas on lower side of abdomen several pairs of broad short dusky vertical bars, interspaces noticeably pale. Above base of anal they are short with whitish spots or blotches distributed usually alternately to dark dorsal markings. Fins all faded more or less pale brownish. Iris dull slaty-brown, pupil brown.

Length about $2\frac{1}{4}$ inches.

Type, No. 33,128, A. N. S. P. Victoria.

Also 2 other examples with same data. They agree in most characters and have the whitish lateral markings distinct.

This species seems to be related to *Blennius tasmanianus* Richardson, but has more dorsal spines, and has no orbital or nasal tentacles. *B. tasmanianus* is also different in color, as it is said to be brownish-gray dotted with brown and the head and vertical fins blackish.

(Named for Victoria in southeastern Australia.)

GOBIESOCIDÆ.

Diplocrepis costatus Ogilby.

One example.

NOVEMBER 5.

ARTHUR ERWIN BROWN, D.Sc., Vice-President, in the Chair.

One hundred and eight persons present.

The death of Charles Mohr, M.D., a member, October 31, 1907, was announced.

Notes on Minerals.—MR. F. LYNWOOD GARRISON, exhibiting specimens, remarked that Nos. 1 and 2 were copper ore, composed of bornite, chalcopyrite in a hard, dense rock, determined microscopically to be a tuff. These ores occur near the town of San Christobal, in the island of Santo Domingo, West Indies. There are at this place two classes of copper deposits, one in veins or mineralized zones carrying quartz and running in a definite direction through the country rock (tuff). The other class is made up of segregations of chalcopyrite and limonite in the tuff, and mostly located near the contact of the tuff and the Cretaceous limestone. The two localities in which these different ores occur are about a mile apart. A description of these deposits with a scientific dissertation thereon was published in the *Mining and Scientific Press* of San Francisco, September 7, 1907, page 305.

No. 3. Molybdenite with chalcocite and chalcopyrite, from the Wallapi Mountains, Mojave Co., Arizona. The association of copper ores with a relatively large proportion of molybdenite is exceedingly rare. Molybdenite and copper minerals are sometimes found associated together in gneiss, as for example at the Frankford quarries near Philadelphia, but the combination of the two minerals in sufficient amount to constitute an ore is, as far as he knew, unique. The country rock containing these deposits is granite, probably not younger than the Tertiary period. The district in which they occur is unexplored in a geological sense, and was visited during July, 1907, by his assistant engineer, Mr. William F. Ward. He hoped to have the opportunity at a future time to examine this deposit and prepare a more elaborate description of it. As a commercial matter it is highly desirable to separate the molybdenum from the copper minerals, but as yet all attempts to do this have been unsuccessful. The molybdenum itself would bring a high price for use in making special steel, since it is found to be more efficient for that purpose than tungsten, chromium or manganese. The practical commercial problem involved in this proposition is to successfully separate the molybdenum from the copper minerals, as the presence of one would vitiate the other for use in the arts. It is to be hoped that at some future time this can be successfully accomplished.

No. 4. Zinc blende from Joplin, Missouri, coated with greenockite (cadmium sulphide) and marcasite (FeS_2) and some small crystals of calcite. These minerals are all associated with and deposited upon the dark blue flint which is characteristic of the Joplin lead and zinc deposits. This flint is of secondary origin and obtains its blue color from association with the black muck derived from the coal shales that once overlaid the ore deposits, but now almost entirely removed by erosion. The paragenesis of these minerals is well illustrated in this specimen: first we have the large zinc blende (sphalerite) crystals, upon them the marcasite and then the greenockite; finally the small, almost microscopic crystals of calcite, one laid down upon the other in orderly succession. There is another mineral deposited upon the flint at the base of the large sphalerite crystals, but as yet he had been unable to determine its name. It is fibrous, resembling asbestos or some of the zeolites, and microscopic in size.

Nos. 5 and 6. Two pseudomorphs, one of sphalerite and the other calamine, after fossils. These minerals were found some seven or eight years ago in a certain mine of the Joplin district. He believed them to be quite rare, for he had never seen but one or two others of a similar kind and they were from the same deposit. The particular fossil which has been replaced by the zinc minerals is a coral, one of the Zaphrentis.

No. 7. An interesting fossil from the zinc deposits near Springfield, Missouri. It is one of the Brachiopoda (a *Spirifer*). On its lower edge is a beautiful nearly perfect dodecahedral crystal of sphalerite, the association of the two constituting an interesting specimen.

No. 8. An association of pink crystallized dolomite with barite ($BaSO_4$) and sphalerite. Barite is rather rare in the Joplin district, but very common in other parts of Missouri, notably in the lead district of the southeast.

DR. HENRY SKINNER made a communication on the scientific results of a visit to Saskatchewan made by him last summer. (No abstract.)

The following was adopted:

The Academy having heard with profound regret of the death of PROF. ANGELO HEILPRIN on the 17th of last July, desires to put on record an expression of its sense of the loss which science has thereby sustained and of its appreciation of the work accomplished by him as a student, administrator and explorer during the years of his connection with the society from 1879 until within a few weeks of the termination of his life.

The Academy considers it a cause of congratulation that much of the work accomplished by Prof. Heilprin during those years was materially forwarded by the resources of the library and museum and by the encouragement of his colleagues. It desires to express to his relatives its sincere sympathy in the bereavement they have sustained.

NOVEMBER 19.

ARTHUR ERWIN BROWN, D.Sc., Vice-President, in the Chair.

Thirty-eight persons present.

The death of Prof. Lucien M. Underwood, a Correspondent, November 16, 1907, was announced.

DR. BENJAMIN SHARP made a communication on Lobster Fisheries. (No abstract.)

J. W. Van Wijke, of Groningen; Otto zu Strassen, of Leipzig, and R. Bowdler Sharpe, of London, were elected Correspondents.

The following were ordered to be printed:

DESCRIPTION OF A NEW SPECIES OF ANNELID FROM WOODS HOLE.

BY J. PERCY MOORE.

Syllides verrilli n. sp.

Form moderately slender, slightly flattened and wider in the middle region. Size small, length 2.5–3 mm., maximum width .2–.3 mm.

Prostomium large (fig. 1, *a*), depressed, slightly wider than long, broadly elliptical or subquadrate with rounded corners, often slightly emarginate anteriorly and nearly straight posteriorly. Eyes three pairs, reddish brown; the first pair minute and situated well in advance of the others just behind and external to the base of the lateral antennæ; the second and third pairs much larger, subequal, their diameter about $\frac{1}{9}$ the width of the prostomium, both on posterior half of prostomium; the middle pair widest apart and separated by about 5 times their diameter, the posterior pair slightly behind and mediad of them near the posterior margin of the prostomium.

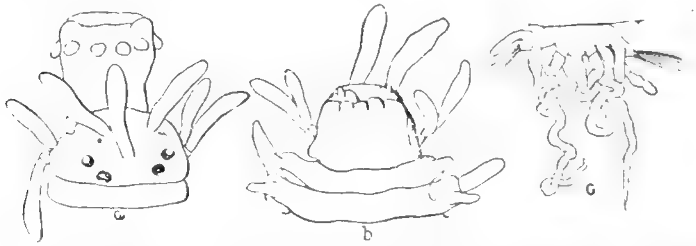

Fig. 1.—*Syllides verrilli*. *a*, dorsal view of head with protruded proboscis; *b*, ventral view of prostomium and 3 segments, showing palps; *c*, pygidium with caudal cirri, all × 83. Fig. *b* from No. 2402, all others from No. 2401.

Palpi (fig. 1, *b*) very small, mammilliform, situated on the ventral face of the prostomium and directed downwards, invisible or nearly so from above. They consist of swollen bases and short cirriform distal portions which alone ever appear in dorsal views. Tentacles (fig. 1, *a*) all short, stoutly clavate; the middle one arising on a line joining the anterior borders of the middle pair of eyes, their length equaling or slightly exceeding the prostomial width, their ends bluntly rounded and about twice as thick as the base. Lateral tentacles arise close to anterior border of prostomium, their bases separated by a distance nearly equal to ½ the width of the prostomium, their length slightly less than the median tentacles and nearly or quite the prostomial width. When visible from above the ends of the palpi appear immediately beneath these.

Peristomium obsolete or nearly so dorsally, almost completely coalesced with the prostomium below and projecting but little beyond it laterally. The mouth far forward, with prominent posterior lip. Tentacular cirri (figs. 1, *a* and *b*) like the tentacles, from which they differ only in being supported on very short cirrophores, the dorsal as long as lateral tentacles, ventral slightly shorter.

Metastomial region very slightly depressed, the segments increasing in width slightly to the middle. The first seven, as far as the caudal end of the gizzard, are short and crowded; succeeding ones are longer and contain the gonads. Pygidium a small ring with rounded posterior outline, scarcely distinguishable from the preceding segment. It bears a short unjointed median ventral style and a pair of very long, slender, unjointed cirri as long as the greatest width of the body (fig. 1, *c*).

Parapodia (fig. 2, *a*) strictly uniramal on the first seven metastomial segments of sexually mature worms and on all segments of immature worms. They are prominent, their length nearly equaling the width of the body, slender, somewhat compressed at the base, the neuropodium becoming conical distally and ending in a salient dorsal angle, from which the distal border slopes ventrad, and which is supported by a single stout aciculum. Anterior and posterior short lips embrace the

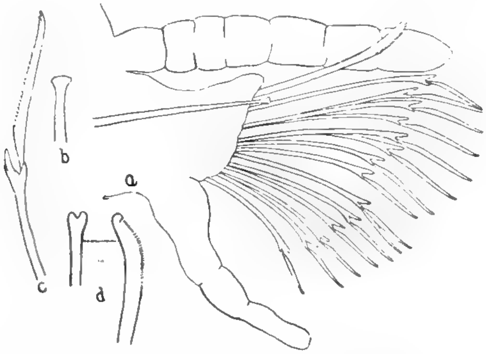

Fig. 2.—*Syllides verrilli*. *a*, parapodium VIII from behind, × 250; *b*, tip of neuropodial aciculum, × 600; *c*, average neuropodial compound seta from X, × 600; *d*, profile and rear views of end of simple neuropodial seta, × 600. All drawn from No. 2402.

bases of the setæ, which are arranged in a broad vertical fan (fig. 2, *a*). The first seven pairs of parapodia have no notopodia whatever, the succeeding ones on sexually mature worms bear notopodial setigerous sacs on the dorsal face of the base of the neuropodium, but there is no distinct notopodial elevation or lobe.

On the first three metastomial segments the notocirri are exactly like the peristomial cirri in both form and size. Succeeding ones become more slender and tapered, with the tip often abruptly more slender, and increase in length until they equal the width of the segments. They also become distinctly jointed or even beaded (fig. 2, *a*). In the middle of the body they are as long as the body diameter and have 7–8 divisions. There is a great difference in this respect in different specimens, some having the cirri much more strongly moniliform than others. Sometimes there is a slight but distinct alternation of longer and shorter cirri, the former being always the more strongly beaded; but these conditions are not constant. Posteriorly the cirri become again shorter. Neurocirri (fig. 2, *a*) are coalesced with the ventral border of the neuropodia to near the end, where the styles become free and reach to the ends of the ventral setæ. They are sub-conical, usually with irregular constrictions and thickenings and a more slender blunt terminal piece.

Aciculum single, neuropodial only, rather stout, tapered, straight or slightly curved, extending obliquely nearly into the dorso-lateral angle of the neuropodium, beyond which it projects and terminates in a large, flattened and roughened knob (fig. 2, *b*). Neuropodial setæ of two kinds, both longer than the parapodium and colorless. The first (fig. 2, *d*) is a single and never more, moderately slender, simple seta arising dorsal to the end of the aciculum of each parapodium, curved and slightly thickened distally, finely toothed along the convex side and slightly enlarged and bifid at the end. The second form is compound (fig. 2, *c*). These form spreading vertical subacicular tufts which on the more anterior parapodia contain 20 or more in several ranks, the number becoming gradually reduced to 10 or 12 on middle segments and 7 or 8 posteriorly. Shafts more slender than the simple setæ, slightly curved, deeply unequally bifid distally, with a single small accessory tooth on the side of the larger division. Appendages delicate, slender, elongated, the longest anterior dorsal ones equalling the diameter of the parapodium, but diminishing toward the ventral side posteriorly until they are only ⅙ as long. Distally they are divided into two slender, unequal, slightly curved teeth separated by a narrow cleft. Apparently the margins are finely fringed, but this appearance disappears posteriorly.

Sexually mature specimens bear, on all parapodia after VIII, a tuft of extremely delicate capillary setæ as long as the width of the body plus one parapodium. These do not arise from a special notopodial tubercle, but from a notopodial setigerous area at the base of the dorsal and posterior face of the neuropodium, and are not even supported by a notopodial aciculum.

When retracted the proboscis occupies the first 3 segments and the gizzard the next 5. When extended the proboscis (fig. 1, *a*) is cylindrical or urn-shaped, reaching to or beyond the end of the cephalic tentacles; the chitinous lining thick, brownish, with a smooth reflected rim and no tooth. Just behind the rim is a circle of 10 rather prominent, rounded, soft papillæ. When the proboscis is protruded the very large gizzard is drawn forward into somites II to VI inclusive.

Body generally colorless when alive, the intestine grayish drab and the eyes bright red.

As noted above the sexual forms are simple epitokes, with swimming setæ and gonads beginning at somite IX behind the stomach.

Taken rather rarely at the surface at Woods Hole. Type No. 2402, Academy of Natural Sciences of Philadelphia. This is the species referred to by Verrill as having been taken at Woods Hole along with *S. setosa* (*Rep. U. S. Fish Comm.* for 1882, 1884, p. 664, footnote), and is perhaps the *S. longicirrata* Oersted, of Webster and Bendict, taken by them at Eastport, Me., but is not that species as described by European authors. From typical species of the genus it differs in the small size and ventral position of the palps. In this respect it stands nearest to *S. setosa,* with which it should probably stand in a separate subgenus.

THE LIFE-AREAS OF SOUTHERN NEW JERSEY.

BY WITMER STONE.

As pointed out by Verrill as early as 1866, the eastern United States is divisible into four main parallel faunal and floral belts or life-zones—the Canadian, Alleghanian, Carolinian and Louisianian (or Austroriparian). While the general trend of these belts is east and west they are greatly deflected by the Appalachian mountain chain, so that in eastern Pennsylvania and New Jersey they run more nearly northeast and southwest.

The Canadian zone is limited to the higher parts of the mountains in Pennsylvania, often mere isolated islands, present in New Jersey only in the northwestern corner of the State—if at all; the Alleghanian occupies the greater part of Pennsylvania and the northern third of New Jersey, while the Carolinian is restricted to the southeastern and southwestern corners of Pennsylvania and central and southern New Jersey.

This would represent roughly the relative position of the three life-zones in these States based upon a study of the birds and mammals, though the exact boundaries are hard to trace, owing in part to the gradual passage of one fauna into the other, the overlapping of the ranges of certain species and the constant changes that are being effected by the destruction of the forests.

These belts may be subdivided into minor areas dependent upon peculiar climatic, topographic or geologic conditions.

The study of the distribution of the various species of terrestrial vertebrates is often of little aid in defining these minor life-areas, because the conditions that produce them are not sufficiently potent to act as barriers to the ranges of such free-moving forms.

Plants, however, are far more susceptible to these influences and their great wealth, both of species and individuals, offers an enormous amount of data to any one engaged in studying the boundaries of minor life-areas.

Consequently in the study of the life-areas of southern New Jersey, in which I have been engaged for a number of years, I have paid especial attention to plants, though I have of course taken advantage of any other data that were available.

While I contemplate a much fuller and more exhaustive treatment of the subject in the future, it seems desirable to present at once some of the conclusions to which my studies have led. It would seem that those portions of eastern Pennsylvania and New Jersey that we have been accustomed to refer to the Carolinian zone are divisible into several areas running in a general northeast and southwest line parallel to the mountains:

I. A hilly or rolling country adjoining the Alleghanian on the west and north and reaching east and south to the flat bottom of the lower Delaware Valley and the old Raritan basin.

II. The Delaware Valley–West Jersey region.[1]

III. The Pine Barrens.

IV. The Atlantic Coast strip, including the higher parts of the coast islands.

V. The Maritime meadows and sea beach.

It is with the three middle divisions that this paper has to deal—the Pine Barrens, the Delaware Valley and Coast Strip.

The greater part of southern New Jersey is composed of what is known as the Pine Barren region, covering according to current views all the country east and south of a line from Long Branch to Bridgeton.

The flora of the Pine Barrens is very uniform with relatively few species, but generally so different from that of the area to the west that the passage from one to the other is easily noticeable even from a moving railway train. Indeed I am not acquainted with any transition so striking elsewhere in the Middle States. The West Jersey flora is identical with that of the low grounds on the Pennsylvania side of the Delaware at Tinicum, Bristol, Tullytown, and doubtless also of the lower part of Philadelphia when that was in a state of nature. This same flora extends northeastward across New Jersey above the Pine Barrens and south of the hilly region to the north. Indeed the resemblance between the plant life at Tinicum, Delaware Co., Pa., and from Monmouth Junction to Princeton Junction, N. J., is remarkable.

The flora of the New Jersey Pine Barrens has long been familiar to botanists, and the species of the south Atlantic coastal plain which here find their northern limit have for the most part been listed for

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[1] Plate XII in Salisbury's *Physical Geography of New Jersey*, 1898 (Vol. IV. *Final Rep. of State Geologist*), shows a remarkable correspondence with my floral areas. The area of Pensauken submergence being almost equivalent to my Delaware Valley and Coast regions, while the elevated Beacon Hill region is the typical Pine Barrens.

many years. A feature of the Pine Barren flora, however, quite as striking as the presence of these southern forms, and one upon which little stress has been laid, is the absence of very many widely distributed species.

In Dr. N. L. Britton's *Catalogue of Plants found in New Jersey* many common species are given as occurring "throughout the State" which are entirely absent from the Pine Barrens. Another point of interest is the fact that the Pine Barren flora does not cover the entire southeastern portion of the State. Along the whole seaboard back of the salt meadows is a strip of varying width supporting a flora essentially similar to that of West Jersey, and in the Cape May peninsula these eastern and western strips join together almost to the exclusion of the true Pine Barren flora, which occurs only in spots or islands south of the Great Cedar Swamp.

The southern portion of the Cape May peninsula, especially on the Delaware Bay side, harbors quite a number of plants that are distinctly more southern than those of the Pine Barrens, and would seem to constitute a tinge of the Austro-riparian zone, which normally reaches its northern limit at the Capes of the Chesapeake.

Some of these plants extend up into West Jersey and others up the eastern coast strip a varying distance, but none of them into the Pine Barrens.

Opposed to these two southern elements we have three boreal incursions into the southern New Jersey flora: First, certain bog species of the Pine Barrens; second, a number of northern species which occur in West Jersey, especially close to the edge of the Pine Barrens, and, third, species which occur in the coastal strip and in the wooded areas that are found here and there on the long narrow islands that form the true sea beach of eastern New Jersey, frequently separated by five or six miles of salt meadows or bays from the mainland.

While not attempting in the present connection to correlate these life-areas and boreal and austral incursions with conditions which may have produced them, I mention below some of the more characteristic species which distinguish them.

I. The Pine Barrens.

The characteristic trees of this region are in the dry portions *Pinus rigida, Quercus marylandica, Q. nana, Q. minor, Q. prinus, Q. prinoides, Sassafras sassafras.* In moist spots *Chamæcyparis thyoides, Nyssa sylvatica, Magnolia virginiana, Acer rubrum, Betula populifolia.* Characteristic shrubs are *Gaylussacia resinosa, G. frondosa, G dumosa,* *Vaccinium vascillans, V. corymbosum, Leucothoë racemosa, Xolisma ligustrina, Kalmia latifolia, K. angustifolia, Azalea viscosa, Clethra alnifolia, Viburnum nudum* and *Comptonia peregrina.*

While the above are the most conspicuous components of the flora, they are by no means confined to this area.

The following list includes the peculiar Pine Barren species and those which occur southward along the Atlantic coastal plane, but which find their northern limit in the New Jersey Pine Barrens. A few of them do occur, it is true, on Long Island, in colonies which seem to constitute northern pine barren islands. A few also occur in such spots in West Jersey, but in the main these species are absent from both West Jersey and the eastern coast strip, and in any case may be regarded as typical Pine Barren species.

Lycopodium carolinianum
Lycopodium alopecuroides
Calamovilfa brevipilis
Sporobolus torreyanus
Panicum sphagnicola
Carex walteriana
Cyperus cylindricus
Rynchospora torreyana
Rynchospora gracillenta
Rynchospora oligantha
Rynchospora pallida
Rynchospora knieskernii
Scleria torreyana
Juncus marginatus aristulatus
Juncus cæsariensis
Xyris fimbriata
Tofieldia racemosa
Abama americana
Xerophyllum aspodeloides
Smilax walteri
Smilax tamnifolia
Smilax laurifolia
Blephariglottis cristata
Lophiola americana
Gyrotheca tinctoria
Arenaria caroliniana
Ascyrum stans
Hypericum densiflorum
Hypericum virgatum ovalifolium
Polygala lutea
Polygala brevifolia
Meibomia stricta
Itea virginica
Dendrium buxifolium
Pyxidanthera barbulata
Sabbatia lanceolata
Gentiana porphyrio
Lobelia canbyi
Lacinaria graminifolia pilosa
Eupatorium leucolepis
Eupatorium resinosum
Sclerolepis uniflora
Helianthus augustifolius
Aster gracilis
Aster nemoralis
Solidago stricta
Solidago fistulosa
Solidago erecta

The northern element in the Pine Barren flora consists of the following species, which find their southern low ground limits in this region or a little to the south of it. Those marked with an asterisk are peculiarly Pine Barren species, so far as southern New Jersey is concerned, not occurring in West Jersey or the coast strip.

*Schizæa pusilla**
*Sporobolus serotinus**
Carex livida
Carex folliculata
Carex trisperma
Eriophorum polystachion
Juncus pelocarpus
Juncus militaris
Unifolium canadense
Blephariglottis blephariglottis
Coreimna conradii
Utricularia clandestina
Gaultheria procumbens
Chamædaphne calyculata
Arctostaphylos uva-ursi
Vaccinium atrococcum
Chrysopsis falcata

Among birds we find three species which breed regularly in the Pine Barrens but not in West Jersey, *i.e.*, *Dendroica vigorsii*, *D. discolor* and *Compsothlypis americana usneæ*. A number of species common in West Jersey are however absent from the Pines. Among mammals we have two species peculiar to the Pine Barrens, *Evotomys gapperi rhoadsi* and *Synaptomys cooperi*, both boreal incursions, and several West Jersey species which are absent, *i.e.*, *Sciurus carolinensis leucotis* and *Tamias striatus*.

II. Lower Delaware Valley Region and Coast Strip.

West Jersey from Trenton southward, west and southwest of the Pine Barrens, supports a far greater variety of trees than the Pine Barrens. The most plentiful species, not found in the latter region, are *Pinus virginiana*, *Juniperus virginiana*, *Quercus phellos*,* *Q. digitata*,* *Q. platanoides*,* *Q. coccinea*, *Castanea dentata*, *Fagus americana*, *Betula nigra*, *Ulmus americana*, *Hicoria alba*, *H. glabra*, *H. minima*, *Carpinus caroliniana*, *Liriodendron tulipifera*, *Platanus occidentalis*, *Diospyros virginiana*,* *Cornus florida*, *Liquidambar styraciflua*,* *Prunus serotina* and *Ilex opaca*.*

Those marked with an asterisk are not found on the hilly country which begins just west of the Delaware, nor north of the low ground between Trenton and the Raritan.

In this West Jersey district too we meet with many plants common to the Pine Barrens but which do not extend farther north or west. Such as

Woodwardia areolata
Woodwardia virginica
Iris prismatica
Lilium superbum
Polygala nuttalli
Rhexia mariana
Euphorbia ipecacuana
Gerardia purpurea
Eupatorium maculatum
Eupatorium album
Eupatorium rotundifolium
Euthamia caroliniana, etc.

There are also a great number of plants common to this region and the upland and not found in the Pine Barrens. The difference in the flora of the two regions, as already stated, is due quite as much to the absence of these plants as to the presence of peculiar southern species.

A few of the commoner members of this group are

Spathyema fœtida
Arisæma triphyllum
Erythronium virginicum
Anemone nemorosa
Ranunculus abortivus
Ranunculus fascicularis
Ranunculus recurvatus
Thalictrum polygamum
Caltha palustris
Viola cucullata
Viola papilionacea
Viola sagittata
Asclepias pulchra
Lobelia cardinalis
Hieracium giganteum
Eupatorium purpureum
Eupatorium perfoliatum
Vernonia noveboracensis
Senecio aureus

The narrow Atlantic coast strip has practically the same flora as the lower Delaware Valley, though many of the trees are absent.

The northern incursions into this flora are as follows, most of them local and some of them rare:

In West Jersey:

Filix fragilis
Actæa alba
Polygonum careyi
Pyrola secunda
Pyrola chlorantha
Vaccinium pennsylvanicum
Rhododendron maximum
Ilicioides mucronata
Pedicularis lanceolata

In Bogs:

Carex fusca
Menyanthes trifoliata
Scheuchzeria palustris

On the Coast Strip:

Sevastana odorata
Triglochin maritima
Sabbatia angularis
Limosella tenuifolia
Trientalis americana
Lacinaria spicata

On the Coast Islands:

Geranium robertianum
Salmonia stellata

Among southern species which reach the lower Cape May peninsula and push northward either in West Jersey or along the coast strip may be mentioned the following. Most of these do not range north of New Jersey; those marked with an asterisk not north of southern Cape May county. None of them are Pine Barren species.

*Chætochloa magna**
*Brachiaria digitarioides**
*Paspalum glabratum**
*Sacciolepis gibba**
Sporobolus asper
Aristida lonosa
Erianthus compactus
Andropogon argyræus
*Eleocharis ochreata**
Eleocharis melanocarpa
Rynchospora corniculata macrostachya
*Rynchospora rariflora**
*Gymnandeniopsis nivea**
Castanea pumila
Quercus michauxii
Blephariglottis peramœna
Juncus setaceus
Kosteletzkya virginica
Silene pennsylvanica
Hypericum gymnanthum
Hypericum adpressum
Euonymus americanus
*Gratiola pilosa**
*Tecoma radicans**
*Diodia virginiana**
Lobelia puberula
*Eupatorium cœlestinum**
Willoughbæya scandens
*Seneccio tomentosa**

The fact that we have in the West Jersey area a number of birds and mammals not found in the Pine Barrens has already been alluded to. We have also certain species which correspond to the northern and southern elements just spoken of in treating of the plants. *Zamelodia ludoviciana* and *Empidonax minimus* both breed occasionally as far south as Camden county, while in Cape May and southwestern Burlington counties we have the only recorded nesting of *Polioptila cærulea* in the State. In lower Cape May we also have record of the occurrence of *Mimus polyglottos, Centurus carolinensis* and *Lanius ludovicianus*, while *Quiscalus major* has occurred once on the coast strip.

The lower part of West Jersey too marks the northern limit of *Oryzomys palustris.*

While the land and fluviatile mollusks of such a sandy country as southern New Jersey are necessarily not abundant, Dr. H. A. Pilsbry tells me that such species as occur on the east coast strip are depauperate forms of northern types, while in the southwestern part of Cape May county he has found *Succinea campestris vagans* and *Bifidaria hordeacella*, southern forms not recorded from elsewhere in New Jersey. The former is a race of *Succinea campestris* of Georgia and Florida, while the latter is not known elsewhere north of the same States.

Among insects, distributions have not, as a rule, been sufficiently well worked out to warrant their use in defining minor life-areas. In the Orthoptera, however, Mr. J. A. G. Rehn tells me that certain species seem to conform quite well to the regions I have defined above. *Orphulella olivacea, Clinocephalus elegans* and *Chorthippus curtipennis* are found along the coast strip but not in the Pine Barrens, while *Chlœaltis conspersa, Paroxya scudderi, Melanoplus impudicus,* and *M. stonei* are restricted to the latter region.

In West Jersey there are a number of species common to the hilly region to the north and west and unknown in the Pine Barrens, just such a condition as we find among the plants.

December 3.

Arthur Erwin Brown, Vice-President, in the Chair.

Eighteen persons present.

Mr. William S. Vaux reported his observations made during the past summer on the glaciers of British Columbia.

December 17.

The President, Samuel G. Dixon, M.D., in the Chair.

Thirty-three persons present.

The following were ordered to be printed:

NOTES ON LANCELETS AND LAMPREYS.

BY HENRY W. FOWLER.

The species listed below are all contained in the collection of The Academy of Natural Sciences of Philadelphia.

BRANCHIOSTOMIDÆ.

Branchiostoma lanceolatum (Pallas).

Mediterranean (Dr. H. E. Evarts); Bay of Naples (Dr. Benjamin Sharp, Dr. H. C. Chapman); Italy (Bonaparte Coll., No. $\frac{421}{c}$).

Branchiostoma caribæum Sundevall.

Off Vieques, Porto Rico (U. S. F. C.).

Branchiostoma californiensis Andrews.

Los Angeles Bay, Cal. (W. N. Lockington).

Epigonichthys leucayanum (Andrews).

Entrance to Castle Harbor, Bermuda Islands (A. G. Gulick).

EPTATRETIDÆ.

Polistotrema stoutii (Lockington).

Pacific Groove on Monterey Bay, Cal. (Dr. Harold Heath).

Gill-openings 11 on both sides in 2 examples, 12 on both sides in 3, and 12 on the right side and 3 on the left also in 3.

Polistotrema polytrema (Girard).

Chili (Dr. H. C. Chapman).

Eptatretus burgeri (Girard).

Off Misaki, Japan (D. S. Jordan and J. O. Snyder).

MYXINIDÆ.

Myxine glutinosa Linnæus.

Lat. 39° 55′ 31″ N., Long. 70° 39′ N., and Bar Harbor, Maine (Dr. H. C. Chapman).

PETROMYZONIDÆ.

OCEANOMYZON gen. nov.

Type *Oceanomyzon wilsoni* sp. nov.

Supraoral lamina not especially contracted, its 2 converging teeth well separated and distinct. Infraoral lamina crescentiform and spout-like at middle, with denticles obsolete. Innermost teeth of disk, or those along each side of orifice, bicuspid, large, and similar to those on supraoral lamina.

Differs from both *Bathymyzon* and *Petromyzon* in the above combination of characters. One species in the open Atlantic, possibly occurring at some depth.

(Ὠκεᾶνὸς, ocean; *μύζω*, to suck.)

Oceanomyzon wilsoni sp. nov. Fig. 1.

Head to first gill-opening $6\frac{2}{3}$; depth $13\frac{7}{8}$; width of head at first gill-opening about 2 in its length; snout $1\frac{1}{2}$; width of disk $1\frac{9}{10}$; interorbital space $2\frac{4}{7}$; height of first dorsal $6\frac{1}{6}$; height of second dorsal 3; eye 3 in interorbital space; tail measured from vent to end of caudal fin (damaged) about 3 in rest of body.

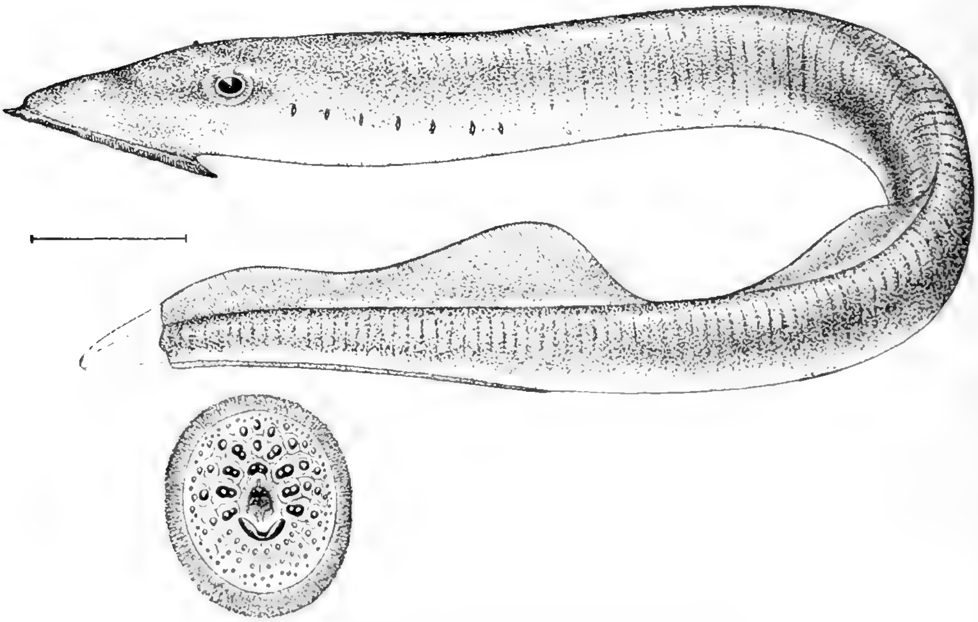

Fig. 1.—*Oceanomyzon wilsoni* Fowler. (Type.)

Body well compressed, rather slender, flexible, tapering backwards from pharynx, with greatest depth a little after last gill-opening. A median broad obsolete ridge down back from about opposite first gill-opening to first dorsal. Lower surface of body rounded convexly. About 72 muscular bands between last gill-opening and vent. Tail from vent compressed, tapering but little and ending in an abrupt tip (damaged).

Head rather large, broad, and rather depressed more or less both above and below. Snout broad, its surface convex, and longer than broad by about an eye-diameter. Eye rather large, lateral, without lids, or covered by skin of head, a little longer than deep, and placed in last fourth of head measured to first gill-opening. Mouth large, rounded to rather an ellipsoid shape, and its width thus about $1\frac{1}{6}$ in its length. Disk thus formed furnished with a fringe of short fleshy tentacles, posterior of which are much longest and edges of each all armed with short fringes. Longest of these posterior flaps about half of horizontal orbital diameter. Surface of disk studded with rather numerous teeth, much smaller and more or less imbedded in outer series. Anterior and on inner sides teeth large and all more or less arranged in concentric radiating series. Inner enlarged teeth on each side as 4 bicuspids and a single antero-median biscuspid. Cusps of all these about similarly developed. Posterior inner dental crescent with its margin converging to a small narrow median trenchant edge, where there are 7 small blunt obsolete closely crowded cusp-like points, so as to appear spout-like. Anterior lingual tooth with a deep median groove, terminating in an incurved point and with 7 serratures right and 6 left. Posterior lingual teeth consisting of two **LJ**-shaped patches of teeth with about a dozen serratures in each. Nostril with a slightly elevated cutaneous rim and placed midway in interorbital space opposite front rim of eye. Interorbital space broadly convex.

Gill-openings 7 on each side of pharynx a trifle inferiorly, and anterior nearer posterior than tip of snout by about half length of latter. Gill-openings becoming a trifle larger as they progress posteriorly and about equally far apart.

Skin smooth, rather soft and thin. No evident mucous pores.

Origin of first dorsal about midway between tip of caudal (evidently damaged) and first gill-opening, reaching its greatest height about first $\frac{2}{5}$ in its length and margin rounded. Second dorsal distinct from first, not connected basally, and inserted a trifle before last fourth in entire length of body, and its greatest height apparently a little after vent. Caudal apparently damaged and then healed. After vent a low thin median cutaneous ridge extending back and apparently joining lower caudal lobe. Vent with a small papilla.

Color in alcohol plumbeous-brown above, more or less uniform, and shading off on sides to paler or grayish-white, and lower surface all more or less entirely whitish with slight leaden or grayish tints. Lower surface of tail only narrowly pale. Dorsals and caudal pale brownish. Disk pale brownish and teeth all dark or wood-brown. Iris pale slaty.

Length 12¼ inches.

Type No. 375, A. N. S. P. Atlantic Ocean. Dr. T. B. Wilson.

This is the only example I have seen. It is apparently related to *Petromyzon* (*Bathymyzon*) *bairdii* Gill, *Proc. U. S. Nat. Mus.*, 1883, p. 254, but differs, according to the account by Goode and Bean, *Ocean. Ichth.*, 1895, p. 4, in several characters. In *B. bairdii* the tips of the two supraoral teeth are said to be barely perceptible, while in the present species they are equally as well developed as either of the adjacent bicuspids. In *B. bairdii* the eye is said to equal a fourth of the interorbital space, while in the present species it is about a third. These differences hardly seem due to age, as the type of *B. bairdii* and the present species differ in length by only 1¼ inches. *Oceanomyzon* will then appear as an annectant form between the true lampreys, or *Petromyzon*, and the bassalian *Bathymyzon*.

(Named for Dr. Thomas B. Wilson, for many years a generous patron of the Academy. Among his numerous gifts may be found much valuable material in the collections of fishes.)

Petromyzon marinus Linnæus.

Italy (Bonaparte Coll.); Boston, Mass. (J. H. Slack); Fannel's Branch near Chestertown in Kent Co. (E. G. Vanatta), and Bacon Hill in Cecil Co., Md. (H. W. Fowler).

Petromyzon marinus unicolor (De Kay).

Cayuga Lake Inlet, N. Y. (S. E. Meek).

Ichthyomyzon concolor (Kirtland).

Two examples without data, and one from the Clinch River in Tennessee (E. D. Cope).

Ichthyomyzon castaneus Girard.

Kiskiminitas River, Pa. (E. D. Cope). I wrongly identified this example in *Am. Nat.*, 1907, p. 6, as *Lampetra wilderi*. The species is therefore now known for the first time in Pennsylvania.

Entosphenus tridentatus (Richardson).

Willamette Valley, Ore. (O. B. Johnson).

Lampetra fluviatilis (Linnæus).

Italy (Bonaparte Coll.); Europe (Smiths. Inst.).

Lampetra cibaria (Girard).

San Francisco Market, Cal. (W. N. Lockington).

Lampetra æpytera (Abbott). Fig. 2.

Ammocœtes æpytera Abbott, Proc. Acad. Nat. Sci. Phila., 1860, p. 327.
No. 354, type. Ohio River. Dr. Hildreth.

Width of head about $2\frac{1}{8}$ in its length, measured to first gill-opening; width of disk $2\frac{3}{5}$; interorbital space 3; eye about 2 in interorbital space. Body well compressed and edges rather convexly rounded, without distinct keels medianly. Muscular bands along side of body distinct, of about even width, and about 53 between last gill-opening and vent. Tail well compressed. Head subcylindrical, soon becoming compressed at pharynx. Snout broadly convex, its width about $1\frac{1}{3}$ in its length. Mouth moderately large, disk-like, rounded and circular. Edges of disk thus formed rather thick, fleshy, and with a fringe of short and rather inconspicuous fleshy flaps. Teeth few, strong and rather large. If outer teeth occur over surface of disk they are minute, imbedded more or less, or deciduous, as no traces seem evident now. Inner teeth well developed on each side as 3 large cusps, and medianly above apparently as 2 smaller cusps. Posteriorly teeth form a hard crescentic keel, apparently entire. Tongue apparently toothless, with a median groove separating fleshy margin on either side. Interorbital space rather narrowly convex. Skin thin, firm, not very tough, and without evident mucous pores. Color faded in alcohol uniform dull brown above and becoming a little paler on under surface. Fins pale brownish, much paler than belly. Eye dull slaty. Length $4\frac{7}{8}$ inches. Type of *Ammocœtes æpytera* Abbott.

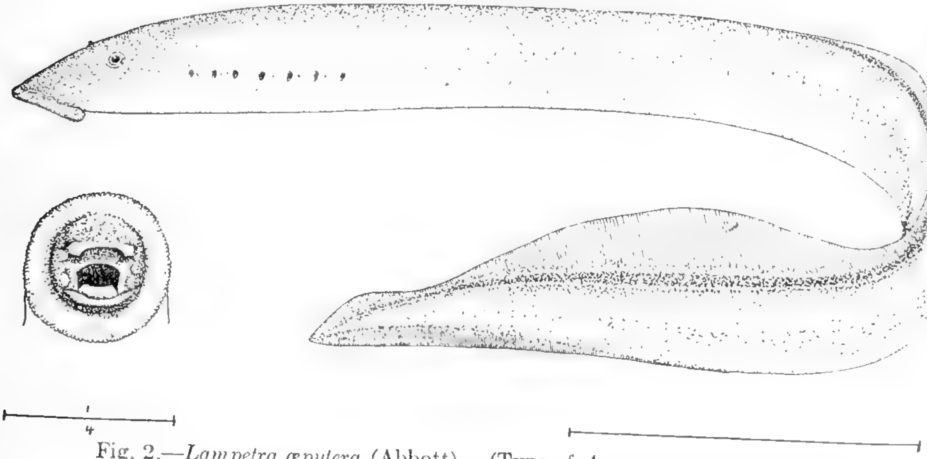

Fig. 2.—*Lampetra æpytera* (Abbott). (Type of *Ammocœtes æpytera* Abbott.)

In *Proc. Acad. Nat. Sci. Phila.*, 1901, p. 328, following the previous identifications of authors, I was led to erroneously identify this specimen with *Ammocœtes concolor* Kirtland, a species with which it most certainly is not to be identified. It is in fact entirely identical with *Lampetra wilderi* Gage, in Jordan and Evermann, *Bull. U. S. Nat. Mus.*, No. 47, I, 1896, p. 13. This will necessitate the suppression of the latter name and thus the small black lamprey now becomes *Lampetra œpytera*.

Grosse Isle and Ann Arbor, Mich. (E. D. Cope); Cedar Rapids, Ia. (S. E. Meek) and Brook River (Charles Aldrichs), Ia.

Lampetra branchiale (Linnæus).

Italy (Bonaparte Coll.).

STUDIES IN NORTH AMERICAN FULGORIDÆ.

BY E. P. VAN DUZEE.

The following studies on the Fulgoridæ refer solely to material from the United States and Canada now in my collection or which has recently passed through my hands. The most practical and useful work in this family has been done by Dr. Stal, and even now we must go back to the synoptical tables published in 1866 in Volume IV of the *Hemiptera Africana* for the determination of new or difficult generic forms. The key to the subfamilies given below is intended only for the forms known to inhabit the United States and Canada, and would be of little use with the complicated Fulgorid faunas of the tropics, especially of the Old World. Mr. G. W. Kirkaldy has recently[1] given us a new arrangement of these subfamilies that in some respects is probably more in accord with the biological relationship of these closely related groups, but my knowledge of the tropical Fulgoridæ is much too limited for me to attempt an adjustment of our genera to the groups there laid down; so for the present I prefer to follow Stal's classification as closely as possible.

This paper is not at all monographic in its character, as I touch only on genera and groups I have had occasion to study in working out certain undetermined material in my collection. I have added a few synoptical tables in the hope that they may assist students in locating some of the new or little known forms.

KEY TO THE SUBFAMILIES OF THE FULGORIDÆ.

Anal area of the wings reticulated, sides of the clypeus carinate, 1, FULGORIDA.
Anal area of the wings rarely reticulated, clypeus in this case without lateral carinæ, ... 1.
1. Posterior tibiæ armed with a movable spur, 11, DELPHACIDA.
—. Posterior tibiæ without a movable spur, ... 2.
2. Clavus granulated; costa dilated, the costal membrane transversely venose, ... 8, FLATIDA.
—. Clavus rarely granulated; costa in this case not dilated, . . . 3.

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[1] Hawaiian Sugar Planters' Assoc., *Ent. Bul.* No. 111, p. 91, 1907.

3\. Veins of the clavus not attaining the apex, but united with the commissural margin before the apex, ... 4.
—. Veins of the clavus either continued to the apex or united with the claval suture before the apex, ... 5.
4\. Apex of the front without an ocellus; elytra reticulated toward their apex, ... 2, DICTYOPHARIDA.
—. Apex of the front usually with a third ocellus; elytra not reticulated apically, ... 5, CIXIIDA.
5\. Elytra ample, held vertical with the costal margin meeting below the abdomen, closely reticulated over the whole surface; the costal and apical margins without transverse veins; front continued over on to the superior aspect of the head without a transverse carina, ... 7, ACANALONIIDA.
—. Elytra when broad held more horizontal, not meeting below nor closely reticulated over the whole surface, and the front usually distinguished from the vertex by a transverse carina at the apex of the head, ... 6.
6\. Head broad, with the eyes nearly or quite as wide as the mesonotum; pronotum without carinæ or with a median carina only, 7.
—. Head usually much narrower than the mesonotum; if as wide the pronotum emarginate behind and tricarinate, ... 8.
7\. Pronotum truncated behind or at most with a shallow rounded sinus, ... 6, ISSIDA.
—. Pronotum angulately emarginate behind, . 9, RICANIIDA.
8\. Elytra distinctly ampliated within and overlapping beyond the apex of the clavus, ... 4, ACHILIDA.
—. Elytra not ampliated within nor overlapping at apex, ... 9.
9\. Elytral membrane strongly differentiated from the corium with numerous simple longitudinal nervures, 3, TROPIDUCHIDA.
—. Elytral venation simple, without a distinct closely veined membrane; pronotum very short, deeply angularly emarginate behind, ... 10, DERBIDA.

Subfamily FULGORIDA Stål.

This subfamily is largely tropical in its distribution; but four genera and five species have thus far been reported from our territory. Doubtless, however, many of the subtropical forms inhabiting Mexico and the West Indies extend their range across our southern border and must eventually be included in our faunal lists.

Subfamily DICTYOPHARIDA Stål.

This subfamily is better represented in our fauna than the preceding; the large genus *Scolops* being almost precinctive. Our genera may be distinguished as follows:

Elytra as long as the abdomen or longer, ... 1.
Elytra much abbreviated, not attaining the middle of the abdomen, 5.

1. Vertex produced and angulated before or frequently forming a long cephalic process, ... 2.
—. Vertex transverse, anterior edge feebly arcuated; elytra in the short-winged form scarcely exceeding the abdomen, convex; anterior femora foliaceous, ... PHYLLOSCELIS Germ.
2. Vertex triangularly produced, rarely more than twice as long as its width between the eyes, with a distinct median carina in our species; pronotum deeply and acutely emarginate behind; color usually green with long greenish-hyaline elytra, DICTYOPHARA Germ.
—. Vertex produced in a linear cephalic process, without a distinct median carina; elytra shorter, opaque; pronotum truncated or broadly, obtusely emarginate behind, ... 3.
3. Cephalic process abruptly contracted before the eyes; pronotum broadly, obtusely emarginate behind, ... 4.
—. Cephalic process not narrowed before the eyes, its sides corrugated; pronotum truncated behind, ... SCOLOPSELLA Ball.
4. Rather stout insects of some shade of pale green or testaceous, becoming fuscous brown in certain species, but not black, SCOLOPS Schaum.
—. Slender black insects with smoky translucent elytra; inhabit California, ... BELONOCHARIS Uhler.
5. Vertex flat, triangularly produced, as long as broad and attaining the apex of the head; pronotum concavely arcuated behind, ORGERIUS Stål.
—. Vertex short, transverse, occupying hardly one-half of the superior aspect of the head; pronotum very obtusely angularly emarginate behind, ... LOXOPHORA n. gen.

Genus **DICTYOPHARA** Germ.

Dictyophara curviceps Stål I have not yet seen. The three species known to me may be separated as follows:

Vertex fully twice as long as its basal width, median carina extending a little more than halfway to its apex, the three frontal carinæ almost parallel throughout their length, . *microrhina* Walk.
—. Vertex scarcely longer than its width at base, its median carina almost attaining the apex; frontal carinæ more widely separated above, forming a spatulate compartment, ... 2.
2. Lateral carinæ of the front meeting in an acute angle on its base, concolorous at that point; plates of the female long and slender, ligulate and curved upward, attaining the apex of the pygofers, *lingula* Van D.
—. Lateral carinæ of the front meeting at the base in an obtuse angle, together with the marginal carinæ lined with black around the apex of the head; plates of the female short, oblique, and oblong in form, not attaining the apex of the pygofers, . *florens* Stål.

Dictyophara microrhina Walker.

In this species the vertex is much longer than in the two other species known to me. It is a little more than twice as long as its basal width, or judging only by the eye it appears much longer; the three frontal carinæ are straight and parallel throughout their length, converging to a point on the subacute base. The plates of the female are ferruginous, ligulate, but not quite as slender as in *lingula*, and scarcely attain the apex of the green superior pieces. The elytra are the same pale greenish hyaline with green nervures that we find in *lingula*, but in some examples they show a distinct brownish tinge toward their apex; the stigma has three or four areoles. Length 13–14 mm.

I took this species at Woodbine, New Jersey, in August, 1902, and on Staten Island in August, 1904.

Dictyophara florens Stål.

Vertex a little longer than its basal width; median carina precurrent, on either side of this is a short lateral carina which is scarcely indicated in Mexican specimens. Front broad, the margins strongly reflexed and a little expanded before the eyes and next the clypeus; three discal carinæ very prominent, the lateral almost attaining the clypeal margin, diverging toward the base where they roundedly converge and meet in an obtuse angle, and together with the marginal carinæ are marked with a black line. Carinæ of the pronotum and mesonotum distinct, the latter converging and meeting before attaining the pronotal margin. Valve of the female short, transverse, oblique within; plates oblong, rounded at apex, oblique, not attaining the apex of the pygofers. Sides of the genital segment of the male slightly oblique at apex, the dorsal angle very obtusely rounded.

I took a good series of this species from a coarse grass at Effingham, Kansas, in July, 1900. They agree in every respect with Mexican material in my collection, except that the base of the vertex is distinctly tricarinate. This would throw the species into another section in Stal's synopsis (*Rio Jan. Hemip.*, p. 64), but they certainly are not distinct.

Dictyophara lingula n. sp.

Closely allied to *florens*. Pale green, lighter beneath and tinged with rufous on the tibiæ. Vertex a little more produced, carinæ distinct. Front somewhat broader than in *florens*, its sides almost rectilinear, the three discal carinæ prominent, slightly diverging to a point before the anterior angle of the eyes, then deflected and running straight to the apex where they unite in an acute angle; apically they run straight to the clypeal suture. Rostrum longer than in *florens*, distinctly surpassing the posterior trochanters. Pro- and mesonotum substantially as in *florens*, but the former a little broader and more truncated between the eyes; the mesonotal carinæ more parallel, almost continuous with those of the pronotum. Elytra a little narrower and more slender, with a closer venation at apex. Valves of the female longer than broad, parallel at base within; plates long and strap-shaped, curved upwards and reaching the apex of the pygofers. Sides of the genital segment of the male very oblique, extended to a subacute angle dorsally, the plates long, ovate, obtuse at apex and attaining the tip of the pygofers.

Described from one female and two male examples taken by me at Cape May and Anglesea, New Jersey; one male taken at Wildwood, New Jersey, by Prof. C. W. Johnson; one female from Anglesea, New Jersey, received from Prof. J. B. Smith; and Mrs. Slosson has sent me a specimen from Florida. This species is very close to *florens*, but the genital characters are very different and the apex of the front is more acute with concolorous carinæ.

Genus **SCOLOPSELLA** Ball.

Scolopsella reticulata Ball.

Dr. E. D. Ball has described both this genus and species in the *Proceedings of the Biological Soc. of Wash.*, Vol. XVIII, p. 118, 1905. I have recently received from Prof. J. B. Smith a fine pair of this interesting insect taken in the Colorado Desert. Dr. Ball's type was collected in Arizona by Prof. F. H. Snow. This insect is dark fuscous varied or tessellated all over with pale fulvous brown. It has much the appearance of a *Dictyophara*, but the long cephalic process is linear or a little spoon-shaped at apex and corrugated along the sides. I would place the genus in our fauna between *Dictyophara* and *Scolops*.

Genus **SCOLOPS** Schaum.

Of this peculiar genus sixteen species have been described from our country, not counting *pungens* of Germar, which may prove to be identical with some one of our eastern forms described by our later entomologists. Of these, thirteen species are now represented in my collection. For a synoptical arrangement they require a more thorough study than I am now able to give them.

Genus **PHYLLOSCELIS** Germ.

This genus is readily distinguished by its short vertex and foliaceous anterior femora. Two species have been described:

Phylloscelis pallescens Germ.

Described from Pennsylvania, but it is common in New Jersey. The macropterous form has a very simple elytral venation; the longitudinal nervures fork near their base and run straight to the apex, before which they are connected by one series of transverse veins; in the center of each areole is a longitudinal carina simulating a supernumerary nervure.

Phyllosoelis atra Germ.

Described from Pennsylvania, and I have taken it in New Jersey and Kansas. In the macropterous form of this species the radial and outer ulnar nervures run straight and unforked to near the apex, the inner ulnar is forked near the apex; thus making three large subapical and seven or eight very small apical areoles. The elytra are opaque, impunctate, but minutely shagreened, and want the longitudinal carinæ found in *pallescens*.

Dr. Melichar has described a variety, *albovenosa*, of this species that seems always to be found with the typical form. It is piceous, with pale legs, scutellum and elytral nervures.

Genus **ORGERIUS** Stål.

The only North American species of this genus, *rhyparus* Stal, was described from California. Dr. Ball and I took this species in numbers at Rifle and Grand Junction, Colorado, in July, 1900. No long-winged form has yet been recorded.

LOXOPHORA n. gen.

Related to *Orgerius* and *Phylloscelis*. Head much narrower than the pronotum. Vertex short, transverse, foveate, not attaining the apex of the head. Front long and parallel, its base returned over on to the superior aspect of the head, anteriorly with a raised tricarinate linear median compartment. Clypeus roundingly narrowed to the apex, distinctly tricarinate. Antennæ placed some distance below the lower angle of the eye. Pronotum short, roundedly produced between the eyes, hind edge broadly angularly emarginate, carinate on the middle line; sides with one carina behind the eye; pectoral flap very large. Mesonotum rather small, tricarinate. Elytra short, truncated, reaching the apex of the second tergal segment, with three longitudinal carinæ, the inner forked before the apex, surface with a few reticulations. Tergum carinate. Posterior tibiæ with four spines in the male.

This genus has the short and broad form of *Orgerius* and the short vertex of *Phylloscelis*. The tricarinate compartment of the front is narrower and the pronotum is shorter and more emarginate than in either of those genera. I cannot agree with Melichar in placing *Phylloscelis* in the *Issida.* It is closely allied to *Orgerius* and *Scolops.* In the macropterous examples the claval nervure is united with the commissural and not continued to the apex as in the *Issida.*

Loxophora transversa n. sp.

Form of *Orgerius rhyparus* Stål. Vertex transverse, about half the length of the superior aspect of the head, differentiated from the base of the front by a transverse, slightly angled carina. Linear tricarinate compartment of the front attaining the apex of the head, not continued on the reflexed superior base, its lateral carinæ diverging at apex on the basal suture of the clypeus. Pronotum scarcely longer than the vertex, a little wider behind the eyes, distinctly produced anteriorly between the eyes. Mesonotum short, tricarinate, the lateral widely divergent, following the hind edge of the pronotum for half their length and leaving but a small compartment at either lateral angle. Elytra feebly reticulated between the longitudinal nervures. Tergum with three broken carinæ on either side of the median, one marginal and two intermediate. Length to tip of the abdomen 4 mm., greatest width 2½ mm.

Color testaceous brown, base of the vertex with a transverse black line; base and sides of the front, pronotum, lateral angles of the mesonotum and the lateral disks of the tergal segments ornamented with large distinct round black punctures. Face and sides of the chest crossed by a broad creamy white transverse band between two black ones; the lower of these latter is varied with paler, the upper is deep black and on the disk of the inferior pronotal flap is intensified and brilliantly polished; median compartment of the front above the black transverse band black with white carinæ. Anterior edge of the pronotum beneath the eyes black, the lower edge of the inferior flaps whitish. Disk of the mesonotum between the lateral carinæ creamy white with the apex black. Elytra piceous brown with a broad subapical creamy white band. Tergum black at base of the apical segments, disk of the fourth segment creamy white between the intermediate carinæ. Venter varied with dark brown and creamy white. Legs brown, anterior and intermediate femora twice banded with pale, posterior tarsi and tibial spines blackish.

Described from one male example kindly sent to me by Prof. H. F. Wickham and labelled "Ch. Ranch, Utah, July 22." This strikingly marked insect is so distinct from any other described species I do not hesitate to describe both the genus and species from a single specimen.

Subfamily TROPIDUCHIDA Stål.

Of this subfamily but two species have heretofore been recorded from our territory: *Tangia sponsa* Uhler and *Monopsis tabida* Spin., both from Florida, but doubtless others will yet be found along our southern border. I describe below a third species which has been masquerading in our collections under a false name.

Genus **PELITROPIS** n. gen.

Closely allied to *Tambinia* Stal and differing principally by its wider head, ecarinate front and different elytral venation. Head with the eyes as wide as the pronotum or nearly so, laminately flattened. Vertex produced, flat; base angularly emarginate; sides parallel; margins and middle line carinate. Front almost horizontal, broad, sides parallel, base angularly rounded, disk a little depressed, ecarinate. Clypeus a little convex, ecarinate. Pronotum roundedly produced before, deeply angularly emarginate behind; tricarinate, the lateral carinæ curved, almost attaining the posterior angles. Mesonotum tricarinate, the lateral approximate before, the median terminating in a transverse furrow before the apex. Elytra long and narrow, parallel, with a very slender costal membrane; radial nervures simple; first ulnar forked behind the middle, second at the middle; claval nervures united before the middle of the commissural margin, the resulting nervure attaining the apex of the clavus; apex of the elytra subangularly rounded; inner edge of the membrane almost rectilinear, outer curved; base of membrane separated from the corium by a subangulated line of transverse nervures, behind which eight longitudinal nervures run straight and almost parallel to the apex; these are crossed about half-way to the apex by a second series of transverse veinlets; a few supernumerary veinlets may occur on the disk either side of this second line, and two short longitudinal nervures are interpolated near the inner angle; apical margin with a very narrow areolate or punctate appendix. Posterior tibiæ trispinose.

This genus is very near *Tambinia* Stål from Ceylon, and in our fauna should be placed near *Monopsis* and *Tangidia*.

Pelitropis rotulata n. sp.

Pale green obscurely varied with brown. Vertex as long as broad, anterior margin obtusely angled, almost parallel with the posterior; edge carinate all around, median carina distinct, surface depressed with a few lineations, most conspicuous of which are two on the middle and two on either side anteriorly, placed at right angles to and touching the margin. Cheeks before the eyes narrow, pointed, together with the pleuræ and sides of the pronotum deeper green, marked with black above under the lateral carinæ of the vertex and with a short parallel line below from the anterior angle of the eye. Front almost horizontal, its disk oblong, depressed; its length one-third greater than its width; its sides parallel and its base obtusely angled, the apical angles cut off in line with the sides of the clypeus. Clypeus an equilateral triangle, the three sides rectilinear. Ocelli minute, placed next the lower angle of the eye. Antennæ placed against the inferior edge of the eye; base green cylindrical, next joint brown, surmounted by a slender brown seta. Pronotum of about equal length across its whole width, deeply acutely emarginate behind; carinæ distinct, the lateral meeting the median before, curved, at first concentric with the anterior edge, almost attaining the prominent posterior angles; sides tricarinate behind the eyes, the inferior carina bounded above by a black line, and there are a few obscure marks along the disk anteriorly. Tegulæ small with a black disk. Mesonotum with some obscure marks on the disk. Elytra pale greenish pellucid, sparsely dotted with black along the nervures of the clavus and corium; those along the costa drawn out in oblique false veinlets; tip of the membrane a little smoky with some of the transverse veins brownish. Beneath deeper green, the legs paler with the tips of the tarsal and tibial spines and a mark on the apex of the femora exteriorly blackish. Length 7 mm.

Described from three examples from Florida. One is a fine fresh specimen kindly given me by Mrs. Slosson, the other two are old specimens changed to a dull testaceous brown. This species is frequently determined as *Monopsis floridæ* Walker. Mr. Otto Heidemann has kindly compared this with National Museum material and sends me the names used here for the genus and species. These were given by Dr. Uhler, who recognized it as distinct from *Monopsis*, but who it seems never published either the genus or species.

Subfamily ACHILIDA Stål.

Genus **HELICOPTERA** A. and S. (1843), (*Elidiptera* Spin. 1839).

This genus was first described as *Elidiptera* by Spinola, and I can see no valid reason for the change made by Amyot and Serville; but as the more recent name has been almost universally adopted I have thought best to retain it here. Our species may be distinguished as follows:

Color black, front white or banded with white, ... 1.
Color brown or grayish, ... 2.
1. Vertex about as long as broad; front white with a black basal band, *opaca* Say.

—. Vertex twice as long as broad; front white without a basal band, abdomen red, ... *colorata* Van D.
2. Front transversely banded, ... 3.
—. Front unicolorous, perhaps shading a little darker toward the base, not banded, ... 4.
3. Front brown, base abruptly darker; elytra narrow, parallel, wider toward the apex, indistinctly variegated or irrorated; pronotum deeply, angularly emarginate behind, . . *Slossoni* Van D.
—. Front creamy white with a fuscous base and brown clypeus; elytra expanded, the costal edge quite uniformly rounded; surface distinctly variegated; pronotum obtusely emarginate behind, *pallida* Say.
4. Vertex as long as broad; pronotum strongly produced, truncated between the eyes; elytra brown, very obsoletely variegated; front unicolorous, pale testaceous brown; venter blackish fuscous, ... *septentrionalis* Prov.
—. Vertex distinctly broader than long; pronotum less produced, rounded before between the eyes; front irrorate, shading to darker at base; elytra variegated, . . . *variegata* Van D.

Helicoptera vestita Prov. is evidently a synonym of *opaca* Say. *Monopsis floridæ* and *fusca* Walker are placed by Stål in *Helicoptera*, but they are unknown to me in nature.

Helicoptera opaca Say.

This large and broad species is black with the elytra more brownish and opaque, the areoles closely and minutely dotted with pale and with a pale stigmatal spot; the face is deep black with a broad transverse band of yellowish white covering the front to the superior line of the eyes. This pale band is extended more narrowly along the sides of the pleuræ. Antennæ pale fulvous. This seems to be a rare and local form. I took one example at Phœnicia, in the Catskills, in August, 1904, and Mr. John D. Evans, of Trenton, Ontario, has sent me another for study that he took in County Hastings, Ontario. Mr. Evans' specimen, which is a male, has the pronotum and disk of the vertex obscurely irrorate with pale. I have seen one or two additional specimens in other collections.

Helicoptera colorata n. sp.

Allied to *opaca*, but smaller and narrower with a strongly produced vertex. Black, front and vertex white, venter sanguineous. Vertex long, moderately narrowed toward its rounded apex, its length a little more than twice its width at base; median line almost obsolete, disk soiled white, margins strongly reflexed, black. Front long, much narrowed toward the base, precurrent median carinæ feeble; reflexed margins expanded towards the base of the clypeus; white with the margins black beyond the apical angle of the eyes; sides of the head to the lower line of the eyes and the clypeus black; antennal base soiled yellowish white like the vertex. Pronotum rather obtusely angularly emarginate behind, strongly produced before, the narrow apex truncated before between the eyes; carinæ strong, the lateral straight and almost reaching the hind margin; color black, a little piceous between the carinæ, the deflexed sides edged with white below. Mesonotum black, opaque, the carinæ distinct at base, becoming obsolete, the lateral at the middle, the median beyond the middle; metanotum apparently rufous. Elytra narrow, but little expanded at base, appendix broad; color black, nervures mostly pale, areoles except along the costa and on the appendix dotted with pale, mostly in a single row in each areole; stigma concolorous. Wings deep smoky brown with fuscous nervures. Sternum black anteriorly, pale posteriorly and about the coxæ; propleuræ edged with white above. Anterior and intermediate legs black, posterior brown. Abdomen sanguineous, perhaps somewhat fuscous above; apical pieces paler edged with black. Sides of the genital segment of the female feebly arcuated, not at all sinuated. Length 8 mm.; width across the elytra scant 3 mm.

Described from one female example swept by me from bushes on a wooded hillside at Gowanda, New York, August 7, 1907. This is a beautiful addition to our Fulgorid fauna. Its strongly produced head, white front, sanguineous abdomen and narrower and blacker elytra, wanting the stigmatal spots, will at once distinguish this from *opaca*. The elongated head seems to ally this species with genus *Pseudohelicoptera* Fowler, but by itself does not seem to warrant the establishment of a separate genus. Fowler's species probably is not congeneric with this.

Helicoptera pallida Say.

Mrs. Slosson has sent me specimens of this species and *septentrionalis* Prov. from the White Mountains that show them to be sufficiently distinct. *Pallida* is proportionately broader than any of our other described species; the vertex is about as long as broad, being longer than in *variegata*; the elytra are very pale brown, closely irrorated and reticulated with pale, these colors being about evenly divided; there are a few larger brown spots, about two on the disk of the corium and three toward the apex, the latter somewhat broken by the pale nervures. The front is pale with its base abruptly, and the clypeus brown. This pale color is extended along the sides of the pleuræ and is bounded above with black. Abdomen mostly fuscous; metanotum rufous. Last ventral segment of the female sinuated, subangulated on either side; genital segment quite deeply notched toward its ventral aspect. Length 9 mm.; width across the elytra about 4 mm.

Helicoptera septentrionalis Prov.

A little narrower than *pallida* with the elytra less expanded, the vertex shorter and the pronotum more deeply angularly emarginate. Front uniformly pale testaceous brown; pleuræ marked as in *pallida*. Elytra more uniformly colored, the claval and costal nervures distinctly alternated; apical field with three brown points and there are indications of three minute ones along the costal areole; abdomen blackish, pale at tip. Last ventral segment of the female feebly sinuated, rounded on either side, edge of the genital segment truncated, scarcely if at all sinuated. Length 8 mm., width across the elytra scant 4 mm.

This species is very close to *pallida*, and without the two for direct comparison it would be difficult to distinguish satisfactorily between them. They are sufficiently distinct, however, and I feel sure that I have rightly identified them here.

Helicoptera slossoni n. sp.

Allied to *variegata*, but proportionately much narrower and with a slightly longer vertex.

Vertex about as long as the median line of the pronotum. Front narrower at base which is rounded, as is the apex of the vertex; its sides straight in the female, slightly arcuated in the male; its color ferruginous brown in the female, yellowish in the male, scarcely irrorate, abruptly darker at base. Produced anterior margin of the pronotum subtruncated between the eyes; lateral carinæ almost straight, a little curved anteriorly; median carinæ short, basal; carinæ of the mesonotum obsolete posteriorly. Vertex, pronotum and mesonotum fuscous brown, minutely irrorated with pale; deflexed sides of the pronotum deep black edged with white in the male and ferruginous yellow in the female; disk of the mesonotum darker with the extreme tip pale. Elytra fuscous brown quite regularly irrorated with paler, and marked in the female with a fuscous spot on the stigma and several round points on the disk, arranged three in a row on the costal areole, three clustered in the apical field and two on the disk of the corium at about the middle. Wings smoky with fuscous nervures. Lower surface and legs in the female pale brownish varied with flavous on the sides of the pleural pieces, the abdomen fuscous, pale on the apex and in places on the edges of the segments; in the male the lower surface becomes yellowish, with the pleural pieces edged with black above and the abdomen more or less fuscous. Sides of the genital segment of the female obliquely truncated, scarcely sinuated. Length 8 mm., width across the elytra 3 mm.

Described from one pair taken on Mt. Washington by Mrs. Annie Trumbull Slosson. It affords me pleasure to dedicate this interesting species to Mrs. Slosson as a slight recognition of her valuable services to entomology in bringing to light so many new and rare insects.

This species may readily be recognized by its uniformly dark color, slender form and narrow elytra with the appendix but slightly developed.

Helicoptera variegata n. sp.

Larger than *pallida* and *opaca*; grayish varied with pale fuscous brown. Vertex shorter than in any other *Helicoptera* known to me, about the length of the eye in its greatest superior diameter, regularly rounded before, disk pale with a longitudinal furrow, edge reflexed, darker. Front narrow, contracted basally, the sides almost sinuated, distinctly tricarinate and with the clypeus pale brownish shading to darker basally and along the carinæ, more or less distinctly irrorated with pale; clypeal suture quite strongly angulated. Pronotum shorter and more deeply emarginate than in *pallida*, the produced anterior margin rounded between the eyes, lateral carinæ broadly rounded outwardly, median carina feeble but almost attaining the anterior margin in one example, upper surface of the pronotum brown or ferruginous brown, closely irrorated with pale, below the carinate edge deep black, bordered with white. Mesonotum brown or ferruginous, irrorated with pale, becoming darker before the pale apex and marked with a darker line without the base of the lateral carinæ close to the basal angles. These carinæ feeble, especially the median. Elytra brown varied with gray patches, most conspicuous of which is one along the base of the inner claval area, about four very irregular and indefinite ones along the median line of the corium and another adjoining the blackish apex of the clavus; the dark areas irrorate with pale in places and the nervures more or less irrorated, those at the apex pale; about three fuscous points in the costal area and three others approximate in the apical field. Wings smoky, darker toward their apex, the nervures fuscous. Beneath testaceous varied with pale brown; disk of the ventral segments sometimes fuscous. Legs pale brown with the knees still paler. Sides of the genital segment of the female quite deeply angularly emarginate. Length 8 to 10 mm.; width across the elytra about 4 mm.

Described from one female example taken by Mr. W. Metcalf at Ottawa, Ontario, and a pair somewhat longer and paler taken by Mrs.

Slosson at Franconia, New Hampshire. Mrs. Slosson has also sent me a male taken at Richmond, Virginia, which I believe belongs to this species. In this the elytra are pale brown, irrorated but scarcely variegated with gray. This is the species most commonly received from correspondents, and I have formerly determined it as *septentrionalis* Prov., but a fine series of *Helicopteras* recently received from Mrs. Slosson has enabled me to correct this determination.

Genus **CATONIA** Uhler.

This genus was founded by Dr. Uhler in 1895 (*Proc. Zool. Soc.*, p. 61). It is certainly very close to *Plectoderes* Spinola, which is still unknown to me in nature, but it has a somewhat different aspect and undoubtedly is sufficiently distinct. I would distinguish it from *Helicoptera* by its narrower, more elongated form and the much shorter pronotum, which forms a rounded flap behind the eyes and not a longitudinal compartment as in *Helicoptera*. Dr. Uhler states that the posterior tibiæ are unarmed, but this is not strictly true of any of the species known to me. All, including *intricata*, the type species, have a minute spine placed much nearer the base than in *Helicoptera*, and in *fusca* there are two such spines. In *Catonia* the basal joint of the antennæ is almost globular, while in all the Helicopteras known to me this joint is much more elongated. The three species of *Helicoptera* described by Fowler in the *Biologia* evidently belong to this genus.

Catonia cinctifrons Fitch is unknown to me, but our other seven species may be separated as follows:

Front conspicuously transversely banded, ... 1
Front not distinctly banded, ... 4.
1. Hind tibiæ with two small spines, elytra uniformly fuscous dotted with pale; inhabits California, ... *fusca* Van D.
—. Hind tibiæ unispinose, ... 2.
2. Elytra unicolorous, nervures impunctate, . *impunctata* Fitch.
—. Elytra variegated, nervures punctate, ... 3.
3. Larger, front strongly narrowed basally, this base scarcely banded, *nava* Say.
—. Smaller, front not greatly narrowed basally, transverse bands two, conspicuous, ... *picta* Van D.
4. Larger, elytral areoles with numerous incomplete transverse veinlets, apex of mesonotum with a pair of ocellated black points, *grisea* Van D.
—. Smaller, elytra maculated, without reticulating veinlets, . . . 5.
5. Vertex and base of the front broader; elytral areoles almost immaculate, with a whitish transverse band indicated across the apical third of the clavus, ... *pumila* Van D.

—. Vertex and base of the front narrower; elytral areoles more variegated and minutely dotted with pale in the darker areas; inhabits the West Indies, ... *intricata* Uhler.

Catonia fusca n. sp.

Form and size of *grisea*; fuscous brown; elytra unicolorous dotted with white; front banded. Length 5½ mm.

Vertex short, transverse, brown with pale carinæ, anterior and posterior margins parallel, hardly arcuated. Front about as in *impunctata*; rather broad and but little narrowed basally, the carinæ strong, the marginal well elevated; whitish tinged with fulvous brown on the base and toward the apex of the clypeus; crossed by two broad black bands; margins scarcely dotted toward their base. Antennæ brown with their setæ black. Pronotum blackish with pale carinæ, the lateral concentric as in all the species known to me, with about three branches to the hind margin. Mesonotum fulvous with the three straight parallel carinæ and extreme apex pale, the carinæ margined with fuscous. Elytra uniformly smoky brown, a little paler toward the margins, nervures pale toward the apex, areoles dotted with pale. Abdomen with pale segmental margins; pleural pieces fuscous varied with pale. Legs pale brown, becoming a little darker at the knees.

Described from one female specimen collected in San Mateo County, California, by a Mr. Coleman.

Catonia nava Say.

This is a somewhat larger and darker species than *grisea*, with the front strongly narrowed basally; base brown minutely irrorated with paler, followed by a white transverse median band and then a blackish band next the base of the pale clypeus; the marginal carinæ dotted with pale. Mesonotum tinged with fulvous with a large blackish central cloud. The elytra quite strongly variegated and dotted on the nervures. I have taken this species at Hamburg and Gowanda, New York, and have seen others from the Eastern States.

Catonia cinctifrons Fitch.

I have not yet seen anything that just answers to the description given by Fitch, but this seems to be a good species very near to *nava* and is perhaps Say's variety "a" of that species.

Catonia picta n. sp.

Allied to *nava* and *cinctifrons*. Face white with two black bands; mesonotum rufopiceous; elytra obscurely banded. Length 5½ mm.

Front broad, but slightly narrowed at base; clypeus short, conical, and with the front tricarinate, the lateral carinæ marginal, strongly elevated.

Vertex short, broader than long, but feebly advanced before the eyes, obtusely angled before; margins and middle line carinate. Pronotum very short, almost linear, tricarinate. Mesonotum much longer than the pronotum and vertex together, tricarinate, the lateral carinæ rectilinear, very slightly diverging posteriorly.

Color testaceous gray; mesonotum and a large costal spot or indistinct transverse band on the basal third of the elytra obscure rufo-piceous, behind this dark band is a broad indefinite whitish vitta; nervures mostly dotted, the dots on the costa and commissure larger; commissure with four black points, two on either margin of the whitish band; tip of the scutellum, a chain of points on the pronotum and a few on the vertex whitish. Beneath pale fulvous. Front deep black with a broad median transverse band of ivory white; the marginal carinæ dotted with white and an indefinite whitish band crosses the base of the clypeus. Tip of the rostrum and tarsal spines black; knees discolored.

Described from one example taken at Lakehurst, New Jersey, August 18, and kindly sent to me for study by Prof. John B. Smith. This may be the variety "a" of Say's *nava*, although that is more likely to be the *cinctifrons* of Fitch, but it is a very distinct species. Its smaller size, strongly marked front, and less maculated elytra, showing obscure transverse banding, will distinguish it.

Catonia impunctata Fitch.

This species, like *cinctifrons*, was described by Fitch as a *Cixius*. It is a little smaller than *nava* with the elytra testaceous brown, subhyaline, almost immaculate, with the nervures touched with white in places, indicating a transverse band near the middle and on the base of the apical areoles. Fitch seems to have described the male and included the female as a variety. The female has the whole basal portion of the face black, with the black marks on the vertex and pronotum scarcely indicated. I have taken this species at Phœnicia in the Catskills, and have received specimens from Pennsylvania and elsewhere in the Middle States. The *Myndus impunctatus* of my Buffalo list was *sordidipennis* and not the present species.

Catonia grisea n. sp.

Nearest to *intricata* Uhler, but a little larger and paler; elytra gray varied with white; front pale feebly maculated; mesonotum brown with two black points posteriorly. Length 6–7 mm.

Front elongated, quite strongly narrowed basally with the sides almost straight and the carinæ strong; pale flavous, in the female obscurely irrorated on the base of the front and clypeus leaving a paler intermediate band, indicated on the marginal carinæ by two brownish spots. Vertex almost square, feebly angled anteriorly, projecting about half its length before the eyes, the lateral fovæ marked with a dark point. Pronotum shorter than the vertex, rather sharply angled and marked with a blackish line beneath the eye. Mesonotum pale, quite strongly maculated with brown in the female, with pale carinæ and a black point posteriorly placed in a pale annulus within the lateral carinæ. Elytra whitish tinged with smoky especially toward their tips; the nervures white, the areoles with numerous imperfect transverse white veinlets; on the costa are a few larger brown spots. Beneath pale, the abdomen fuscous with the segments edged with pale.

Described from a series of both sexes taken at Niagara Falls, Hamburg and Gowanda, New York, and one female taken on basswood at Ottawa, Ont., by Mr. W. Metcalfe. This is our most abundant northern species of *Catonia*. It varies some in the extent of maculation on the vertex, pronotum and mesonotum, but the pair of ocellated points near the tip of the scutellum seems to be a persistent character.

Catonia pumila n. sp.

Allied to *grisea*, but much smaller and wanting the ocellated points before the apex of the scutellum. Length 4 mm.

Vertex longer and narrower than in *grisea*, projecting for more than half its length before the eyes, subangularly rounded before. Front proportionately a little broader and shorter than in *grisea*; carinæ distinct, but the marginal not as strongly elevated as in its ally. Color yellowish testaceous tinged with fulvous on the vertex and scutellum and with the carinæ slightly paler. Pronotum pale obscurely dotted with brown; front nearly immaculate, the marginal carinæ obscurely dotted; eyes and antennal setæ black. Elytra obscure brownish hyaline becoming fulvous along the costa; a whitish transverse band is indicated before the apex of the clavus, and the apex of the corium and some vague areas along the costa are paler; apical nervure margined within by a fuscous vitta which is broken by the pale veins; all the nervures more or less distinctly dotted with pale. As in the allied species the wings are smoky hyaline with strong fuscous nervures. Anterior and intermediate tibiæ banded.

Described from one pair taken by me at Milan, Ohio, September 1, 1905, and another male which I took in August, 1904, at Jamaica, Long Island. This latter has the edges of the ventral segments touched with sanguineous. This is a neat little species recognizable by its small size and unmarked front.

Catonia intricata Uhler.

This is a small species very close to *pumila*, but the front is more narrowed basally, pale, closely dotted with brown, and the elytra are more variegated and minutely dotted with pale, and in some examples are quite decidedly tinged with rufous toward the costa. Dr. Uhler described this species from the Island of St. Vincent. I took it in Jamaica and Prof. Ball has received it from Hayti. So far it has not been reported from the United States, but it is quite likely to be found in southern Florida.

Subfamily CIXIIDA Stål.

This subfamily has a wide distribution in the temperate regions of the world. Six genera and thirty-five species are now known from this country. *Monorachis* Uhler is too insufficiently known to me to be included in this table. Our other genera may be separated as follows:

Posterior tibiæ armed with two or three spines, ... 1.
Posterior tibiæ unarmed, ... 2.
1. Base of the head broadly sinuated; mesonotum tricarinate, *Cixius* Latr.
—. Base of the head angulate-emarginate; mesonotum normally 5-carinate, ... *Oliarus* Stål.
2. Eyes sinuated anteriorly, antennæ inserted before this sinus, *Bothriocera* Burm.
—. Eyes sinuated inferiorly, or entire, antennæ inserted below the eyes, 3.
3. Base of the head truncated; vertex very narrow, its sides parallel or wider anteriorly; front and clypeus elongated, . *Œcleus* Stål.
—. Base of the head subsinuated; vertex broader, narrowed anteriorly; front and clypeus together elliptical, . . . *Myndus* Stål.

Genus **MONORACHIS** Uhler.

Monorachis sordulentus Uhler.

Mrs. Slosson has very kindly sent me for study a type specimen of this species which unfortunately is without a head. As nearly as I can judge from the fragment remaining, I believe this is the species afterward described by Canon Fowler as *Metabrixia aspersa* from Mexico and Vera Cruz. This may sink the genus *Metabrixia* as a synonym of *Monorachis*, although this is by no means certain, as Canon Fowler says, "This species differs considerably from the rest and may belong to another genus." Mrs. Slosson's specimen seems to be of a short-winged form.

Genus **BOTHRIOCERA** Burm.

Bothriocera tinealis Burm.

After a careful study of further material received from Mrs. Slosson and others, I am convinced that the species found throughout the West Indies and Florida and listed by me as *B. Signoreti* in my paper on Jamaican Hemiptera is really *Adana Westwoodi* Stal, which Canon Fowler places as a synonym of *Bothriocera tinealis* Burm. He states that *Signoreti* may be known by its having the apex of the elytra broadly blackish, while in *tinealis* it is more or less invaded with hyaline.

Bothriocera undata Fabr.

Described from the West Indies. Mrs. Slosson has sent me a specimen captured by her at Lake Worth, Florida.

Genus **OLIARUS** Stål.

Of this cosmopolitan genus nine species have been recorded from North America, of which six are now represented in my collection. Here we find the vertex longer than in *Cixius*, almost quadrangular, with the base angularly emarginate. Generally there are five distinct carinæ on the mesonotum. The following artificial key will assist in placing the species known to me:

Elytra pellucid or nearly so, sometimes banded or mottled with brown, 1.
Elytra deep smoky brown, at least toward the apex, ... 4.
1. Elytral nervures distinctly punctate, ... 2.
—. Elytra hyaline or a little dusky at apex where the nervures are then heavy and brown, nervures impunctate or nearly so, . 5.
2. Front broad, brown with an ivory white area on either margin next the base of the clypeus; elytra hyaline with the stigma and nervures toward their apex brown, ... *aridus* Ball.
—. Front unicolorous, the clypeus sometimes a little paler, . . 3.
3. Clypeus scarcely paler than the front; elytra less maculated, the stigma distinctly longer than broad, ... *vicarius* Walk.
—. Clypeus generally paler than the front; elytra more maculated or generally transversely banded, stigma subquadrate, 5-*lineatus* Say.
4. Elytra deep smoky brown, the slender costa and stigma pale, *cinnamomeus* Prov.
—. Elytra smoky at apex beyond the stigma, base usually subhyaline, size smaller, ... *humilis* Say.
5. Length 8 mm., elytra entirely pellucid with fuscous nervures, stigma, and basal band, ... *hyalinus* Van D.
—. Length 4–5 mm., elytra nearly hyaline or somewhat infuscated at apex, without a basal band, ... *complectus* Ball.

The following North American species of *Oliarus* are still unknown to me:

O. franciscanus Stål, *Frega Eugenes Resa. Ins.*, p. 273, 1859. California. Seems to be near *aridus* Ball.

O. sementinus Ball, *Can. Ent.*, xxxiv, p. 152, 1902. Colorado. A small robust species.

O. pima Kirk., Haw. Sugar Plant. Assoc., *Bul.* iv, p. 62, 1907. Arizona.

1. Oliarus vicarius Walker.

This species is very close to 5-*lineatus* Say. I separate it by its slightly larger size, less strongly maculated elytra, longer and narrower stigma and pellucid wings. The general color is paler, the rostrum is considerably longer, nearly or quite attaining the hind edge of the sixth abdominal segment; and the intermediate carinæ of the mesonotum become evanescent or join the median carina some distance from the hind margin of the pronotum. I took an example of this species at Atlanta, Georgia, in May, 1899, and have seen one pair taken by Mrs. Slosson at Jacksonville and Ormond, Florida.

2. Oliarus quinquelineatus Say.

This is our most abundant and widely distributed species. I took a fine series at Boulder, Colorado, in July, 1903, and have also taken it about Buffalo, New York, and at Cape May, New Jersey, and Atlanta, Georgia. Prof. Osborn has sent me specimens from Ohio, and I have examined material from other localities as far south as Florida. *O.* 5-*lineatus* is proportionately broader and shorter than *vicarius*, with heavier elytral maculations, a blacker and nearly quadrate stigma and a distinctly broader front. The general color is darker, almost a piceous brown on the head and thorax, and the wings are quite deeply infuscated toward their apex. The male genitalia are quite distinct from that of *vicarius*; the ventral sinus on the genital segment is deeper with the median tooth pale yellowish and slender, reaching to the line of the rounded lateral lobes; the plates are narrow and abruptly bent and but little widened at apex, and the pygofers are expanded and rounded at apex and considerably longer than the plates, forming a concave dome beyond their tips. In *vicarius* the median tooth does not attain the line of the lateral lobes of the genital segment; the expanded apex of the plates are broader and more rounded and strongly reflexed, and the pygofers are narrower, flatter at apex, and but little surpass the tip of the plates.

3. Oliarus aridus Ball.

A western form of which I have before me only Colorado specimens. It is of about the size of the preceding species and may be distinguished by its broader vertex, the somewhat indefinite pale spots on the apex of the front and the whitish-hyaline elytra with minutely dotted nervures and slender stigma. The cross veins toward the apex of the elytra are marked with fuscous, the wings are milky hyaline with brown nervures and are unclouded, and the intermediate carinæ of the mesonotum are obsolete anteriorly in my specimens.

4. Oliarus hyalinus n. sp.

Most closely related to *humeralis* Fowler. Mesonotum tricarinate; elytra hyaline, with fuscous nervures, stigma, basal band and commissural nervure. Length 8 mm.

Vertex long and narrow, about as in *complectus* Ball; blackish fuscous with fulvous carinæ and a whitish line either side next the inner margin of the eye. Front strongly widened below; dark castaneous with pale carinæ and a pale area on either side next the clypeal margin. Clypeus blackish fuscous with pale carinæ. Pronotum very short, linear, acutely emarginate behind almost to the anterior margin; soiled yellowish clouded with fuscous at the sides and under the eyes. Tegulæ pale clouded on their disks. Mesonotum dark castaneous; intermediate carinæ obsolete or very feebly indicated anteriorly. Elytra long and narrow, clear hyaline with the nervures brown, under a lens very obscurely and minutely punctate; marginal and transverse nervures heavier; stigma long and narrow, fuscous, darker inwardly and bounded by a whitish nervure anteriorly; base marked by a transverse fuscous band across the apex of the scutellum which scarcely attains the costal margin; claval suture pale; commissural nervure fuscous, heavier for a space on the middle, then whitish to the apex of the clavus. Beneath blackish fuscous, paler on the meso- and metapleura and edges of the abdominal segments. Legs brownish testaceous, darker on the femora. Ventral sinus of the male genital segment deep, with a short median tooth; its sides obliquely rounded; plates long, but little separated at base; expanded apical plate as long as the slender base, roundedly triangular, inner edges approximate, grooved; pygofers just as long as the plates and concentric with them at their rounded apex.

Described from one male example taken by Mrs. Annie Trumbull Slosson at Biscayne Bay, Florida. This species is somewhat anomalous in genus *Oliarus* by its narrow pellucid elytra, practically impunctate nervures and tricarinate mesonotum, in all which characters it agrees most closely with *complectus* Ball. It has however the short pronotum, angularly emarginate hind margin of the vertex and frontal ocellus of *Oliarus*, in which genus I now place it. It closely resembles Fowler's figure of *O. humeralis* (*Biologia*, pl. x, fig. 18), but the basal band is narrower and the elytra are pellucid, not milky-hyaline, and the nervures are fuscous. I believe it quite distinct.

5. **Oliarus complectus** Ball.

This small species has much the aspect of *Œcleus decens* Stål, but the vertex narrows anteriorly not posteriorly as in *Œcleus*, and the hind edge is angularly emarginate. In *complectus* the intermediate mesonotal carinæ are almost obsolete in some specimens. I have taken this species at Effingham, Kansas, Washington, D. C., Niagara Falls and at other localities about Buffalo. The eastern specimens differ from those from Kansas in having the wings quite strongly infuscated toward their apex, but the genital and other characters seem to be substantially the same. This is the only species known to me in which the frontal ocellus is represented only by a scar.

6. **Oliarus cinnamomeus** Prov.

This is very distinct from any other species known to me. It can at once be distinguished by its fuscous elytra with the slender costa and the stigma whitish. Provancher's type came from Vancouver Island; Mrs. Slosson has taken it in the White Mountains, and Prof. W. E. Britton has sent me three examples taken at Colbrooke, Connecticut. It seems to be a rare and local northern form.

7. **Oliarus humilis** Say.

This our most abundant northern species is sufficiently distinct from any other. It varies considerably in size and depth of coloring.

Genus **CIXIUS** Latr.

Elytra black or nearly so; commissural margin and the costa slenderly pale; body black above with a broad pale vitta covering the vertex and middle line of the pro- and mesonotum, *dorsalis* Van D.

Elytra hyaline or slightly enfumed, frequently more or less banded or maculated with fuscous; nervures with brown punctures, . 1.

1. Vertex distinctly transverse, at most obtusely angled before; elytra proportionately broader; outer sector of the corium forked as near to or nearer the base than is the inner; maculation transverse, ... 2.

—. Vertex a little longer than broad, triangular, its apex subacute; elytra proportionately narrower; outer sector of the corium forked farther from the base than is the inner; maculation longitudinal, ... *cultus* Ball.

2. Vertex broad triangular, obtuse or subacute before, its apex very nearly attaining the apex of the front and almost bisecting the transverse compartment at the apex of the head; front black with the carinæ pale; plates and stiles of the male about equalling the pygofers, ... *stigmatus* Say.

—. Vertex short, transverse, rounded before; transverse compartment at the apex of the head much less narrowed, divided by a median carina, ... 3.

3. Larger, 6–7 mm.; clypeus paler than the front; plates and stiles of the male distinctly shorter than the pygofers, ... 4.

—. Smaller, 5 mm.; face entirely black with pale carinæ; plates and stiles of the male as long as the pygofers, . *colæpeum* Fitch.

4. Length 7 mm.; clypeus abruptly paler, at base strongly angled; plates of the male less than half the length of the pygofers; elytra generally quite strongly maculated, their base more or less distinctly fuscous, ... *basalis* Van D.

—. Length 6 mm.; clypeus less strongly differentiated; plates more than half the length of the pygofers; elytra almost immaculate or with some small broken spots beyond the middle, base not darker, ... *pini* Fitch.

Cixius basalis n. sp.

Size and general aspect of *Oliarus 5-lineatus*, but readily distinguished by the three mesonotal carinæ. Vertex short transverse, arcuated, its anterior and posterior margins about parallel, its outer angles rounded, median carina not pronounced; transverse compartment at the apex of the head but slightly narrowed at center. Front proportionately longer than in *pini*, but shorter than in *stigmatus*; black with the strong carinæ fulvous; clypeus abruptly fulvous, its apex and the tylus blackish, basal margin strongly angled. Pronotum linear and deeply angled as in the allied species; soiled fulvous-yellow as are the carinæ of the vertex and the tegulæ; mesonotum deep black with a pale point at the posterior end of each carina. Elytra abruptly widened near the base, then almost parallel to the stigma; whitish hyaline, nervures white conspicuously dotted with black, costal stronger with about 16 larger dots before the stigma, a few of which are grouped where the transverse band touches the margin; the radial forked nearer the base than is the second ulnar. In fully marked specimens the base of the elytra are deep fuscous or black to behind the tip of the scutellum; a broken linear transverse band crosses about halfway to the stigma and another at the stigma; sometimes there is a costal spot between these bands, and the transverse nervures at the base of the apical areoles are heavily brown. Frequently the base is but slightly obscured and the anterior band and costal spots or all the markings are wanting or feebly indicated. Beneath black varied with soiled yellow; legs pale with the femora more or less fuscous. Abdomen black with the narrow edges of the segments and base of the genital pieces of the female pale; in the male the plates, inferior surface of the pygofers at base and a dot at each incisure on the edge of the abdomen is pale. Plates of the male short, slender at base, abruptly expanded above in a transverse oblique plate lying against the slightly oblique apical margin of the genital segment; pygofers extending for more than half their length beyond the plates, estimating from the ventral notch of the genital segments. Length 7 mm.

Described from twelve examples taken by me at Hamburg and Gowanda, New York; several taken at Quinze Lake, P. Q., by Mr. W. J. Palmer, of Buffalo, and one strongly marked female taken at Como, P. Q., by Mr. R. M. Moore. This our largest *Cixius* seems to be distinctively a northern form. Like the closely allied *stigmatus*, *pini* and *colœpeum*, it varies greatly in the extent of elytral maculation. These species are very distinct in the characters of the male genitalia, but it is difficult to so describe them that they may be readily recognized. I feel tolerably certain of my determination of Say's *stigmatus*, but have had to place the two species of Fitch more by size and general appearance, and these can so stand until more definitely located by comparison with the types, if they still exist.

Cixius stigmatus Say.

In this species and *colœpeum* the male plates are not shorter than the pygofers. In *stigmatus* the sides of the genital segment are short and rounded, not oblique, the ventral notch broad and shallow, and the expanded apex of the plates are broad and rounded.

Cixius stigmatus seems to be more widely distributed than our other species. I have taken it about Buffalo, New York, and have received others from Rhode Island, and Mr. Palmer has taken it in numbers along the trail from Temagami, Ontario, to Quinze Lake, Quebec.

Cixius pini Fitch.

In this species as in *basalis* the male plates are much shorter than the pygofers, but here they reach somewhat beyond their middle, reconning from the ventral notch of the genital segment. The sides of this segment are much more oblique than in *basalis*, and the expanded apices of the plates are broader and more rounded and compressed about the pygofers. This species I have taken at Buffalo, Hamburg, Colden and Lake Placid, New York, and Denver, Colorado.

Cixius colœpeum Fitch.

I have placed here a small species with more regularly maculated elytra. At least they are so in the only specimens I have seen, but doubtless this character is as variable as in the allied species. Here the sides of the male genital segment are rounded, a little oblique, with a broad shallow ventral notch. In all our species there is a small median tooth at the apex of this ventral notch. In *colœpeum* the male plates are long, slender at base, expanded at apex in suborbicular disks which just attain the apex of the pygofers. In this species, *pini*, and *stigmatus* the elytra are proportionately broader, with the costa more rounded than in *basalis*. I have taken one male of *colœpeum* at Buffalo and another at Sunset, Colorado, at an altitude of over 8,000 feet.

Cixius dorsalis n. sp.

Color blackish fuscous, paler beneath; front pleuræ and legs testaceous brown, tinged with ferruginous on the clypeus; front clouded with brown, the carinæ paler. Dorsal surface almost black with a broad pale yellow vitta tinged with fulvous covering the whole vertex the pro- and mesonotum between the lateral carinæ and the elytral commissure, where it becomes narrower and more obscured. Sides of the mesonotum deep black. Costa very narrowly pale with a pale spot on the base of the stigma; nervures concolorous, punctured, apical areoles with a few vague paler spots.

Vertex longer than in our other species, transverse, almost quadrangular, widened before by the expanded sides of the front. Pronotum very short, linear, roundly produced before, the anterior and posterior margins almost parallel, very feebly angled behind; lateral carinæ very oblique, terminating outside of the mesonotal carinæ, the latter straight, but little divergent posteriorly; post-scutellum pale across the middle. Pale commissural vitta of the elytra occupying the interior claval areole. Wings smoky hyaline with fuscous nervures. Length about 6 mm.

Described from one female example taken by Mrs. Annie Trumbull Slosson at Biscayne Bay, Florida. This species is very distinct from any other known to me. Its black color with broad yellowish dorsal vitta will at once distinguish it.

The above six species of *Cixius* are all that are known to me to inhabit North America, but Prof. Smith, in his *Catalogue of the Insects of New Jersey,* enumerates *albicincta* Germ. from that State. I have seen nothing that could be identified with that species, or have I learned of its having been found elsewhere in this country.

Genus MYNDUS Stål.

Myndus sordidipennis Stål.

The species I have placed under this name is not uncommon about moist springy spots in rich woods near Buffalo. All my specimens differ from Stal's short and inadequate description in having the abdomen more or less blackish fuscous. The elytra however agree exactly and I believe my identification to be correct.

Myndus pictifrons Stål.

This is another allied species with banded front, but it may be readily separated from *sordidipennis* by the brown v tta at the inner apical angle of the elytra. About Buffalo it is less abundant than the preceding. Mrs. Slosson has taken it in the White Mountains.

Of our other described species I have or have studied *Slossoni* and *viridis* of Ball and *radicis* of Osborn. *Slossoni* and *impiger* Ball have a brown front almost immaculate; in *radicis* the front is pale with a basal fuscous band indicated, while *viridis* Ball and *fulvus* Osborn are almost unicolorous insects. *Cixius impunctatus* Fitch is a *Catonia.*

Myndus delicatus n. sp.

Closely allied to *sordidipennis*, but a little smaller and paler. Vertex a little narrower anteriorly, the sides almost parallel before the middle; in *sordidipennis* these sides converge nearly to their apex; black with a broad longitudinal line toward the apex pale fulvous. Eyes black with their inner edges slenderly pale. Front rounded ovate; yellowish white with a black band across the base and apex; these bands a little narrower than in the allied species; carinæ on the apex of the head pale, lower down on the front the lateral carinæ become blackish within. Clypeus soiled white. Pronotum about as wide as in the same sex of *sordidipennis*; the hind edge more angularly emarginate and the humeral angles more rounded; superior disk black with the slender hind edge and median carina pale; sides pale slightly stained, the deflected portion black more or less broadly bordered with pale; in *sordidipennis* entirely pale in the specimens before me. Patagia black, fuscous in its ally. Mesonotum black with its side compartments invaded with ferruginous before, the small scutellum pale. Elytra almost hyaline, slightly smoky at tip; nervures white dotted with concolorous bristle-bearing pits; stigma whitish. Beneath whitish, a little suffused with flavous on the venter. Apex of the genital segment oblique, armed with a minute triangular ventral tooth; in *sordidipennis* this ventral tooth is larger with the adjoining margin quite deeply excavated; stiles undulated at base as in *sordidipennis* but distally approximated to their rounded apex. In *sordidipennis* most of the lower surface and genital pieces are black. Length 5 mm.

Described from two male examples taken at Hot Springs, North Carolina, by Mrs. Annie Trumbull Slosson.

Subfamily ISSIDA.

This subfamily is quite largely represented in our territory. I notice here one new species taken by Mrs. Slosson in Florida and two western forms.

Peltonotellus decoratus n. sp.

Closely allied to *simplex*, but with the elytra and abdomen mostly piceous black. Characters of the front, vertex, pro- and mesonotum almost exactly as in *simplex*; the anterior edge of the pronotum is, however, more regularly rounded instead of forming an indistinct angle at the inner corner of the eyes; the mesonotum is shorter with its lateral posterior margins much less oblique and the pectoral flap of the pronotum is narrower and more transverse. Immediately below this flap projects the inferior end of one of the pleural pieces; in *decoratus* its sides are almost at right angles with the emarginated apex which fits around the base of the intermediate coxæ; in *simplex* the hind edge of this piece is oblique and the apex is scarcely sinuated; the next adjoining piece is almost square in this new species but subtriangular in *simplex*.

Color fuscous deepened almost to ferruginous in the male in which sex the elytra and abdomen are deep piceous black, almost blue-black on the elytra, with the base of the abdomen and the apex of the genital segments touched with fulvous. Legs fulvous with the tarsal claws and the line of fine bristles on the edges of the tibiæ blackish; the pustulate border of the front is also slightly infuscated. In the female the general color is more flavous and this pale color is much more extended over the abdomen and inner field of the elytra.

In the characters of the male genitalia this species is quite distinct. The ventral aspect of the genital segment is much shorter with the valve small and triangular, not short and transverse as in *simplex*; the plates (stiles of some authors) are much shorter and more rounded and do not nearly attain the anal tube. In *simplex* the plates are longer and thicker, are narrowed to an incurved pointed apex like the strong stout claws of some birds, and in my specimens project almost at right angles to the apex of the segment, and would about reach the anal tube if depressed.

Described from one male and three female examples taken at Charlotte Harbor, Florida, by Mrs. Slosson. At first sight this looks like a mere color variety of *simplex*, but the different form of the pro- and mesonotum, pleural pieces and male genitalia as well as its very distinct coloring will readily separate it. This species and *simplex* differ from our three other known species, *histrionicus* Stal, *rugosus* Ball, and *bivittatus* Ball, in having a pale clypeus.

Genus **HYSTEROPTERUM** A. and S.

Hysteropterum cornutum Melichar.

Dr. Melichar has described this species on p. 147 of his *Monograph of the Issida.* His specimens were from California, but I found it abundant in Utah and in Colorado west of the Continental Divide.

Two other species of this genus have been described from this country: *auroreum* Uhler and *punctiferum* Walk., the latter redescribed by Dr. Uhler as *aciculatum* according to Melichar.

Genus **THIONIA** Stål.

This genus is well represented in Central and South America. Melichar enumerates the following from this country:

Thionia simplex Germ. Recorded from Washington, D. C., to Texas. I have taken it in Ohio.

Thionia elliptica Germ. Recorded from Washington, D. C., to Missouri.

Thionia transversalis Mel. Recorded from "N. Am."

Thionia bullata Say. Recorded from New York to Georgia. I have taken it in numbers at Niagara Falls and Gowanda, N. Y., and Mr. Palmer took it in North Carolina. Melichar places *Issus conspersus* Walker as a synonym.

Thionia ocellata Mel. Recorded from "N. Am."

I add the following:

Thionia producta n sp.

Form of *naso* Fowler, but smaller and less elongated. Vertex much longer than broad, almost equally five-sided; the basal portion nearly square, its sides slightly diverging anteriorly, the apical portion produced in an angle a little less than a right angle; sides carinate, hind edge very feebly arcuated, surface flat with a feeble median carina at apex. Front narrow, much longer than the head, a little narrower toward the angulated base; apex deeply emarginate for the reception of the clypeus; the three carinæ distinct, acutely converging at base; clypeus long, strongly convex with a prominent median carina. Pronotum shorter than the vertex, strongly advanced and rounded anteriorly between the eyes, truncated behind, ecarinate, with two impressed points on the disk. Mesonotum short, not longer than the pronotum, its sides arcuated. Elytra narrower than in *bullata* with the costa more angled and the apex more obtusely angled, not obliquely truncated as in that species; venation typical of this genus. Wings deeply cleft. Length 6 mm.

Color dull testaceous, paler on the abdomen. Vertex and pronotum mostly black with a broad median pale vitta; slender edges of the pronotum and some marks behind the eyes also paler; front much invaded with black on the base, sides and apex; clypeus darker, either side with a few oblique lines; cheeks except at base and apex ivory white; pleural flaps of the pronotum white and pruinose below, above black with a pale median cloud; hind margin of the eyes pale. Scutellum pale with the median line, basal angles and a short vitta on either side black. Elytra with the longitudinal nervures and a broad vitta following the inner margin of the scutellum to behind the middle, black. Venter marked with black along the middle and sides.

Described from one pair taken at Rifle, Colo., July 26, 1900. This species and *naso* of Fowler present a new facies in this genus by their produced vertex, but in every other respect they are true *Thionias* and should doubtless be retained here.

Subfamily ACANALONIDA Stål.

I can see no reason for uniting this subfamily with the *Issida* on one hand or with the *Flatida* on the other. Four genera and ten species have been recorded from our territory, but doubtless many others will yet be found.

Genus **AMPHISCEPA** Germ.

Amphiscepa pumila n. sp.

Form nearly of *Hysteropterum*, much smaller than any other described species; elytra almost semicircular in outline. Vertex very short, rounded almost from the base to the front with no transverse carina between the two; anterior and posterior margins parallel. Front almost quadrate, the lower angles cut off in line with the sides of the clypeus, the sides below a little expanded and reflexed; base of the clypeus strongly angled, reaching almost to the line of the antennæ. Pronotum short, broadly rounded before, almost straight behind. Elytra but little longer than broad, somewhat tumid toward the base, the costa semicircularly rounded, the whole surface rather closely but not very distinctly reticulated. Length 4 mm.; of the elytra 3 mm.; width of the elytra 2½ mm.

Color soiled brownish testaceous a little tinged with green, paler beneath, commissural and apical margins of the elytra faintly dotted with brownish; tumid basal part of the elytra with a piceous spot. Spines of posterior tibiæ tipped with black.

Described from a single example taken by Mrs. Slosson at Biscayne Bay, Florida.

I have not yet seen Germar's description of this genus, but evidently it was founded for his *malina*, which Stal places as a synonym of *Flata bivittata* Say, published the same year. In three places where Stal mentions this genus he places it in the *Issida* and states that the hind tibiæ are unispinose, but in this he is certainly mistaken, as pointed out by Melichar. In this genus the head is broader than in *Acanalonia,* but the longer scutellum and broad vertical reticulated elytra seem to ally it most closely with *Acanalonia* and I follow Melichar in placing it with that genus. Through a clerical error Melichar has credited this genus to Say instead of Germar.

Genus **ACANALONIA** Spinola.

Acanalonia clypeata n. sp.

Allied to *virescens* Stål but a little smaller with much narrower elytra. Vertex horizontal, longitudinally a little concave; slightly conical before, a little more so than in *virescens,* but with its length distinctly less than its width between the eyes; passage to the front rounded. Front broad, much shortened by the encroachment of the broad truncated base of the clypeus, which reaches above the lower line of the eyes; base tumid, sides well rounded, less angled than in *virescens.* Clypeus very large, transversely tumid, polished. Pro- and mesonotum about as in *virescens,* ecarinate. Elytra as long as in *virescens* but much narrower, their length twice their greatest width which is at about the basal fourth, then narrowed and a little sinuated or subparallel to the feebly rounded apex; longitudinal venation strong, reticulations weak and somewhat coarser than in *virescens.* Wings as long as the elytra; whitish hyaline or a little infuscated, with prominent nervures. Length 7 mm. to the tip of the closed elytra; width across the elytra 3 mm.

Color pale greenish yellow tinged with testaceous on the clypeus; eyes brown; tarsi tinged with rufous; apical spines of the posterior tibiæ and antennal setæ black. Elytra pale pea-green becoming whitish along the base of the costa and with the marginal nervure about the apex very slenderly brown.

Described from a single male example taken at St. George, Utah, in July, by Prof. H. F. Wickham. This species is very near to *delicatula* Fowler, but the elytra are still narrower, the vertex is shorter and not separated from the front by a carina, and there are no discernible carinæ on the mesonotum. The large oval and tumid clypeus and narrow elytra are good characters for distinguishing this species.

Subfamily FLATIDA Stål.

Genus **CYARDA** Walker.

Cyarda Melichari VanDuzee.

A fine series of Cyardas from Florida received from Mrs. Slosson has enabled me to correct one other error of determination in my Jamaica list. The Florida specimens there mentioned under *Cyarda* were of

Melichari (*punctata* Walk. of Melichar), but those from Jamaica were probably the *acuminipennis* Spinola. The length given by Spinola is about 8 mm., which corresponds with my Jamaican material. In this Jamaican species there is a blackish cloud beneath and behind the elytral hump, the anterior side of which is piceous; and the elytra are subfalcate at apex, which is cut off obliquely and a little arcuated; the vertex is longer and less deeply sculptured than in *Melichari* and the base of the front is piceous brown.

In these Florida specimens of *Melichari* the apex of the elytra is narrower, wedge shaped and subacute; the costa is more abruptly expanded at base and the disk wants the infuscation found in the other species. Here the base of the front is scarcely if at all darker. I cannot accept Melichar's synonymy of Walker's species he places under *acuminipennis, conformis,* and *punctata.*

Genus **FLATOIDES** Guer.

Flatoides fuscus n. sp.

Form of *Flatoides scabrosus* Melichar; dull blackish fuscous, disk of the elytral areoles and all beneath pale yellowish brown. Length 10 mm.; width across the elytra 4½ mm.

Vertex a little more than one-half as long as the width between the eyes, disk depressed, anterior margin quite regularly rounded. Front a little longer than broad, narrowed toward the base, sides broadly reflexed, moderately rounded, basal and clypeal margins parallel, almost rectilinear; clypeus long triangular, a little convex. Pronotum strongly rounded before between the eyes, of equal length across its whole width, the discal plate formed by the strong curved lateral carinæ semicircular with the hind edge rather deeply arcuated. Mesonotum lozenge shaped, the sides nearly equal, anterior angle rounded, carinæ obscure. Elytra about twice longer than broad, costa straight and parallel with the commissure, apex regularly rounded; costal membrane twice wider than the costal areole, broader toward the base where it projects moderately in a rounded lobe; crossed by numerous transverse veins; all the nervures heavy, those of the disk irregular; toward the apex with two transverse lines, the inner indistinct and irregular; the subbase with a strong blackish tubercle. Plates of the male genital segment long triangular, approximate at base within.

Color blackish fuscous covered with a grey mealy tomentum which obscures the neuration and other characters; indefinite disk of the vertex and pronotum, marginal nervure and disk of all the areoles of the elytra and all beneath dull yellowish brown; base of the front with a blackish band which crosses the sides of the face and inferior flap of the pronotum; basal joint of the antennæ brown with a pale tip; clypeus tinged with ferruginous, darker toward the apex; anterior and intermediate legs, middle pleural pieces and disk of the ventral segments clouded with darker brown. Wings smoky with strong fuscous nervures.

Described from one male and two female examples labelled "Colorado Desert" and received from Prof. J. B. Smith. In this species the elytra are moderately convex and are held at an angle of about 45 degrees. This species is very close to *scabrosus* Mel., but the vertex is shorter, the colors very different and the elytral nervures stronger and more irregular. These species are not characteristic of this genus and are intermediate between it and *Dascalia*.

NEW CLAUSILIIDÆ OF THE JAPANESE EMPIRE—XI.

BY HENRY A. PILSBRY.

The present paper[1] deals chiefly with species of the Ryukyu Islands and Formosa, and especially with an interesting series of very small *Clausiliæ* related to *Zaptyx*. This series now comprises some twenty-nine species, all but one of them discovered by Mr. Hirase and his assistants. No member of the Zaptychoid group has been recognized in China. All are insular; and being among the most specialized of all Clausiliæ in structure, they indicate a greater antiquity for the Ryukyuan fauna than zoogeographers have generally been disposed to admit.

Section MEGALOPHÆDUSA Bttg.

Clausilia martensi concrescens n. subsp.

In this form the spaces between the palatal plicæ are filled up, making a straight lunella with slightly uneven edge. Cuticle greenish yellow. Length 35, diam. 8.5 to 9 mm.

Shishikui, Awa, Shikoku Island. Types No. 90,044, A. N. S. P., from No. 1,189 of Mr. Hirase's collection.

Section LUCHUPHÆDUSA Pils.

To the nine species of this section already known two are now to be added.

Clausilia inclyta n. sp. Pl. XXXII, figs. 1–4.

Shell rather slender, gradually and regularly tapering from the penultimate whorl to the small apex; extremely thick and solid; grayish white, being denuded of cuticle throughout; *very coarsely sculptured with strong straight rounded ribs* nearly as wide as their intervals, about 24 or 25 in number on the last whorl, and not coarser on its back. Whorls about 11, moderately convex, the last smaller than the penultimate, its last half compressed. Aperture small, vertical, piriform; peristome

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[1] This is the eleventh paper treating exclusively of Japanese Clausiliidæ collected by Mr. Hirase. Seven of them appeared under the title "Additions to the Japanese Land Snail Fauna," the rest under various titles. A list of them is appended to this paper. In all 165 pages, and 31 plates containing 535 figures drawn by the author, have been published.

Isabella-tinted, thick, well expanded and slightly reflexed; the *parietal margin cut into one or several rounded tubercles,* the peristome elsewhere smooth. Superior lamella marginal, subvertical, thick at its end, thin within and continuous with the spiral lamella, which penetrates past the aperture to the left side. Inferior lamella thick but not in the least doubled, forming a prominent fold in the mouth, very strongly spiral within, becoming horizontal and very strong a half whorl inward, then abruptly diminishing, penetrating as far as the spiral lamella. Subcolumellar lamella emerging to the lip-edge, penetrating inward as far as the other lamellæ. Principal plica not long, latero-ventral. *No upper palatal plica.* Lower palatal plica long, oblique and arcuate, a very oblique, long lunella rising from it near the middle, and curved inwards somewhat at the upper end.

Length 26, diam. 6, length of aperture 6.2 mm.

The clausilium (Pl. XXXII, figs. 3, 4) is well curved, the columellar margin straight, strengthened by a rib which terminates in a straight finger-like apical process; palatal margin arcuate.

Ogimi, prov. Kunchan, Ryukyu (Okinawa). Types No. 89,890 A. N. S. P., from No. 1,347 of Mr. Hirase's collection.

This is more coarsely sculptured than any other known *Luchuphædusa,* and is further distinguished by the very long lunella, as in *C. tokunoshimana,* and the absence of an upper palatal plica, present in the other species. The clausilium has most resemblance to that of *C. mima.*

In quite mature individuals the sculpture is largely worn from the ventral face of the shell, as shown in the figure.

Clausilia koniyaensis n. sp. Pl. XXXII, figs. 5-8.

Shell fusiform, the penultimate whorl widest, pale straw-yellow, glossy, closely and evenly striate, the striæ usually a little more spaced on the back of the last whorl. Whorls 9½, slightly convex, the last compressed laterally, convex below. Aperture small, piriform, the peristome white, reflexed and somewhat thickened, the parietal margin weakly, irregularly crenulated. Superior lamella marginal, continuous with the spiral lamella, which penetrates past the ventral to the left side. *Inferior lamella more or less distinctly double,* forming two contiguous columellar folds; as long inside as the spiral lamella. Subcolumellar lamella emerging to the lip-edge, but rather weak; as long inside as the other lamellæ. Principal plica lateral, about a half whorl long. Upper palatal plica rather short and very oblique. Lower palatal plica long, strong and arcuate, a rather long, oblique lunella rising from it in the middle.

Length 14.3–15.3, diam. 4 mm.

The clausilium (Pl. XXXII, figs. 6, 7) is much twisted, tapering and acuminate distally, with a notch between the thick terminal point and a smaller point on the palatal side, a short distance from the apex.

Koniya, Ōshima, Ōsumi, Types No. 94,543, A. N. S. P., from No. 654*a* of Mr. Hirase's Collection.

This snail is much like *C. mima* Pils., also of Ōshima, but it is slightly larger and more strongly rib-striate, the inferior lamella is usually distinctly double, the subcolumellar lamella is less dilated below the lower palatal plica, and finally the shape of the clausilium is very different, as may be seen by comparing the figures here given with figs. 17, 18 of Plate 22 of these *Proceedings* for 1901. *C. koniyaensis* also resembles *C. tokunoshimana*, but differs in the shape of the clausilium, the less coarse sculpture, more lateral lunella, etc.

ZAPTYCHOID PHYLUM.

Numerous new species and groups of this phylum were discussed in the preceding paper of this series, but the modifications of internal armature and clausilium seem to be interminable, and a number of peculiar additional forms must now be described. These require an amplification and various modifications of the key to sections previously given. The key given below is designed to show the natural relationships of the groups so far as they are now understood.

KEY TO THE SECTIONS OF ZAPTYCHOID CLAUSILIÆ.

I.—Lunella normally developed, lateral, oblique, above united with or contiguous to the upper palatal plica, which varies from very long to short or even wanting, but when present this plica projects inward beyond the upper end of the lunella. Clausilium entire and rounded distally, or rarely mucronate.
  a.—Inferior lamella receding, inconspicuous or invisible from in front, obliquely ascending and straightened within the back of the last whorl. Remote from the superior lamella.
    b.—Shell without sutural plicæ, fulcrum or parallel lamella.
      c.—Clausilium parallel-sided, flattened, rounded at the end. Section HEMIZAPTYX.
      c^1.—Clausilium swollen and callous outside near the palatal margin, either angular or rounded at the end. Section HETEROZAPTYX.
    b^1.—Shell thin; sutural plicæ, fulcrum and parallel lamella developed. Distal end of the clausilium rounded. Section ZAPTYX.

a^1.—Inferior lamella ascending in a broad spiral curve within the last whorl, approaching the superior lamella.

b.—Clausilium strongly tapering to the angular or narrowly rounded apex, not buttressed externally; fulcrum present; sutural plicæ weak or wanting, Section STEREOZAPTYX.

b^1.—Clausilium tapering to the bluntly angular apex, buttressed outside by an erect transverse plate; no sutural plicæ or fulcrum; inferior lamella receding, Section PARAZAPTYX.

b^2.—Clausilium wide distally, the apex rounded; smooth outside. Shell thin, sutural plicæ developed; inferior lamella approaching the superior in the aperture as a thin fold. Section METAZAPTYX.

II.—The lunella arises from the middle of a long, arched lower palatal plica, and curves inward at its upper end; superior lamella developed or wanting; inferior lamella spirally ascending within; sutural plicæ, fulcrum and parallel lamella developed Clausilium short, deeply notched on the palatal side near the apex, ... Section OLIGOZAPTYX.

III.—The upper palatal plica is very long, an extremely short lunella branching from near its inner end; inferior lamella spirally ascending within; superior lamella and sutural plicæ developed. Clausilium notched on the palatal side near the apex, Section DICERATOPTYX.

IV.—The lunella is merely a continuation obliquely downwards of the inner end of the upper palatal plica, and its position is ventral in known species; no sutural or lower palatal plicæ or fulcrum; inferior lamella receding, vertical below, then bent to the left within the back of the last whorl. Palatal margin of the clausilium more or less excised below the middle.

a.—Peristome entire, the aperture normally clausilioid; upper palatal plica and lunella together much shorter than the principal plica, ... Section SELENOPTYX.

a^1. Peristome widely interrupted; shell imperforate, not in the least rimate; the upper palatal plica with the lunella forms a very long, slightly bowed fold, subparallel to the principal plica, but diverging downward towards the inner end, Section THAUMATOPTYX.

Section HETEROZAPTYX Pils.

Proc. A. N. S. Phila., 1905, p. 739, footnote.

Shell like *Hemizaptyx*; the upper palatal plica either short (as in *Zaptyx*) or very long, approaching the aperture, and sometimes it is interrupted. The clausilium is deeply excised on the columellar side at the filament, *callous and swollen outside near the palatal margin*, and either acuminate or rounded at the end. Type *C. munus* (*Heterozaptyx*, unlike *Zaptyx*).

The two species of this group hitherto known were referred to *Hemizaptyx* as a second division (*Proc. A. N. S. Phila.*, 1904, p. 825); but the discovery of more species with the same type of clausilium makes it expedient to recognize the group by name. It is closely related to *Hemizaptyx* in shell features, but differs in the peculiar swell and callus along the outside of the clausilium near its palatal border.

The species now known are as follows:

- I.—Clausilium rather long, acuminate at the apex, which is a little hooked backward.
  - *a*.—Upper palatal plica interrupted, a short portion being situated at the top of the lunella and a long one in the back of the last whorl, visible in the mouth. Formosa, *C. diacoptyx*.
  - a^1.—Upper palatal plica very long, extending nearly to the lip. Clausilium unknown. Formosa, . . . *C. uraniscoptyx*.
  - a^2.—Upper palatal plica short; shell striate.
    - *b*.—Shell dark reddish-brown, glossy, and rather thin, 10 to 11 mm. long, 2 to 2.3 wide, with 7½ whorls; sides of the clausilium strongly reflexed. Tokunoshima, *C. hyperaptyx*.
    - b^1.—Shell pale chestnut or brownish corneous, rather thin, 11 to 13 mm. long, 2.7 wide, with 9 to 10½ whorls; clausilium distinctly hooked at the apex. Ōshima, *C. oxypomatica*.
    - b^2.—Shell brown or yellowish-brown, quite solid when adult, 12 to 15 mm. long, 3 to 3.6 wide, with 9 to 10 whorls. Clausilium distinctly hooked at the apex. Ōshima, *C. munus*.
- II.—Clausilium short, very wide distally, where it is broadly rounded and recurved at the edge. Upper palatal plica very long, approaching the aperture. Kerama-jima, Ryukyu, *C. longiplicata*.

Clausilia hyperaptyx Pils.

Proc. A. N. S. Phila., 1904, p. 827.

The clausilium (Pl. XXXII, fig. 10), seen from the palatal side, is here figured, to show the unusual width of the reflexed palatal margin. The terminal hook is much less developed than in *C. oxypomatica* (*hyperaptyx*, with no fold above).

Clausilia munus Pils.

Proc. A. N. S. Phila., 1901, p. 423.

The clausilium is here figured (Pl. XXXII, figs. 11, 12) from the type specimen. It is conspicuously angular at the apex, which is decidedly thickened, and in profile view is seen to be hooked backward. The columellar margin is regularly arcuate, bordered by a thickened rim. The palatal margin is rather strongly convex in the middle, and above the middle it is very much thickened outside, as shown in the profile view. In some specimens it has a concavity in the inner face corresponding to the external callus. The main curvature of the clausilium is not far from the origin of the filament; elsewhere it is nearly straight in profile view.

In specimens from Ikejijima, Ōshima, the external callosity referred to is weak. In those from Koniya, Ōshima, the clausilium is typical. The shells from this place are more delicate, thinner than the types of *C. munus* (*munus*, a gift).

Clausilia diacoptyx n. sp. Pl. XXXIII, figs. 13–19.

Shell fusiform, the apex rather obtuse, whorls 8 to 9, moderately convex, the last tapering downwards. Surface glossy, smooth, faintly striatulate, the last whorl rib-striate for a short distance behind the outer lip. Pale greenish corneous, somewhat transparent. Aperture ovate, the lip well reflexed and thick. Superior lamella marginal, continuous with the spiral lamella, which is high in the lateral region, and extends inward to a point above the superior lamella. Inferior lamella deeply receding, straightened and obliquely ascending within, shorter than the spiral lamella, or equal to it. Subcolumellar lamella strongly emerging to the lip-edge, a groove with raised margins on each side of it. Principal plica somewhat more than a half whorl long, dorsal and lateral, approaching the lip. Upper palatal plica consisting of two portions, the inner portion short, across the top of the straight, lateral lunella, the other portion widely separated from it, dorsal, visible in the mouth, long, and diverging forward a little from the principal plica.

Length 10, diam. 2.3 mm.
" 8.8 " 2.3 "
" — " 2.7 "

The clausilium (Pl. XXXIII, figs. 15, 16, 17) is rather long with subparallel margins, the columellar margin abruptly excised above, then straight, and near the apex strongly curved towards the palatal margin. The apex is curved toward the palatal margin and then outward in an acute point, separated from the palatal side by a rather deep excision, which is scarcely apparent in a front view, but is conspicuous in a profile view from the palatal side. The palatal margin is thick and slightly arched.

Sammaipo, Taiwan (Formosa). Types No. 89,896, A. N. S. P., from No. 1,430 of Mr. Hirase's collection.

This species is probably related to *C. uraniscoptyx* Schm. and Bttg., from Bankimtsong, Formosa, but unfortunately the clausilium of that species has not been described. The present form differs from that described by Schmacker and Boettger by its broadly interrupted upper palatal plica and the non-ascending last whorl.

Clausilia oxypomatica n. sp. Pl. XXXIII, figs. 20-24.

Shell cylindric-fusiform, attenuated towards the rather acute apex, pale chestnut or brownish corneous, slightly transparent, the old shells opaque, very finely but not deeply striate, more coarsely so on the last half whorl. Whorls 9 to 10½, but slightly convex, the last compressed laterally, the base tapering. Aperture rhombic-ovate. Peristome expanded and reflexed, rather narrow and not much thickened except in old shells; parietal wall free, emarginate above the superior lamella. The superior lamella is vertical, marginal, thin but rather high, continuous with the spiral lamella, which is very high in the lateral position, and penetrates to a point above the superior lamella. The inferior lamella recedes deeply, is straight and oblique within the last whorl, and penetrates inward less deeply than the spiral lamella. The subcolumellar lamella emerges. Principal plica more than a half whorl long, dorsal and lateral, approaching the aperture. Upper palatal plica thin but moderately long, with the lunella forming a T-shaped barrier.

Length 13, diam. 2.7 mm.
" 11, " 2.7 "

The clausilium (Pl. XXXIII, figs. 21, 22, 23) is not much curved, but is quite concave internally and convex or somewhat baggy externally. The columellar side is very deeply excised at the filament. The two sides are about equally arcuate, the apex somewhat acuminate and projecting, as though a drop were hanging there. There is a rib inside along the columellar margin, and a more diffuse callus on the outside along the palatal margin.

Ōshima, Ōsumi. Types No. 89,889, A. N. S. P., from No. 1,336 of Mr. Hirase's collection.

This species falls into the second division (II) of my key to *Hemizaptyx* (*Proc. A. N. S. Phila.*, 1904, p. 825). It differs from both the species of that division (*C. hyperaptyx* and *C. munus*) in having the upper palatal plica somewhat longer, the lunella joining it in the middle. It is thinner and more slender than *C. munus*, larger, wider, paler and less sharply striate than *C. hyperaptyx* (*oxypomaticus*, having a sharp lid or "clausilium").

At Koniya, Ōshima, there is a variety of *C. munus* more delicate than the type lot, the shell usually somewhat smaller and more slender. It is this form which approaches *C. oxypomatica*.

Clausilia longiplicata n. sp. Pl. XXXIII, figs. 25–29.

Shell cylindric-fusiform, strong, light yellowish brown, subtransparent except when old, when it becomes opaque. *Surface very smooth and glossy,* as if varnished, marked with faint growth-lines only. Whorls $8\frac{1}{2}$, moderately convex, the last a little compressed laterally, pinched into a short low and rounded basal crest. Aperture rhombic-ovate, the white peristome a little expanded and narrowly reflexed, thickened in old shells. *Superior lamella high and compressed,* continuous with the spiral lamella which is also exceptionally high, and continues inward to a point above the sinulus. Inferior lamella receding, low but strong and callous within, at first vertically ascending, then abruptly bent to the left, after which it ascends vertically again, abruptly becoming low on the ventral side, and much shorter there than the spiral lamella. Subcolumellar lamella very slender, emerging to the lip-edge, bounded by grooves. Principal plica dorsal and lateral, extending nearly to the lip. *Upper palatal plica very long,* parallel to the principal plica on the side, but diverging from it on the back, where it approaches the lip, and is seen conspicuously in the mouth. Lunella lateral, *very oblique,* slightly arcuate, tapering towards the ends, not reaching the upper palatal plica, or but weakly joining it. There is no lower palatal plica. Sutural plicæ and fulcrum are absent.

Length 11, diam. 2.9 mm.
" 10, " 2.3 "
" 10, " 2.6 "

The clausilium (Pl. XXXIII, figs. 25, 26) is very short, spatulate, being broad and rounded distally. It is excised near the filament as usual in Zaptychoid clausiliæ; near the distal end it bulges inward, and has a corresponding concavity on the outer face. It is somewhat calloused along the palatal margin.

Kerama-jima, Ryukyu. Types No. 89,892, A. N. S. P., from No. 1,361 of Mr. Hirase's collection.

This peculiar snail resembles *C. agna* in its general form and brilliant gloss, but differs widely in internal structure. The long upper palatal plica reminds one of *C. dolichoptyx,* but that species is in everything else a true *Zaptyx.* The long upper palatal plica and short lunella suggest *Diceratoptyx,* which, however, differs by the shape of the inferior lamella, the different clausilium, etc. *C. uraniscoptyx* of Formosa differs from *longiplicata* by its ascending last whorl (*longiplicatus,* long-folded, in allusion to the long upper palatal plica).

Section ZAPTYX Pils.

The following species enlarges our conceptions of *Zaptyx* by a structure not before known in the section; the upper palatal plica being greatly lengthened, as in *Heterozaptyx*, while in the other known species of *Zaptyx* it is comparatively short.

Clausilia dolichoptyx n. sp. Pl. XXXIV, 30-33.

Shell slender, fusiform-turrited, chestnut-brown, rather opaque, shining; the spire long, tapering and somewhat attenuate, apex obtuse, whitish. Whorls 9½ to 10, convex, very slowly increasing, irregularly striatulate or marked with growth-wrinkles. Aperture narrowly piriform, small; the peristome white, continuous, narrowly expanded, the outer lip a little reflexed. *The superior lamella is very small or subobsolete;* the *spiral lamella is reduced to a very small, short lamella in the region of the lunella.* The inferior lamella recedes deeply, being hardly visible in the aperture; in the back it ascends obliquely, is low, rather thick and straightened, not continuous with a short portion which lies parallel to the short spiral lamella. There is a fulcrum and a parallel lamella. The subcolumellar lamella is usually quite immersed, but sometimes emerges. The principal plica is short, about a fourth of a whorl long, and in a lateral position. *The upper palatal plica is very long,* the lunella joined to it near its inner end; thence it diverges from the principal plica, running towards the aperture. The lunella is long and nearly straight. Two short sutural plicæ stand above the lunella.

Length 12.5, diam. 3, length of aperture 2.5 mm.
" 10.5 " 2.5, " " " 2 "

Clausilium (Pl. XXXIV, figs. 31, 32) with the curvature chiefly near the filament, as usual in *Zaptyx*; very wide above, tapering distally, rounded at the apex. It is deeply excised on the columellar side of the filament, and much dilated on the palatal side.

Heda, Kunchan, Ryukyu. Types No. 90,020, A. N. S. P., from No. 1,342 of Mr. Hirase's collection.

This species is readily recognized by the very long upper palatal plica, the small superior lamella very widely separated from the short spiral lamella, and the number of whorls, which is greater than in the other species. With the exception of the upper palatal plica, the structure is not unlike that of *C. hirasei*, the type of *Zaptyx* (*dolichoptyx*, long fold).

Clausilia dolichoptyx micra n. subsp.

Shell smaller than *C. dolichoptyx*, nearly smooth except the last half whorl, which is sharply and finely striate, whorls 8 to 8½. Superior lamella well developed; subcolumellar lamella emerging.

Length 9.5, diam. 2.3 mm.
" 8.5 " 2 "

Heda, Kunchan. Types No. 90,021, A. N. S. P., from No. 1,343 of Mr. Hirase's collection.

Clausilia hyperoptyx Pils.

Specimens from Heanza-jima, Kunchan, are smaller than the types, 8 to 9 mm. long. They have the upper palatal plica rather long.

A series from Sezoko-jima, Kunchan, consists in part of typical *hyperoptyx,* in part of densely striate specimens which would be referable to *yaeyamensis,* from which they differ only in the slightly finer striation.

The study of these specimens causes me to reduce *C. yaeyamensis* to a variety of *C. hyperoptyx.* It differs only in the striation, and in showing the inferior lamella somewhat more conspicuously as a thin fold, in an oblique view in the mouth. In *hyperoptyx* this lamella recedes more. The superior and spiral lamellæ are weakly continuous (*hyperoptyx,* fold above).

Section STEREOZAPTYX Pilsbry.

Shell Zaptychoid, with the inferior lamella strongly spiral within, thick at its base, which recedes more or less; spiral lamella weak and low; lunella well developed; a nodular fulcrum present; sutural plicæ weak or absent. Clausilium well curved, wide above, strongly tapering to the angular or narrowly rounded apex, abruptly excised on the columellar side at the origin of the filament.

This section differs from *Parazaptyx* and *Metazaptyx* in the calloused columellar or inferior lamella, which in both of the others is thin and high. It further differs from *Parazaptyx* in lacking a transverse rib on the clausilium, and from *Metazaptyx* by the strongly tapering distal end of the clausilium; that of *Metazaptyx* being wide distally. In the species now known the superior and spiral lamellæ are not continuous.

Clausilia entospira Pils. Pl. XXXII, fig. 9.

Proc. Acad. Nat. Sci. Phila., 1901, p. 645.

A figure is here given to show the internal structure, and especially the fulcrum (*f.*), which was overlooked when I first described the species. It has been found only on Tanega-shima. Additional specimens received agree with the types. It is a rare snail (*entospira,* spiral within).

Clausilia exulans n. sp. Pl. XXXIV, figs. 40, 41, 42.

Shell fusiform, the spire attenuated above, rather thin, glossy, yellowish or brownish corneous, somewhat transparent except when old. Whorls 9 to 9½, the earlier, attenuated ones quite convex, the larger later ones less so, the last whorl tapering, laterally flattened, shortly free in front. Surface weakly striatulate, the last whorl becoming strongly evenly striate on the back, rounded below. Aperture small, piriform-ovate, the peristome expanded and reflexed, rather thin. Superior lamella small, short and thin, broadly separated from the small, low and short spiral lamella. Inferior lamella deeply receding, appearing as a doubly nodular fold in an oblique view in the mouth. Inside it is strongly spiral, low, thin, with a callous nodule below; above it becomes strong and high; not continued parallel to the spiral lamella, and therefore not nearly so deeply penetrating. The subcolumellar lamella emerges. There is a nodule-like fulcrum. Principal plica about a half whorl long, extending from the middle of the dorsal to the middle of the ventral side. Upper palatal plica small and short. Lunella very strong and high, *subventral,* slightly arcuate. There is a small sutural plica.

Length 11.7, diam. 2.25, length of aperture 2.25 mm.
" 10, " 2 mm.
" 11, " 2.3 "

Clausilium (Pl. XXXIV, figs. 40, 41) strongly arcuate, deeply and abruptly excised on the columellar side of the filament; wide above, strongly tapering to the apex, which though narrow is rounded. The palatal side is dilated near the filament. The filament is deeply inserted in the middle of the penultimate whorl.

Nase, Ōshima, Ōsumi. Types No. 89,888, A. N. S. P., from No. 1,335 of Mr. Hirase's collection.

This form is closely related to *C. entospira* of Tanega-shima. It is a more lengthened, slenderer shell than that, with more whorls; it is much thinner, and there is a weak upper palatal plica, not present in the other; finally, the aperture projects farther forward.

Section OLIGOZAPTYX Pilsbry.

Clausilia hedleyi hyperodonta n. subsp.

Similar to *C. hedleyi,* but it differs in having a superior lamella distinctly developed. Varying in size from

Length 9.5, diam. 2 mm., to
" 7.5, " 1.7 "

Koniya, Ōshima. Types No. 90,019, A. N. S. P., from No. 1,202*a* of Mr. Hirase's collection.

Section SELENOPTYX nov.

Shell with the oblique ventral lunella and the upper palatal plica united into a continuous crescentic barrier, the convex side of the crescent inward and upward; otherwise like *Hemizaptyx.* Clausilium excised on the columellar side at the filament. Palatal border reflexed, the lower half more or less excised. Type *C. noviluna.*

This group is unlike any other in palatal armature, the inner end of the upper palatal plica passing directly into the oblique lunella, forming a crescent which may be somewhat angular in the middle. This is ventrally or latero-ventrally situated, and except in old, opaque shells is visible through the front of the shell. The inferior lamella is remote from the superior, not visible in a front view, vertical within, with a bend to the left in the middle. The clausilium is peculiar.

Clausilia noviluna n. sp. Pl. XXXIV, figs. 34–39.

Shell fusiform, attenuate above. Whorls about 10½, the upper ones convex, the last flattened laterally. Surface glossy, brown, *densely and very finely striate throughout,* the striation not coarser on the last whorl. Aperature rhombic-ovate, the peristome expanded, thick. The superior lamella is slightly oblique, thin and rather high, marginal, continuous with the spiral lamella which is very low within the back, but high ventrally, penetrating past the aperture. The inferior lamella recedes deeply, is flattened and ascends vertically within the back, then bends abruptly to the left, and finally ascends again. It is not continued parallel to the spiral lamella. The subcolumellar lamella emerges. It is weak throughout. The principal plica is more than a half whorl long, dorsal and lateral extending nearly to the aperture. The upper palatal plica is of moderate length, inwardly continuous with the obliquely descending lunella, which is latero-ventral in position. There are no accessory lamellæ or plicæ.

Length 10.7, diam. 2.8 mm.
" 8.5 " 2.3 "

The clausilium (Pl. XXXIV, figs. 34, 35, 36) is abruptly excised on the columellar side of the filament. In the middle of the palatal margin there is a backwardly projecting point or angle of the recurved margin, below which the edge is notched and irregular.

Iheya-jima, Ryukyu. Types No. 90,046, A. N. S. P., from No. 1,356 of Mr. Hirase's collection.

This curious little snail is related to the following species, having the same kind of palatal plica and lunella, completely united into a single curved barrier (*noviluna,* new moon, in allusion to the narrow, curved lunella).

Clausilia inversiluna n. sp. Pl. XXXIV, figs. 43, 44.

Shell fusiform, the lower half rather obese, the spire rapidly tapering, and strongly attenuated above. Whorls 9 to 10½, the upper ones quite convex, the lower less so, last whorl tapering, laterally flattened. Surface brown, shining, striatulate, the last whorl very finely and densely striate. Aperture rhombic-ovate, the peristome reflexed, thick, pale brownish. Superior lamella marginal, subvertical, becoming very low inside, where it is weakly continuous with the spiral lamella, which becomes high within the ventral side, and penetrates past the sinulus to the middle of the left side. The inferior lamella recedes deeply. Within the back it is thick and ascends vertically, then bends inward, but is not continued on the penultimate whorl parallel to the spiral lamella. The subcolumellar lamella emerges. The principal plica is three-fourths of a whorl long, extending from near the lip to a point above the sinulus. The upper palatal plica is of moderate length, and inwardly is continuous with the slightly shorter lunella, which is exactly ventral in position and descends obliquely inward, to the peristome just above the superior lamella.

Length 11.8, diam. 2.8 mm.
" 10, " 2.8 "
" 10, " 2.6 "

The clausilium (Pl. XXXIV, fig. 44) is rather wide above, excised at the origin of the filament, on the columellar side; it tapers distally to a narrow, rounded apex, near which it is concave on the palatal side. Both sides are rolled back.

Kumejima, Ryukyu. Types No. 90,045, A. N. S. P., from No. 1,359 of Mr. Hirase's collection.

This is closely related to the preceding species (*C. noviluna*), but it differs in being larger, less strongly striate, with the inferior lamella bent less abruptly within the back; the lunella is situated more deeply, and the clausilium is much less specialized, wanting the angular lobe and notch on the palatal margin, so conspicuous in *C. noviluna*. The peristome reminds one of the Formosan *C. sheridani* (*inversiluna*, moon inverted).

Section THAUMATOPTYX nov.

Clausiliæ with discontinuous peristome, the columellar and parietal walls covered with an adnate callus, the aperture therefore somewhat Bulimoid. Inferior lamella receding, vertical below, abruptly bent inward in the middle. *Upper palatal plica and lunella indistinguishably united into one extremely long, arcuate fold*, subparallel to the principal plica, but curving down at the inner end. Clausilium Zaptychoid, with an angular projection near the middle of the palatal margin. Type *C. bivincta.* (*Thaumatoptyx,* wonderful fold.)

This group is proposed for a marvellously specialized *Clausilia.* The shell is not in the least rimate, the columellar and parietal margins of the peristome being wholly adnate to the whorl, represented by a thin-edged callus spread upon the whorl. It has some resemblance to *Selenoptyx* in the deeply receding closing apparatus, the abruptly bent inferior lamella within the last whorl, the shape of the combined upper palatal plica and lunella, and in the form of the clausilium.

Clausilia bivincta n. sp. Pl. XXXIV, figs. 45, 46.

Shell slenderly fusiform, slowly tapering above to the rather large, obtuse apex; thin, yellowish-corneous, subtransparent. Surface glossy, faintly striatulate, the last whorl slightly striate behind the lip. Whorls 8 to 9, the upper ones quite convex, the penultimate whorl largest, the last whorl tapering, *constricted around the middle* as though bound in by two tightly encircling cords. Aperture irregularly piriform, the outer and basal lips expanded, narrowly reflexed, not thickened within; outer lip sinuous, being arched forward above the middle, retracted at sinulus and base. *The columellar and parietal lips are reflexed and wholly adnate,* appearing only as a whitish callus spreading upon the last whorl. The superior lamella is very small, thin and oblique, not attaining the margin, continuous with the spiral lamella, which is low within the back, but becomes high on the ventral side. It penetrates past the aperture to the middle of the left side. The inferior lamella recedes so as to be invisible from in front; within the back it ascends vertically a short distance, then turns abruptly and horizontally to the left, and then again ascends in a very wide plate to its insertion. It does not penetrate parallel to the spiral lamella. The subcolumellar lamella emerges. The principal plica is one whorl long, running from near the lip to the middle of the left side. The upper palatal plica is as long as the principal plica and subparallel to it, but it diverges somewhat forwardly, where it is visible in the mouth, and its inner end (apparently representing the lunella) diverges still more, running obliquely down to the suture, behind the posterior angle of the aperture. The principal plica and the upper palatal plica are visible through the shell, and appear like cords causing the constriction of the last whorl. There are no other palatal plicæ, but the subcolumellar lamella runs up on the palatal wall in the position of a lower palatal plica.

Length 9, diam. 1.8 mm.
" 7.3, " 1.8 "

The clausilium is rather wide and somewhat resembles that of *Clausilia noviluna.* It is excised at the filament on the columellar side, and there is a projection or point near the middle of the palatal margin. It lodges ventrally (*bivinctus,* twice bound).

Hotawa, Taiwan (Formosa). Types No. 89,894, A. N. S. P., from No. 1,405 of Mr. Hirase's collection.

This minute Clausilia is highly specialized, and is without near relatives among known forms. It is a rare species, of which only five were found. The last whorl has the appearance of being bound with two cords about the middle.

LIST OF PAPERS DESCRIBING JAPANESE CLAUSILIIDÆ COLLECTED BY MR. Y. HIRASE, 1900–1907.

1. Additions to the Japanese Land Snail Fauna—II. *Proc. A. N. S. Phila.,* 1900, pp. 443–448, Pl. XIV.
2. Additions to the Japanese Land Snail Fauna—III. *Proc. A. S. Phila.,* 1900, pp. 672–683, Pls. XXIV, XXV (1901).
3. Additions to the Japanese Land Snail Fauna—IV. *Proc. A. N. S. Phila.,* 1901, pp. 465–485, Pls. XXV–XXVIII.
4. Additions to the Japanese Land Snail Fauna—V. *Proc. A. N. S. Phila.,* 1901, pp. 622–646, Pls. XXXV–XXXIX (1902).
5. The Land Mollusks of the Loo Choo Islands: Clausiliidæ. *Proc. A. N. S. Phila.,* 1901, pp. 409–424, Pls. XXII, XXIII.
6. Catalogue of the Clausiliidæ of the Japanese Empire. *Proc. A. N. S. Phila.,* 1901, pp. 647–656 (1902).
7. Additions to the Japanese Land Snail Fauna—VI. *Proc. A. N. S. Phila.,* 1902, pp. 360–382, Pls. XVII–XXI.
8. Additions to the Japanese Land Snail Fauna—VII. *Proc. A. N. S. Phila.,* 1902, pp. 517–533, Pls. XXVII, XXVIII.
9. Additions to the Japanese Land Snail Fauna—VIII. *Proc. A. N. S. Phila.,* 1903, pp. 315–319, Pl. XIV.
10. New Clausiliidæ of the Japanese Empire—X. *Proc. A. N. S. Phila.,* 1904, pp. 809–838, Pls. LII–LVII (1905).
11. New Clausiliidæ of the Japanese Empire—XI. *Proc. A. N. S. Phila.,* 1907, pp. 479–513, Pl. XXXII–XXXIV (1908).

EXPLANATION OF PLATES XXXII, XXXIII, XXXIV.

PLATE XXXII.—Figs. 1–4.—*Clausilia inclyta* n. sp.
Figs. 5–8.—*Clausilia koniyaensis* n. sp.
Fig. 9.—*Clausilia entospira* Pils., broken to show interior of last whorl; f, fulcrum. A. N. S., No. 84,898.
Fig. 10.—*Clausilia hyperaptyx* Pils. Palatal view of the clausilium.
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THE EARLY DEVELOPMENT OF A POLYCLAD, PLANOCERA INQUILINA Wh.

BY FRANK M. SURFACE.

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It gives me great pleasure to express my deep indebtedness to Prof. E. G. Conklin for his many suggestions and kind encouragement throughout this and other work. I also wish to acknowledge the many favors I have received from the University of Pennsylvania by which this work was made possible. My thanks are also tendered to the donor of the University of Pennsylvania room at the Marine Biological Laboratory at Woods Holl during the summer of 1906.

INTRODUCTION.

Our knowledge of the development of the polyclad worms is based chiefly on the admirable works of Arnold Lang. In his extensive monograph of this class of the Turbellaria, published in 1884, Lang has not only summarized the results of all previous investigators, but has himself added very materially to our knowledge of their embryology.

Previous students of polyclad embryology have shown the undoubtedly spiral nature of the cleavage up until a late stage of segmentation. In this respect the development of these platodes corresponds closely with the cleavage of annelidan and molluscan eggs. Wilson (92) says (p. 439): "Up to a late stage in the spiral period (twenty-eight cells) every individual blastomere and every cell division is represented by a corresponding blastomere and a corresponding cell division in the embryo of the polyclad and in that of the gasteropod." The same practically may be said of the annelid.

This striking resemblance in the early ontogeny of three great groups of animals should not be without some significance. Yet, according to the accounts of these earlier investigators, the later history of the cells in the polyclad embryo differs very greatly from that of the apparently homologous cells in the annelids and mollusks. The difference is so marked that Conklin (97) has characterized it as "very great, perhaps irreconcilable." Wilson (92) has summarized this difference as follows (p. 441): "In the polyclad the first group of micromeres gives rise to the entire ectoblast, the second and third groups to the mesoblast, the macromeres to the entoblast. In the mollusk and annelid, on the other hand, the second and third groups of micromeres give rise to the ectoblast, like the first set, and the mesoderm arises subsequently."

The formation of the ectoderm from the first quartet alone and of the mesoderm from the whole of the second and third quartets has been a serious stumbling block to those embryologists who have attempted to establish cellular homologies. Wilson in a later paper (94) has cited this case as the climax in the contradictions of comparative embryology. A number of recent writers have expressed a doubt as to the correctness of Lang's interpretations. Thus Mead (97) writes (p. 289): "I am not convinced that the cells described by Lang do give rise to the mesoderm, and I believe it possible that the mesoderm of the polyclad is formed in the same manner and from exactly the same cell as in the annelids with unequal cleavage."

This was the state of affairs until 1898 when Prof. Wilson published in his paper on "Cell Lineage and Ancestral Reminiscences" some observations on a Pacific coast species of *Leptoplana*. Wilson's investigations showed that Lang was wrong in certain particulars, but did not fulfill Mead's prediction with regard to the mesoblast. Wilson found that each of the first three quartets of micromeres contributed to the formation of ectoderm, but also found that the mesoderm arose by inbudding from cells of the second quartet and possibly some from the third. Wilson's work was not a detailed study of the development, and it leaves the impression that there may be something still undiscovered in the embryology of these interesting worms. Most of Wilson's work and all of Lang's was on the living egg. Every student of embryology knows how unsatisfactory this method is for the late stages of segmentation, unless checked by properly fixed and stained material.

In view of these facts it has seemed worth while to enter into a more or less detailed account of the cell lineage of this form and gain, if possible, data to support or refute the theory of cellular homology. Besides, such data should throw some light on the phylogeny of this class of the Turbellaria.

Lang has given so complete a review of the literature on polyclad embryology previous to 1884 that it would be mere repetition to go over that in detail here. The earliest investigators were Girard (1846–1854), Vailliant (1866–1868) and Keferstein (1868). Of these the work of Keferstein was by far the best. Three other investigators had studied polyclad development previous to 1884. The first of these was Hallez (1878–1879). Hallez recognized but one quartet of micromeres. From this the ectoderm arose. The macromeres budded off four small cells at the oral pole which he believed formed the mesoderm. He described four other later buds at the oral pole which formed the wall of the gut. The work of Goette (1878–1882) and Selenka (1881) followed close on that of Hallez. Goette also observed but one quartet of micromeres in *Stylochus pillidium.* When the ectoderm had reached the equator of the egg two to four small cells were formed at the oral pole (lower endoderm). Later the large macromeres budded large cells towards the aboral pole. These cells formed the upper endoderm. From the upper and lower endoderm the wall of the alimentary canal was formed, while the large macromeres became food yolk. Goette found no mesoderm.

Selenka (1881) determined that two quartets were given off. According to him the first formed ectoderm and the second the mesoderm. Four small cells were formed at the oral pole (lower endoderm of Goette), from which he believed the entire wall of the alimentary canal was formed. He found no upper endoderm.

Lang (1884) found that three quartets of micromeres were formed. As already stated he believed the first formed the ectoderm, the second and third the mesoderm. From the large macromeres four small cells were formed at the oral pole (lower endoderm). Then each of the large macromeres (fourth quartet) budded towards the aboral pole an upper endoderm cell, as Goette had found. He derived the alimentary canal from the upper and lower endoderm cells, while the macromeres (middle endoderm) broke up into food yolk and were absorbed by the other cells. All of the last four writers found that the posterior macromere behaved differently from the other three in that it divided with its nuclear spindle lying horizontally, thus giving rise to five macromeres (fourth quartet).

Material and Methods.

The following paper is based upon the study of a species of polyclad, *Planocera inquilina*, described by Prof. Wheeler in 1894. The material was obtained at the Marine Biological Laboratory at Woods Hole, Massachusetts, during the months of July and August of 1906.

Planocera inquilina is peculiar among polyclads in that it leads an apparently parasitic life. These worms are found in the branchial chamber of the large whelk, *Sycotypus canaliculatus* Gill. As Wheeler suggests, it seems probable that they live on the excretory or waste products of this gasteropod. No evidences that they feed on the tissues of the host have been found. The adult worms were obtained in considerable abundance, averaging about three worms for every whelk opened. The adult polyclads were transferred to dishes of sea water, in which the water was changed by means of a system of balanced syphons. These syphons served to keep the water free from sand and dirt, and also prevented the overflow of the water and the escape of the worms. The animals usually laid eggs soon after being brought into the laboratory. As described by Wheeler, the eggs are laid in spiral, gelatinous capsules containing anywhere from 100 to 2,000 eggs each. Each egg is surrounded by a separate egg membrane and the whole is imbedded in the capsule material. In many cases two eggs are deposited in a single egg membrane, both of which develop normally. This is the usual way in which polyclad eggs are deposited. The tough capsule is difficult to penetrate with fixing and staining reagents. This fact no doubt is one of the chief reasons why so few embryologists have worked on polyclad development. The eggs of *Planocera inquilina* seem more favorable in this respect, and with care it is possible to get very good preparations. The egg capsules were deposited against the sides of the dishes, and it was necessary to cut them away with a scalpel.

Wheeler (94) did not succeed in getting the eggs of this species to develop under laboratory conditions. On the contrary I experienced no difficulty of this kind. Stages from the maturation to the free swimming, Müller's larvæ were obtained without difficulty. I do not know wherein my methods differed from Wheeler's. He suggested that the water in the laboratory was too warm. However I made no attempt to keep it cool, and in some cases the sun shone directly on the dishes without apparently affecting the eggs. The adult animals however would live for only a few days. After the first day they became very sluggish and their bodies began to break up in a manner similar to that described by Wheeler.

Although I studied the question a good deal, I have never been able to ascertain where the eggs of this polyclad are laid under natural conditions. The animals were laying throughout the entire summer from June to September, yet I have never found a single capsule except when deposited in my dishes. I have repeatedly searched the interior of the branchial chamber of the whelks in which adult worms were found, but to no avail. I have also examined carefully the shells of these gasteropods, both inside and out, but no evidence of egg capsules was found. I found that the worms always laid soon after being removed from the whelk to the dishes of sea water, and it is possible that this is the normal stimulus to egg deposition. If such is the case the adult animals must deposit their eggs on stones or other smooth objects on the bottom. In such a case both adult and young would have to run the risk of again finding a *Sycotypus* and entering its branchial chamber. The risk seems to be considerable, and the number of eggs deposited by an individual is perhaps hardly sufficient to warrant such an hypothesis.

The early divisions up to the forty-eight- or fifty-cell stage were followed and figured in the living egg. The eggs are rather opaque and it is difficult to be certain concerning many of the divisions. This whole portion of the cell lineage was later gone over in the stained preparations and the previous observations on the living material were verified or corrected.

Eggs were fixed in various solutions, among which were sublimate acetic both aqueous and in 95 per cent. alcohol, Gilson's mureuro-nitric, picro-sulphuric, picro-acetic, Perenney's fluid and Flemming's solution. Of these the sublimate-acetic mixtures and Gilson's fluid proved most valuable. For staining whole mounts Conklin's (02) picro-hæmatoxlyn was used. Slightly stronger hæmatoxlyn than recommended by Conklin was found better for these particular eggs. The eggs were then cleared in xylol and mounted in balsam. It was impossible on account of their small size to remove the eggs from the capsules, but it was found that they cleared better if the capsules were torn into small pieces.

In studying the cell lineage the chief difficulty experienced was in not being able to rotate the eggs under the cover glass. The eggs are not orientated in any definite direction within the capsules, and it was necessary to pick out for study those eggs which were favorably oriented. Besides it is particularly difficult to determine the lineage of certain cells if one is able to view them from one side only. The fact that the eggs could not be rotated accounts for some of the drawings being from a somewhat oblique view.

The results obtained from studying the whole mounts were checked as far as possible by the use of serial sections. It was found necessary to bleach the Flemming material with peroxide of hydrogen before sectioning. A number of stains were used for the sections, but Delafield's hæmatoxlyn, either in *toto* or on the slide, proved most useful. A combination of thionin and acid fuchsin also gave good results. There is too much yolk in these eggs to use Haidenhain's iron-alum-hæmatoxlyn to advantage.

NOMENCLATURE.

The system of nomenclature followed in the cell lineage of this paper is that used by Chabry (87), Wilson (92) and Conklin (97), with slight modifications. This system is the same as has been used by Child (1900), Treadwell (1901), Casteel (1904), Nelson (1904), and many others. For the sake of convenience the chief points are repeated here. Each of the four quadrants of the egg is denoted by one of the first four letters of the alphabet. The left quadrant is A, the anterior B, the right C, and the posterior D. The four macromeres form the basal quartet; the first group of four micromeres to be separated from these is the first quartet, and so on. A micromere is denoted by a lower case letter, while the capital letters are reserved for the corresponding macromeres. The number of the quartet to which a micromere belongs is indicated by a coefficient, while the cell generation is shown by the exponent. Of the two cells of any division of a micromere (except $4d$), the one lying nearer the animal pole is regarded as the stem cell and receives the smaller exponent. Thus $2a^1$, a cell of the second quartet in the A quadrant, will divide into $2a^{1.1}$ and $2a^{1.2}$. $2a^{1.1}$ lies nearer the animal pole than $2a^{1.2}$. $2a^{1.1}$ will divide into $2a^{1.1.1}$ and $2a^{1.1.2}$. In the case of the divisions of the mesentoblast, $4d$, the lower cell is regarded as the stem cell and receives the smaller exponent (Conklin, 97).

A division is to the right, dexiotropic, if the upper cell lies to the right of the lower when viewed by an imaginary observer situated at the animal pole and facing the cell in question. If the upper cell is to the left of the lower the division is læotropic (Lillie, 95). If the spindle is horizontal, *i.e.*, the cleavage meridional, the cell to the right receives the smaller exponent.

Following Child (1900), the macromeres receive the coefficient of the quartet to which they last contributed. Thus 3*A* gave rise at its last division to 3*a*. Further details of the system will become evident by reference to the tables of cell lineage and to the figures.

The Living Egg.

The living egg of *Planocera inquilina* consists of a uniformly dense mass of granules which vary only slightly in size. Between these granules is a light colored fluid substance. When the one-celled egg is strongly centrifuged for some time the yolk granules are compacted to one side and a cap of the light colored fluid, in which are only a few granules, lies at the opposite side. This cap of fluid occupies perhaps one-fourth or a little less of the entire egg. When the egg is crushed under a cover glass and examined with an immersion lens, minute bodies (microsomes?) are found in the fluid portion. These small bodies exhibit a constant "brownian" movement. When the egg is entire, however, no motion of any kind can be discerned.

The eggs of this species of Polyclad appear perfectly uniform throughout. Selenka, Goette and Lang have found that in many polyclad eggs there is a darker inner portion and a lighter outer layer to the eggs. I could make out no such differentiation in these eggs. Lang did not find this separation of substance in *Discocœlis tigrina.*

Considerable time was spent during the summer attempting to experiment on these eggs. But in all cases where the conditions were varied from the normal the egg died in a short time and no results were obtained.

All the early cleavages as well as the maturation divisions occur at intervals of about one hour. The whole development proceeds rather more rapidly than in most polyclads. At the end of the second day or at the beginning of the third the embryo is completely covered by the small ectodermal cells. Cilia soon begin to form on these and by the third day the embryo begins to slowly rotate within the capsule. During the next day or two the cilia become better developed and the embryo rotates faster and faster. The rotation takes place first in one direction and then after a short pause in another. Occasionally they cease moving for some time. The eye spots appear about the fourth day. During the fourth and fifth days a number of homogeneous yolk spherules can be seen inside the embryo. By the end of the fifth day the ciliated processes characteristic of the Müller's larvæ begin to appear and the embryo exhibits frequent contractions of its body. On the sixth day the larvæ begin to burst through the egg membranes and to swim about as typical Müller's larvæ. I did not succeed in keeping these larvæ more than two or three days, during which time they seemed to undergo but little change.

GENERAL ACCOUNT OF THE EMBRYOLOGY.

Following the example of many writers on embryology, it seems that the later detailed account can be made briefer and more readily understood if it is prefaced by a brief general sketch of the development. The segmentation of the egg is total and slightly unequal. From the first two divisions four cells result, of which one, the posterior, is slightly the largest. Three quartets of micromeres are then given off in alternating dexiotropic and læotropic directions. The large cells of the basal quartet then bud off at their lower, vegatative pole four very small cells, which are to be regarded as the macromeres. The large upper cells of this division form the fourth quartet. The large posterior cell of this quartet, *4d*, behaves very differently in its future divisions from the other three. We may designate this cell as the "mesentoblast," following Conklin's nomenclature. At the stage with forty-four cells this mesentoblast buds into the interior of the egg a large cell, $4d^2$. Both of the mesentoblast cells then divide. In these divisions the nuclear spindles lie horizontally. From the lower pair of cells the greater part of the alimentary canal is derived. The upper pair probably contribute a small amount to the alimentary canal, while the larger portion goes to form the mesoderm of the body.

In the later development the chief axis of the egg, *i.e.*, the axis from the animal to the vegetative pole, becomes bent, so that the animal pole comes to lie at the anterior end of the embryo.

From the first quartet arises the ectoderm, covering the anterior and dorsal portions of the body. From cells of this quartet four strings of cells bud into the interior of the embryo and form the ganglion. The eyes arise in ectodermal cells of this quartet. The second quartet gives rise to the larger portion of the ectoderm on the ventral and posterior regions of the body. From cells of this quartet is formed most of the ectodermal pharynx. A portion of the second quartet is budded into the embryo and forms mesoderm. From this source arises probably only that mesoderm found around the blastopore and which is later concerned in the structures of the pharynx.

The third quartet consists of small cells from which apparently only ectoderm is derived. The individual divisions of these cells have not been traced very far, but there is every reason to believe that they form ectoderm only.

The history of the fourth quartet is peculiar. As already stated, the posterior cell *4d* is the mesentoblast, from which the alimentary canal and a portion of the mesoderm arises. The other three cells of the fourth quartet, *4a, 4b* and *4c*, do not divide as long as their history can be traced. They, however, break up into a large number of homogeneous yolk spheres which are absorbed by the endoderm cells. The large nuclei of these three cells can be traced until the alimentary canal is partly formed.

The nuclei of the small macromeres show evidences of degeneration. These do not divide as long as they can be followed. They are carried into the embryo by the pharyngeal invagination of ectoderm, and it seems probable that they degenerate without giving rise to any morphological structure.

THE UNSEGMENTED EGG.

The unsegmented egg of *Planocera inquilina* is nearly spherical in shape and measures about one-tenth of a millimeter in diameter. In many cases, however, the eggs are pressed out of their normal shape by crowding within the capsule. The eggs when laid possess a large germinal vesicle which lies slightly to one side of the centre (fig. 1). This statement is not remarkable in itself, were it not for the fact that the eggs in the uterus of the adult possess a well-developed spindle with equatorial plate, centrosomes, etc. Apparently this spindle never goes farther than the equatorial plate stage and then degenerates so that the egg when deposited possesses a germinal vesicle. This phenomenon was first observed in certain polyclad eggs by Selenka (81*d*), and later Wheeler (94) has recorded it for this species. Gardiner (99) has studied this phenomenon in *Polychærus caudatus* and concludes that the uterine spindle is due to abnormal conditions of the adult. I have not attempted to study this phenomenon in detail, but a casual survey shows that in animals which were fixed as soon as possible after removal from the whelk this uterine spindle was well developed. Since other animals from these same lots laid eggs which developed normally, one must conclude that if it is not a normal phenomenon it at least does not interfere with the later development. Selenka (81*d*) suggests that this spindle is of use in bringing the yolk granules to the centre of the egg, but, as Wheeler has noted, such could hardly be the case here, since the distribution of the yolk granules is uniform throughout the egg.

Wheeler (94) has stated that the impregnation is probably what Whitman (91) has called "hypodermic." I have several times observed animals apparently in copulation. In this act the two animals remain in contact for some time and move about together. Most frequently the ventral sides of the animals were in contact. Fertilization is necessarily internal, although the means by which the sperm reach the eggs is not known.

Two maturation divisions occur after the egg is deposited. The first occurs about one hour after deposition and the second about one hour later. At each of these divisions the egg goes through some of the most remarkable contortions (fig. 2). The egg becomes very irregular, and processes occur from all sides. These processes consist of the more fluid substance and contain few yolk granules. In many cases parts of the egg are cut off entirely. In one case observed, the egg was actually cut into two, so that I first mistook it for a two-cell stage, but later these parts fused and it then underwent normal development. In some cases minute pieces seem to be cut off which do not fuse with the egg, for some time at least, but continue to float about between it and the egg membrane.

The movement of the egg substance is very slow. It takes about twenty minutes for an egg to pass through such a contortion and regain its normal spherical shape. The phenomenon is the same at each of the two maturation divisions. Similar phenomena have been observed by Hallez (79), Goette (82) and Selenka (81) in other polyclad eggs. Such amœboid movements are also quite common in the eggs of other animals, especially annelids.

THE FIRST CLEAVAGE.

About one hour after the second maturation division the first cleavage furrow makes its appearance. The spindle for the first cleavage lies near the centre of the egg. The first two blastomeres are not of equal size, although the difference is slight (fig. 4). In order to make certain that there is a recognizable difference, I have made a number of camera drawings both of living and stained eggs. In all cases where it was not evident that the egg was pressed out of shape in its membrane the difference in size is quite easily recognized.

According to Lang (84) this difference in size of the first two blastomeres is very constant in polyclads. Lang says (p. 330): "Ich habe diese allerdings wenig auffallende Verschiedenheit in der Grösse der zwei ersten Blastomeren, die Selenka bei Thysanozoon und Eurylepta constatirte, nicht nur bei *Discocelis tigrina*, sondern auch bei allen Pseudoceriden und Eurylepta nachweisen können. Ich glaube, dass sie auch bei allen Leptoplaniden existirt, obschon sie hier schwer nachweisbar ist."

Since the polar bodies do not remain attached to the animal pole, I have been unable to ascertain whether there is a rotation of the spheres, indicating that the first cleavage is spiral, as Conklin (97) has shown for *Crepidula*. With the separation of the two cells their outlines become more or less irregular. Especially along their line of contact delicate protoplasmic processes extend outward. This is very much less marked than in the case of the maturation divisions, but there seems little doubt but that it is due to the same internal causes, whatever those may be. The same phenomenon may also be observed in several of the next succeeding cleavages, *i.e.*, at the four- or even eight-cell stage. But with each successive cleavage the processes are smaller and more delicate and the phenomenon less marked.

The Second Cleavage—Two to Four Cells.

A little less than an hour after the first two cells have separated a furrow appears in each. These furrows often appear simultaneously, but in many cases one cell begins to divide in advance of the other. Lang finds that in *Discocœlis* this is always the larger. "Die Theilung erfolgt aber nicht ganz gleichzeitig, die grössere Furchungskugel theilt sich vielmehr etwas früher als die kleinere." In *Planocera* this succession is not so marked as in *Discocœlis*. In many cases the two spindles are in the same phase at the same time.

The cells resulting from this second cleavage are much more unequal in size than those of the first division. Each of the two cells buds off a smaller cell in a læotropic direction (Pl. XXXV, figs. 5 and 6). As Lang has found in *Discocœlis*, the two spindles of this division cross at an angle. Viewed from the side these spindles form an X (fig. 5). It thus happens that the two smaller cells lie at a higher level than the two larger. The former tend to meet in a point at the animal pole (fig. 6). Before the next division they move downwards a short distance, so that a portion of the first furrow is visible between them and forms a short polar furrow. Viewed from the vegetative pole the two larger blastomeres always meet in a line the so-called vegetative polar furrow ("Brechungslinie," Rauber (82), or "Querfurche," Rabl (79)). As in the case of all dextral mollusks and in annelids, this polar furrow turns to the right when viewed in the plane of the first cleavage.

The two smaller blastomeres, *A* and *C*, are approximately equal in size (fig. 6), while of the remaining two, one is significantly larger than the other. The larger of these, *i.e.*, the largest of the four cells, is the one denoted by *D*, and lies on the posterior side of the egg. The next largest cell, *B*, is anterior, while the two smaller cells, *A* and *C*, are lateral in position. It thus happens that the larger of the two blastomeres in the two-cell stage gives rise to the posterior and right blastomeres, *D* and *C*, while the smaller forms the anterior and left blastomeres, *B* and *A*. Thus the first cleavage separates the posterior and right sides from the anterior and left.

Third Cleavage—Four to Eight Cells.

The third cleavage is strongly dexiotropic. The resulting cells, 1*a*, 1*b*, 1*c* and 1*d*, come to lie, when completely separated, in the furrows between the macromeres (fig. 8). They retain this position only until after the next cleavage. As has been found in the case of other spirally cleaving eggs, the resulting position of the blastomeres here is not due to surface tension alone. The spindles from the moment of the breaking of the nuclear membranes indicate clearly the direction the cleavage is to take (comp. fig. 12). It is thus a phenomenon inherent in the cell structure, although surface tension no doubt plays a part in giving the blastomeres their final position.

The divisions of the four blastomeres do not usually take place synchronously. Lang gives the following rhythm for *Discocœlis*. The largest cell (*D*) divides first, next the anterior large cell (*B*), and after these have divided the lateral cells *A* and *C* divide at about the same time. In *Planocera inquilina* as a greneral rule the same rhythm holds true, although there are often exceptions to it. The spindles are usually present in all four of the cells at the same time, but those of the two larger cells are nearly always more advanced. The fact that in the great majority of cases this rhythm holds true is exceedingly interesting. Lang (84) was the first to point out that there was such a constant rhythm in the divisions of embryonic cells. Lang found that not only did this succession hold good for divisions of the blastomeres where there is an actual difference in size, but also that the descendants of these cells divided in the same order (see quotation p. 526).

Since that time many other observers have found a more or less similar and constant rhythm in various animals, *e.g.*, Lillie (95) in *Unio*, Jennings (96) in *Asplanchna*, Child (00) in *Arenicola*, and Nelson (04) in *Dinophilus*. In *Unio*, *Arenicola* and *Dinophilus* the order is *D*, *C*, *A*, *B*; in *Asplanchna* it is *D*, *C*, *B*, *A*; while in *Discocœlis* and

Planocera it is *D, B* (*A, C*), the latter two cells dividing at about the same time. It is evident that this is correlated with the larger size of certain blastomeres. It is thus in contradiction to Balfour's (80) law, that a greater amount of yolk retards the rapidity of cleavage. Kofoid (94) has suggested that this difference in rapidity of cleavage is due to the greater absolute amount of protoplasm in the larger cells.

In general this rhythm can be recognized for six or seven cleavages in *Planocera*, although, as stated, there are often exceptions to it.

The cells of the first quartet are only slightly smaller than the cells of the basal quartet (fig. 8). The inequality, while sufficient to be easily recognized, is not so great in this species as in *Discocœlis* and most other polyclads. Girard (54) has described the cleavage of *Planocera elliptica* as total and equal. In all others so far as known it is unequal. All the cells of the first quartet are approximately equal in size (fig. 8), notwithstanding the inequality of the cells from which they arose. Of these cells in *Discocœlis* Lang says (p. 331): "Anscheinend sind die vier Ur-Ectodermzellen [first quartet] gleich gross; es ist aber sehr leicht möglich, dass sie in Wirklichkeit ähnliche Grössenunterschiede zeigen, wie die vier grossen Blastomeren . . . . weil sie bei ihren weiteren Theilungen ganz genau demselben Rhythmus folgen, wie die vier grossen Blastomeren."

Fourth Cleavage—Eight to Sixteen Cells.

The next cleavage is initiated by the division of the largest of the macromeres, 1*D*. This division is followed very closely by the cleavage of 1*B* (Pl. XXXVI, fig. 9). Before the daughter cells 2*d* and 2*b* have been completely separated spindles appear in the two lateral cells 1*A* and 1*C*. The formation of this second quartet takes place in a læotropic direction (fig. 9). By the separation of these cells, the cells of the first quartet are pushed towards the left, thus in the opposite direction from which they were given off. While the macromeres are dividing the first quartet begins to divide, also in a læotropic direction (fig. 9). These cells divide very nearly synchronously, but in very nearly all cases the spindle of the posterior cell 1*d* is further advanced than that of the others (fig. 9). The result of this division of the first quartet is eight cells very nearly equal in size (fig. 10). When the divisions are completed the upper or apical cells have rotated almost 45 degrees to the left, so that they now occupy a position very nearly over their respective macromeres (comp. fig. 12). They would no doubt occupy such a position were it not for the inequality of the macromeres, which becomes more marked with the separation of each quartet. The distal cells of this division, viz., $1a^2$, $1b^2$, $1c^2$ and $1d^2$, correspond in their method and time of origin to the "Trochoblasts" of annelids (Wilson, ·92) or the "Turret cells" of mollusks (Conklin, 97). Their future divisions correspond more closely perhaps to the trochoblasts. Since, however, no structure directly homologous with the prototroch is recognizable in the polyclad larvæ, we cannot say that these cells are homologous with those of annelids.

The cells of the second quartet are slightly smaller than the original cells of the first quartet.

FIFTH CLEAVAGE—SIXTEEN TO THIRTY-TWO CELLS.

In the next cleavage each of the sixteen cells divides so that the ideal thirty-two-cell stage is realized. Again the cells of the posterior quadrant *D* divide slightly in advance of the others. The first cell to divide is the large macromere *2D*, which sends off in a dexiotropic direction a small cell *3d*; *3b* of the anterior quadrant is next separated off. The other two cells of the third quartet may not come off until after the cells of the first and second quartets have divided (fig. 14).

The cells *2d* and *2b* begin to divide shortly after the furrows for *3d* and *3b* are formed. The divisions of the second quartet are nearly meridional, but, as Pl. XXXVII, figs. 16 and 19 show, the right cell is slightly higher than the left, so that the division is dexiotropic. The lower distal cells, $2a^2$–$2d^2$, are the larger (fig. 16). Before this division has proceeded far the apical or stem cells of the first quartet divide in a dexiotropic manner (fig. 12). The distal cells, $1a^{1.2}$–$1d^{1.2}$, are somewhat smaller than the remaining apical cells (fig. 13). The former lie in the angles between the latter, and the cells $1a^2$–$1d^2$ are pushed out until they lie opposite the ends of the apical cells. By this time the other two cells of the third quartet, *3a* and *3c*, have usually been constricted off (fig. 14). Next the remaining cells of the first quartet, $1a^2$–$1d^2$ (trochoblasts), divide in a dexiotropic manner. In this case the lower distal cells, $1a^{2.2}$–$1d^{2.2}$, are somewhat smaller than their stem cells (fig. 13).

At this stage the cells of the third quartet, *3a*–*3d*, are the smallest cells present. The formation of this third quartet in polyclad eggs was first observed by Lang, the older workers having overlooked it. Lang calls this quartet the primitive mesoderm of the second order.

The thirty-two cells are distributed as follows:

First quartet,	16	cells.
Second quartet,	8	“
Third quartet,	4	“
Basal quartet,	4	“
	—	“
	32	“

From the above it is noticeable that the cells of the first quartet show a tendency towards rapid division. In a number of mollusks, *e.g.*, *Neritina* (Blochman, 81), *Unio* (Lillie, 95), *Crepidula* (Conklin, 97) and *Fiona* (Casteel, 04), the first quartet has divided only once before the third quartet is formed. In *Umbrella* (Heymens, 93) and *Urosalpinx* (Conklin, 91) the first quartet does not divide at all until after the third is formed. On the other hand, in the polyclads so far studied (Lang, 84), in *Neries* (Wilson, 92), *Limax* (Kofoid, 94), and in *Dinophilus* (Nelson, 04), the first quartet divides twice before or at the time the third is forming. As Conklin (97) has pointed out, this indicates the general rate of development of the upper hemisphere. In *Planocera* this is exceedingly rapid as its further history will show.

Formation of the Fourth Quartet—Thirty-two to Forty Cells.

After the thirty-two-cell stage the divisions become more or less irregular; certain cells divide several times before others divide at all. After the completion of the thirty-two-cell stage the next cells to divide are the large basal quartet cells, $3D$ and $3B$. The nuclei of these cells have moved from the upper to the lower edge of cells, and when the spindle forms it reaches from the centre of the cell downward to its lower margin (figs. 15 and 16). These spindles are very nearly radial in position. Concerning them in *Discocœlis* Lang says (p. 335): “Nur sehr schwach ist die Abschnürung in der Richtung einer rechts gewundenen Spirale (wenn wir das Ei so orientiren, dass der orale Pol unten, der aborale oben liegt, und der Beobachter in der Achse des Eies steht) angedeutet.” By comparing figs. 20 (Pl. XXXVII), 25 and 26 (Pl. XXXVIII) and 30 (Pl. XXXIX), it will be seen that the small macromeres show a twisting towards the left as seen from below, thus showing that the fourth quartet arose by dexiotropic cleavage. As may be seen from the spindles in fig. 15, the turning of the spindle itself is very slight indeed.

As figs. 20, 25, 26 and 30 show, these lower cells are very small compared to the cells from which they arose. Wilson (98) has designated these small cells the macromeres, and the large cells from which they arose the fourth quartet. As will become evident later on, I have additional evidence which points to this as the true interpretation. Although the name "macromere" is evidently a misnomer in this case, it nevertheless seems well to retain the name for these small cells. Wilson (98, p. 21) calls attention to the fact that these macromeres "are relatively not very much smaller than in some of the mollusks," for example *Planorbis* (Rabl, 80). Judging from the figures, however, the relative size of the cells varies considerably in different species of polyclads. In *Planocera inquilina* these cells are relatively very small as compared to the fourth quartet.

Hallez (79) first interpreted these small cells at the oral pole (macromeres) as mesoderm. Selenka in his earlier work called them pharyngeal cells, and in his later papers primitive endoderm cells. Goette (82) and Lang (84) designate them as lower endoderm, and believe that they give rise to part of the alimentary canal. These four cells form one of the chief landmarks up until a very late stage of segmentation. At a time when the ectoderm is well established in a layer, and just before it begins to invaginate at the lower pole to form the pharynx, one can still make out these four cells. Up until this time they have not divided. Their later history is exceedingly difficult to follow. I am inclined to the view that these cells do not take part in the formation of any structures in the embryo of *Planocera*, but that they degenerate and that their substance is absorbed by the endoderm cells. The reasons for this view are, first, that they cannot be traced to any organ, and, secondly, that the nuclei of these cells from the time of their formation until the last trace that can be found of them show increasing evidence of degeneration. Soon after these cells are formed it can be seen that the chromatin is massed on one side of the nucleus in a dark staining mass (figs. 17 and 20, Pl. XXXVII, and fig. 25, Pl. XXXVII, etc.). It is this marked evidence of degenerating nuclei that enables one to follow these cells even until the ectoderm has reached this pole of the egg. In the other nuclei of the egg the chromatin is more or less evenly distributed in granules often along distinct linin threads. *We thus have the remarkable and unique phenomena of the "macromeres" degenerating without giving rise to any part of the embryo.* Evidently the function of the macromeres in this case has been taken over by the cells of the fourth quartet. These latter cells, as the figures show, are by far the largest cells in the embryo and contain the great bulk of the food yolk. In fact three of these cells, *4a*, *4b* and *4c*, probably function entirely as the bearers of yolk, and if they do take part in the formation of the alimentary canal it is only a minor part. The history of the other member of the fourth quartet, *4d*, is of especial interest and will be dealt with later. From the fact that this cell gives rise to both endoderm and mesoderm we may call it the "Mesentoblast" (Conklin, 97).

HISTORY OF THE FIRST QUARTET—APICAL CELLS.

After the first two macromeres, $4B$ and $4D$, are formed and before the other two cells, $3A$ and $3C$, have divided, spindles appear in the four stem cells of the first quartet, $1a^{1.1}$–$1d^{1.1}$. The division of these cells takes place in a very marked læotropic direction. The results of this division are four very small cells, $1a^{1.1.1}$–$1d^{1.1.1}$, lying at the proximal end of the spindle or just over the animal pole, and four much larger distal cells, $1a^{1.1.2}$–$1d^{1.1.2}$. As fig. 18, Pl. XXXVII, shows, the læotropic direction of the spindle is so marked that the cell $1a^{1.1.1}$ comes to lie in front of $1d^{1.1.2}$ and $1b^{1.1.1}$ in front of $1a^{1.1.2}$ and so on, so that there is a rotation of 45 degrees.

These small cells at the animal pole have been observed by Selenka and Lang in polyclads, and designated by Selenka as the apical or crown cells (Scheitelzellen). Selenka described these cells as arising from the stem cells of the first quartet, *i.e.*, $1a^{1.1}$–$1d^{1.1}$, as I have done. Lang, on the other hand, says that they arise from the cells which alternate with these stem cells, *i.e.*, ae_3, be_3, ce_3 and de_3 of his system, or $1a^{1.2}$, $1b^{1.2}$, $1c^{1.2}$ and $1d^{1.2}$ of our system. He states that these cells $1a^{1.2}$–$1d^{1.2}$ send in processes between the stem cells, and from the ends of these processes the small apical cells arise. Lang describes this process in considerable detail, and while it is possible he is right for *Discocœlis tigrina*, I think it is very unlikely.

Lang's observations were all made on the living eggs and not checked with stained material. I first observed these divisions in the living egg of *Planocera* and came to the same conclusion as Lang, viz., that the apical cells came from the cells $1a^{1.2}$–$1d^{1.2}$. It was only later when I studied the preserved material of this stage that it became unmistakably evident that it was the stem cells $1a^{1.1}$–$1d^{1.1}$ that were dividing (fig. 18). The appearance in the living egg is very deceptive owing to the great angle through which the spindles turn and to the small size of the resulting apical cells.

These apical cells consist of a well-formed, normal-sized nucleus and a very small amount of cytoplasmic material. In the stained eggs it is only seldom that one can see anything at all of the cell boundaries. Consequently in most of the drawings only the nuclei of these cells are represented.

In their method and time of origin and in their relative size these cells correspond closely with the "apical rosette" of annelids. In *Dinophilus* (Nelson, 04) these cells arise by exactly the same division as in *Planocera.* In *Nereis* (Wilson, 92) they arise one division earlier, *i.e.*, by the division of $1a^1$–$1d^1$. In many mollusks, cells of this same lineage $1a^{1.1.1}$–$1d^{1.1.1}$ are not formed until much later in the development, *e.g.*, in *Crepidula* at the eighty-eight-cell stage, in *Fiona* at the sixty-four-cell stage, etc. The formation of these small apical cells in the polyclad embryo is an interesting and significant phenomenon, marking in another detail the close resemblance between the early cleavage of these platodes and that of annelids and mollusks. The fate of the apical rosette in the majority of annelids is the formation of an apical sense organ with an apical tuft of cilia. In *Capitella* (Eisig, 98) and *Dinophilus* (Nelson, 04) the apical plate does not bear a tuft of cilia. Conklin (97) finds that these cells form an apical sense plate in the *Crepidula veliger,* without, however, bearing a bunch of large cilia.

As to the ultimate fate of these cells in *Planocera,* I must again disagree with the previous students of polyclad embryology. Both Selenka (81) and Lang (84) state that these cells sink down and are finally covered over by the other ectoderm cells. Thus Lang (p. 337) says: "Ihre Abschnürung geschieht nicht ganz gegen den aboralen Pol zu, sondern etwas nach innen, gegen die Furchungshöhle, so dass sie, wie auch Selenka bemerkt, den Boden einer napfartigen Vertiefung am aboralen Pol bilden. . . . . Da später in der Nähe der Stelle, an der sich die Scheitelzellen gebildet haben, in besonderen Zellen des Ectoderms die Augen entstehen, so wäre es möglich, dass aus ihnen Theile des Nervensystems, vielleicht der sensorielle Theile des Gehirns (oberes Schlundganglion?) entständen." Again, I believe the deceptive conditions of the living egg have led both Selenka and Lang astray. It is true that by reason of the small size of these apical cells the surrounding cells somewhat overtower them and form a "bowl-like depression" (Pl. XXXVII, fig. 21). However I do not find, as Lang states, that by the further division of the first quartet cells the apical cells are covered over and so sink beneath the surface of the ectoderm. In focusing on an egg from the animal pole in stages shown in Pl. XXXVIII, figs. 22, 23 and 24, the first nuclei to come into view are those of the apical cells. Furthermore these cells tend to move out from the animal pole and remain on the surface (figs. 24, 29, 31). In the later stages of segmentation they cannot be definitely distinguished from other cells of the same size which come to lie near them. The further division of the ectoderm cells in this region do not show any indications of covering over these cells. I believe that these apical cells form a part of the ectodermal covering of this region of the embryo. And furthermore I believe that these are the first of a series of divisions occurring from now on in all the ectodermal cells, by which a small epithelial cell is cut off towards the exterior and a larger cell remains somewhat deeper down. It is by this kind of divisions that nearly all of the later ectodermal layer is formed. These divisions will be discussed farther on in this paper.

Whether these apical cells form a definite sense organ or not I am unable to say. It is in this region, as Lang points out, that the eyes arise and that later the tentacles of the adult appear. However, the exact fate of these cells is mere speculation, since I have found it impossible to distinguish them in the late segmentation.

Further History of First Quartet.

We have so far followed the divisions of the first quartet until it is composed of twenty cells, and to the time when there are forty cells in the embryo. The last cells to be formed were the small apical cells, $1a^{1.1.1}$–$1d^{1.1.1}$. Very soon after this the cells $1a^{1.2}$–$1d^{1.2}$ divide in a dexiotropic manner into two almost equal cells. The lower cells, $1a^{1.2.2}$–$1d^{1.2.2}$, appear slightly smaller than the upper cells (figs. 21, 22). Next, and sometimes coincident with the last division, spindles appear in the large cells $1a^{1.1.2}$–$1d^{1.1.2}$. These divide in a dexiotropic direction into two very unequal cells (figs. 22, 23). The upper cells, $1a^{1.1.2.1}$–$1d^{1.1.2.1}$, are much the smaller and lie on the surface of the egg between the cells $1a^{1.1.2.2}$–$1d^{1.1.2.2}$ (fig. 24). While this division is occurring the cells $1a^{2.1}$–$1d^{2.1}$ are dividing in a læotropic direction (figs. 22, 23). Shortly after these divisions are completed the cells $1a^{2.2}$–$1d^{2.2}$ divide dexiotropically (fig. 24). In this case the lower cells, $1a^{2.2.2}$–$1d^{2.2.2}$, form very small cells which lie on the surface of the egg (figs. 24, 27).

At this time there are thirty-six cells in the first quartet and about sixty-six cells in the entire embryo. This fact indicates clearly the very rapid development of the upper hemisphere. In *Crepidula* at the sixty-eight-cell stage there are only sixteen cells in the first quartet. In *Fiona* at a similar stage there are twenty cells in this quartet. In *Nereis* at the fifty-eight-cell stage there are thirty-two cells in the first quartet, and a similar number in *Dinophilus* at the sixty-five-cell stage.

Soon after the last division the cells $1a^{1.1.2.2}$–$1d^{1.1.2.2}$ divide again in a slightly dexiotropic direction (fig. 28). This time the distal cells, $1a^{1.1.2.2.2}$–$1d^{1.1.2.2.2}$, are the smaller and lie opposite the cells from which they have been derived (Pl. XXXIX, figs. 29, 31). At this time there are three circles of four small cells each, lying on the surface of the egg and arranged around the animal pole (figs. 29, 31). These twelve cells have been derived by three successive divisions of the large stem cells of the first quartet, $1a^{1.1}$–$1d^{1.1}$. The inner circle consists of the small apical cells already described. The middle circle consists of the cells $1a^{1.1.2.1}$–$1d^{1.1.2.1}$, which were derived next and are the largest of these twelve cells. The outer circle was derived at the last division described. At the next division of these stem cells four more small cells are cut off to the exterior.

At the same time that the last division described is occurring, the cells $1a^{1.2.1}$–$1d^{1.2.1}$ divide in a læotropic direction (fig. 28) into nearly equal moieties. With the completion of the above divisions there are forty-four cells in the first quartet, eleven in each quadrant. After a short resting period the cells $1a^{1.1.2.2.1}$–$1d^{1.1.2.2.1}$, which have been so actively dividing, prepare to divide again. This time they bud into the interior of the egg four comparatively large cells, $1a^{1.1.2.2.1.2}$–$1d^{1.1.2.2.1.2}$, the primitive ganglion cells. The outer smaller cells of this division, $1a^{1.1.2.2.1.1}$–$1d^{1.1.2.2.1.1}$, form the fourth circle of small cells about the animal pole. This is as far as I have been able to follow accurately the divisions of these cells, and it is possible that the cells here designated primitive ganglion cells may still bud one or two generations of ectoderm cells to the exterior. The four cells which are to form the ganglion divide repeatedly. Their individual divisions have not been traced, but four strings of cells can be distinguished for some time, each of which is the result of the subdivision of one of these primitive ganglion cells. These ganglion cells lie at first just above the mesoderm cells, $4d^{2.1.1}$ and $4d^{2.2.1}$, and it is extremely difficult to differentiate the later divisions of these cells.

In the divisions of this first quartet we have had a number of examples of the process already alluded to, in which a very small cell is budded to the exterior of the egg and partially covers the larger, deeper lying moiety. Other examples of this same phenomenon will be described in the history of the second quartet. The four sets of four small cells each which, beginning with the apical cells, are budded off in rapid succession from the large stem cells of the first quartet ,$1a^{1.1}$–$1d^{1.1}$, are among the more striking examples of this phenomenon. These sixteen cells (and possibly more) very nearly cover the aboral surface of the egg, and by their further divisions the ectoderm of this region is formed. Other cells of this first quartet show the same process more or less strikingly. For instance, by the divisions of $1a^{2.2}$–$1d^{2.2}$ a very small cell is cut off at the lower edge (figs. 24, 27). The same is true of the divisions of $1a^{2.1}$–$1d^{2.1}$. On the other hand the cells $1a^{1.2}$–$1d^{1.2}$ do not show such an unequal division. These latter cells have been traced accurately through only three or four divisions, but the resulting cells are all more or less equal in size and apparently will enter directly into the formation of the ectoderm. This latter process, *i.e.*, the equal division of the ectoderm cells, is much more in accord with what has been found in annelids and mollusks than is the former.

History of the Second and Third Quartets.

Just after the formation of the apical cells, and at about the time the large cells $3A$ and $3C$ are dividing, the larger cells of the second quartet, $2a^2$–$2d^2$, divide in a nearly vertical direction (fig. 17). In many cases the spindles show a slight dexiotropic turn. Since the resulting distal cells $2a^{2.2}$–$2d^{2.2}$ come to lie in the furrows between the large cells of the fourth quartet, they are somewhat shifted in position to accommodate themselves to the inequalities of these large cells.

It thus happens that after the cells are separated some may be to the right of the upper cell and others to their left. The division is always nearly radial, but is still to be considered as belonging to the series of spiral divisions.

With this we have traced the divisions of the second quartet until there are twelve cells present, three in each quadrant and all on the surface of the egg.

Just after the mesentoblast cell has divided for the first time the cells $2a^1$–$2d^1$ divide almost vertically but in a slightly læotropic direction. The lower or distal cells, $2a^{1.2}$–$2d^{1.2}$, are very much smaller than the upper ones (fig. 21). The former lie on the surface of the latter. This is another example of the cutting off of a small cell to the exterior. At about this time, sometimes before and sometimes afterwards, the small cells $2a^{2.2}$–$2d^{2.2}$, lying in the furrows between the four primary cells of the fourth quartet, divide. The direction of the nuclear spindle is nearly vertical (figs. 26, 27). The two cells seem nearly equal in size. The lower cells, $2a^{2.2.2}$–$2d^{2.2.2}$, reach almost to the upper edges of the macromeres (figs. 26, 30). The descendants of these cells are the first to reach the lower pole of the egg, and form without a doubt a considerable portion of the ectodermal pharynx.

Shortly after these two divisions the large cells of the second quartet, $2a^{2.1}$–$2d^{2.1}$, divide in a dexiotropic manner, the two cells varying only slightly in size (figs. 25, 27). At this time there are twenty-four cells in the second quartet, six in each quadrant, and about seventy-eight cells in the entire embryo. So far all the cells of this quartet lie on the surface of the egg. At the next division in this quartet however the cells $2a^{1.1}$–$2d^{1.1}$ cut off a small cell to the exterior and the major portion of the larger cell pushes inwards (figs. 30, 32), so that they become almost covered by the surrounding cells. Unfortunately I have not been able to follow the further divisions of these cells with certainty. At a later stage one finds one or two more small cells lying over these larger, deeper lying ones. For this reason I am led to suspect that these cells bud off one or two more ectoderm cells. The major portions of these four cells remain on the interior of the egg and form a portion of the mesoderm. Since these cells when first budded in are well towards the lower (oral) side of the egg, it is very probable that they form a portion of the mesoderm around the blastopore. In later stages (Pl. XL, figs. 36–39) a considerable amount of mesoderm is found in this region. This later supplies the muscles and other mesodermal structures connected with the pharynx. The other mesoderm cells found just beneath the ectoderm in these stages are derived from the divisions of $4d$, as will be described shortly.

This account of the second quartet agrees closely in its main features with that of Wilson (98) for *Leptoplana*. Wilson, however, believed that these second quartet cells, on the interior, multiplied rapidly and formed the entire mesoderm of the body. The development of the remainder of the mesoderm will be dealt with farther on, and it need only be pointed out here that this account confirms Wilson's with regard to ectoderm arising from the second quartet. In contradiction to Lang (84), who believes that the whole of the second and third quartets formed mesoderm, we find here only a relatively small portion of the second quartet budding to the interior. By far the greater bulk of this quartet is ectodermal.

With regard to the third quartet, this is in all probability entirely ectodermal. The cells of this quartet when first formed are relatively very small. These cells divide in a nearly radial direction (slightly dexiotropic) at about the seventy-four-cell stage (fig. 26). Further divisions of this quartet have not been traced accurately. At later stages, however, one or both of these cells in each quadrant have divided and all their progeny remain on the surface. There is no indication that any of these cells pass to the interior. Their small size and epithelial character indicate that they are purely ectodermal.

HISTORY OF THE FOURTH QUARTET—THE MESOBLAST.

Shortly after the apical cells are formed and the cells $2a^2$–$2d^2$ have divided once, giving a stage with forty-four cells, the mesentoblast cell, *4d*, divides, with the nuclear spindle lying in a vertical direction. By this division a single large cell is budded into the interior of the embryo and occupies most of the previous segmentation cavity (text fig. 1 and Pl. XXXVII, fig. 19). The spindle for this division is directed upwards and lies exactly in the future median longitudinal plane of the embryo. So far as one can observe it is inclined neither to the right nor the left, and the resulting cell $4d^2$ comes to lie directly over $4d^1$ (figs. 20, 25). This is thus the first division which shows a strict deviation from the spiral type. The cell $4d^2$ on the interior of the egg is about three-fourths the size of the outer cell $4d^1$. Very soon after its formation $4d^2$ divides by a horizontal division into two approximately equal moieties (figs. 24, 25 and 26). This division is strictly bilateral, the future median plane of the embryo passing between these two cells (figs. 25 and 26). Just as this division is completed the cell $4d^1$ divides parallel to the last division (fig. 26). The two cells resulting from this division are also equal in size (fig. 30).

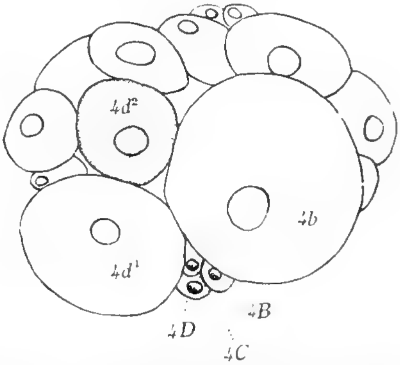


Fig. 1.—Optical section of an egg viewed from the right side. Shows the mesoblast cell, $4d^2$, just after it has been budded into the segmentation cavity (cf. fig. 19, Pl. III).

Of these three divisions of *4d* only one, the last, has been previously observed. Hallez, Selenka, Goette, Lang and Wilson have all found that this posterior cell divides in a horizontal direction into two more or less equal portions. This peculiar division of *4d*, so similar to that of annelids and mollusks, led Mead (97) to predict that it gave rise to the mesoderm. No one, however, has hitherto shown that it budded cells into the interior of the egg.

We have so far traced the divisions of *4d* until there are four cells.

Two of these, $4d^{1.1}$ and $4d^{1.2}$, are the larger and lie on the surface of the egg. These two cells are purely entoblastic and hence we may leave their future history for the present. The other two cells, $4d^{2.1}$ and $4d^{2.2}$, lie entirely concealed (figs. 26–31) and are still probably mesentoblasts. Soon after these cells are formed they again divide. This time both spindles point towards the midline of the embryo and the division is very unequal (fig. 31). Two very small cells, $4d^{2.1.1}$ and $4d^{2.2.1}$, are thus budded into the interior of the embryo and lie very near its centre. The nuclei of these cells are very small and stain very intensely. Their position is constant, always lying just posterior to the very large nucleus of *4b*, which has been crowded towards the centre of the egg. Since these small cells do not divide again for a very long time they form an excellent landmark in the later stages. In fact these two minute cells lying near the centre of the embryo can be followed until just before the pharyngeal invagination. Fig. 36,*e* shows two small cells lying just above the large mass of endoderm cells. From their position and character I believe these are the cells $4d^{2.1.1}$ and $4d^{2.2.1}$. At this time, which is immediately preceding the ectodermal invagination from the oral pole, the mesoderm cells have migrated to the sides of the embryo and lie just beneath the ectoderm. The whole centre of the egg is occupied by the homogeneous yolk spheres, in which the somewhat shrunken nucleus of *4b* can be seen. Lying just below this nucleus are these two small cells, which I believe take part in the formation of the alimentary canal. From their first appearance, the character of their nuclei (small, dense and intensely staining) indicates that their fate may be different from the other descendants of $4d^2$. They are formed and remain in exactly the path later traversed by the alimentary canal, while the other descendants of $4d^2$ move towards the periphery of the egg.

The much larger cells, $4d^{2.1.2}$ and $4d^{2.2.2}$, from which these small endoderm cells arose, are now entirely mesoblastic. After a short resting period they again divide, giving rise to two rather small cells, $4d^{2.1.2.1}$ and $4d^{2.2.2.1}$, lying above and somewhat posterior to the small entoblasts, $4d^{2.1.1}$ and $4d^{2.2.1}$ (fig. 34). The nuclei of these small mesoblasts are larger and more normal in appearance than those of the previously described entoblasts ($4d^{2.1.1}$ and $4d^{2.2.1}$). Not long after this the larger cells, $4d^{2.1.2.2}$ and $4d^{2.2.2.2}$, again divide. The spindles for this division are shown in optical section in fig. 34. Pl. XL, fig. 35, represents an optical section of an egg somewhat older than the preceding one. In this figure we are looking down nearly upon the vegetative pole of the egg. The position of the large shrunken nuclei of *4a*, *4b*, and 4*c* are shown in dotted outline. Just posterior to the nucleus of 4*b* lie the two small cells $4d^{2.1.1}$ and $4d^{2.2.1}$ with the darker staining nuclei. Just posterior to these cells are the slightly larger cells $4d^{2.1.2.1}$ and $4d^{2.2.2.1}$ mentioned above. Finally, extending dorsally and anteriorly from each of these are two cells which represent the results of the division just mentioned and for which the spindles are shown in figure 34. The resemblance to the so-called "mesoblast bands" of annelids and mollusks is, I think, evident. In many cases, however, the "band" formation is not so marked as in this egg, which was chosen for drawing on account of its regularity. In many cases the mesoblast cells do not form such evident bands. Instead the nuclear spindles in the cells $4d^{2.1.2.2}$ and $4d^{2.2.2.2}$ lie at varying angles. This is shown by the direction of the spindles in these cells in fig. 34. The result tends to be a cluster of cells rather than symmetrical bands. The lineage of these cells becomes too involved to trace further with any accuracy. They lie well towards the dorsal side of the egg, and become more or less confused with the cells which are now budding in from the first quartet to form the ganglion. Nevertheless a fairly definite group of cells can be found in this region during several of the succeeding stages. I have attempted to represent something of the

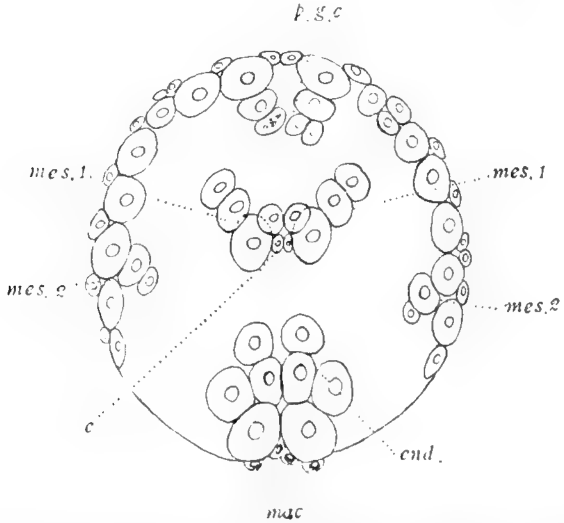


Fig. 2.—Schematic optical section of an egg viewed from the posterior side. To show the relation of the ectoderm, mesoderm and endoderm. *Mes.* 1, Mesoderm derived from $4d^2$. *Mes.* 2, Mesoderm derived from second quartet cells. *End.*, Endoderm from $4d^1$. *e*, Entoblasts from $4d^2$. *p. g. c.*, Primitive ganglion cells.

relation of these cells in the diagramatic optical section (text fig. 2). Text fig. 3 represents an actual optical section of a somewhat later stage. Here the large nuclei of 4*a*, 4*b*, and 4*c* are again shown, while lying just above them is a group of mesoderm cells derived from the division of $4d^2$. The mesoderm now consist of a large number of cells. From this time on these begin to spread out and gradually form a layer of cells lying just beneath the ectoderm.

While I have not been able to follow the exact lineage of these cells, I think there is no doubt that the greater portion of the mesoderm of the body arises from the posterior mesoblasts, while as stated before only the mesodermal structures in the region of the pharynx arise from cells of the second quartet.

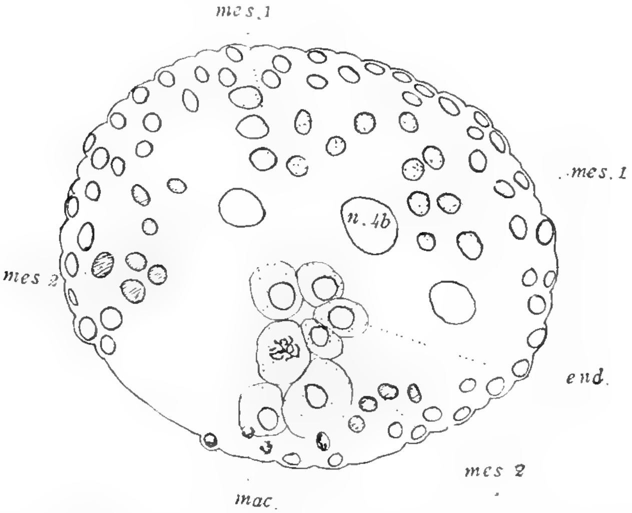


Fig. 3.—Optical section of an egg viewed from the posterior side. *end*, Group of endoderm cells derived from $4d^1$. Below these are the degenerating nuclei of the four macromeres. Near the middle of the egg are the three large nuclei of 4*a*, 4*b* and 4*c*. Above these are shown the nuclei (stipled) of a few of the mesoderm cells derived from $4d^2$, *mes.* 1. Toward the vegetative pole are mesoderm cells derived from the second quartet, *mes.* 2.

Text fig. 3 shows a number of cells lying further towards the vegetative pole than the derivatives of $4d^2$ have yet reached. These cells undoubtedly arise from the further proliferation of the second quartet cells, $2a^{1.1.2}$–$2d^{1.1.2}$, which, as we have shown (p. 535), were budded into the interior of the embryo (cf. fig. 32). These second quartet cells, $2a^{1.1.2}$–$2d^{1.1.2}$, when first formed lie considerably below the equator of the egg. With the overgrowth of the ectoderm they are carried further down to the region of the blastopore. Thus the large group of mesoderm cells found later around the pharynx arise, in large part at least, from the second quartet cells. It is, however, quite possible that some of the derivatives of $4d^2$ later wander into this region also.

We have now followed the history of the mesoderm from its origin until it forms a layer of cells about the embryo just beneath the ectoderm. We may leave the discussion and comparison with other forms until after we have traced the history of the endoderm.

The Entoblast.

The alimentary canal of the polyclads has been derived in various ways by different investigators. Vaillant (68) and Keferstein (68) observed that at the time the embryo began to rotate within its membranes there was a mass of roundish fat-like spheres on the interior. Hallez (78 and 79) observed drops of an egg-white-like substance on the inside of the embryo, surrounded by a one-cell layer of the alimentary canal. The cellular elements of the canal he derived rather doubtfully from the four small cells at the oral pole (macromeres). Selenka (81*c*) came to a similar conclusion, *i.e.*, that the entire canal arose from the four small "primitive endoderm cells" (macromeres). These were carried into the embryo by the pharyngeal invagination and rapidly spread over the large yolk cells (fourth quartet). According to this investigator these yolk cells break up without nuclear division into a large number of yolk spherules and serve as food for the developing endoderm. They give rise to no morphological structure of the embryo. Selenka (81) says that as soon as "die Nahrungsdotterzellen in ein Dutzend oder mehr ungleich grosse kernlose Kugeln zerfallen sind, beginnen die vier Ur-Entodermzellen (macromeres) ihre Theilung und Wanderung. Zunächst strecken sie sich in die Länge, entsenden Ausläufer und breiten sich auf den benachbarten Dotterkugeln aus."

Goette (82) in *Stylochus pillidium* finds, as already mentioned, upper endoderm cells. From these and from the middle endoderm cells (fourth quartet) small cells are separated, which at first contain some of the fat-like yolk. This soon disappears in these cells and they come to form a definite layer of endoderm. The small lower endoderm cells (macromeres) also take part in forming this layer. Large drops of the homogeneous yolk substance separate from the large middle endoderm cells and are gradually absorbed by the cells of the canal.

Lang (84) in *Discocælis*, it will be remembered, also finds an upper endoderm as well as a lower and a middle layer. Like Selenka, he no longer finds any nucleus in the large cells (fourth quartet) after the upper and lower endoderm have separated off. With regard to the middle endoderm cells he says, p. 356: "Die in ihnen enthaltenen groben Dotterkörner scheinen miteinander zu verschmelzen so dass die in Frage stehenden Zellen das Aussehen von beinahe homogenen, stark lichtbrechender Fettkugeln bekamen. Ich habe in diesen Kugeln bei ihrem zerfall nie Amphiaster sich bilden sehen, obschon ich aufmerksam danach gesucht habe."

The breaking up of these yolk cells is very irregular. The wall of the alimentary canal, according to Lang, is formed by the cells of the upper and lower endoderm. These increase by division and extend over the yolk spheres. Finally they unite to form a definite layer in which the cell boundaries cannot be distinguished. The endoderm cells have a more or less amœboid character and send out protoplasmic processes over the numerous yolk spheres. According to him the middle endoderm (fourth quartet) contains only yolk granules and does not take part directly in the formation of any organ.

Throughout all these accounts one or two phenomena are constant, *e.g.*, the yolk breaks up into a large number of spherules which are later absorbed by the endoderm cells. With regard to the development of the canal itself there is some variation. In all the accounts at least a portion of the canal is derived from the lower endoderm (macromeres). In some cases (*Stylochus* and *Discocœlis*) upper endoderm cells are formed from the large yolk cells.

The account which I have to offer of the development of the alimentary canal in *Planocera inquilina* differs from any of the above in several particulars. At the time when the mesoblasts, $4d^{2.1.2}$ and $4d^{2.2.2}$, are preparing to divide, the two large entoblasts, $4d^{1.1}$ and $4d^{1.2}$, are dividing (fig. 33). By this division two large cells, $4d^{1.1.2}$ and $4d^{1.2.2}$, are budded into the interior of the embryo. Soon after this these cells divide again. At a considerably later stage the two cells $4d^{1.1.1}$ and $4d^{1.2.1}$, which remained on the surface after the last division, divide again, budding two more large cells into the lower part of the embryo. At this time or shortly afterwards the ectoderm has covered this region, and all six cells and their descendants originally derived from the two primitive entoblasts, $4d^{1.1}$ and $4d^{1.2}$, are on the interior of the egg.

Text fig. 3 shows in optical section an egg of a considerably later stage, in which a number of cells are lying just above the vegetative pole. These cells, of which there are several more in the egg, all came from the primitive entoblasts, $4d^{1.1}$ and $4d^{1.2}$. By examining a large number of eggs it is found that these cells are in very active division and soon a large group of cells is found in this region (cf. fig. 36). A careful study of the eggs themselves leaves no doubt but that they all arise from the primitive entoblasts. Pl. XXXIX, fig. 33, shows the spindles for the first division of these cells. I have repeatedly found eggs showing the second and later divisions of these cells, but in every case it has been found impossible to make an intelligible drawing of the egg. The fact that these eggs cannot be rotated under the cover glass has added greatly to the labor of finding eggs suitable for study or drawing. In this case it has effectually blocked all attempts to portray a certain stage. The material itself, however, leaves no doubt that the divisions take place as described. I have attempted to embody the essential facts of these divisions in the schematic text fig. 2.

During all this time the very large nuclei of the three anterior cells of the fourth quartet, *4a*, *4b* and *4c*, can still be found (fig. 34). Previous to this time there has been some shifting of the relative positions of the fourth quartet cells. At the time the mesentoblast cell is budded into the interior (fig. 19) all the four cells of this quartet lie in nearly the same plane. The two lateral cells, *4a* and *4c*, are perhaps slightly higher than the others. When $4d^1$ divides bilaterally these two cells overlap *4a* and *4c*. With the further development of the mesentoblast on the interior of the egg and the ectoblast on the outside, the large cell *4b* is pressed upwards. A narrow process from this cell runs along the centre of the egg, and in this, reaching almost from one side of the process to the other, lies the enormous nucleus of *4b* (figs. 32 and 34). The nuclei of *4a* and *4c* are also pressed up along the sides, but not so high as that of *4b*. These three cells are closely crowded together, and while their boundaries remain distinct for some time (fig. 32) they tend to become obliterated.

In the meantime an interesting process has been going on within these cells. As has been noted by all previous students, the yolk granules tend to fuse together, thus forming homogeneous fat-like drops. As Selenka and Lang have noted, this breaking up of the yolk is not accompanied by nuclear division. The process is more or less irregular, but one or two regular features can usually be recognized. The first one of these spherules to be formed is from the anterior and ventral portion of the cell *4b*. At first the centre of these spheres is composed of granules, while around its periphery the granules dissolve into a fluid substance. Soon afterwards smaller spheres appear in this cell and in *4a* and *4c*. No nuclear division is concerned in this process, for the undivided large nuclei of all three of these cells can be followed to a much later period. In or near the centre of many of these yolk spheres a diffusely staining substance can be found when the egg is well stained and cleared. This is not a nucleus, for it has no regular boundaries and often several such bodies are seen in a single yolk spherule. They do not stain deeply, but appear as a sort of cloudy material. These bodies may be merely the small portions of cytoplasm remaining in these large cells or, what seems more likely to me, they may be of the nature of nuclear sap. If they were of a cytoplasmic nature there is no reason why they should not show in earlier stages. Instead they became evident only after the yolk begins to break up into spherules. In many respects they resemble the archiplasmic material often found around a nucleus just after the nuclear membrane has broken. Further, the large nuclei, which are at first spherical, in the late stages become irregular in shape or even very much shrunken (fig. 35). That these yolk granules should be broken up through the action of enzymes coming from the nucleus is not at variance with the modern views of nuclear activity.

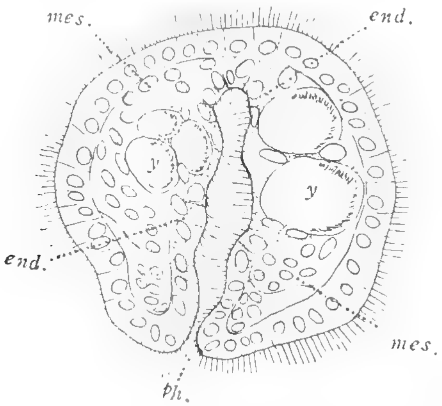


Fig. 4.—Transverse section of an embryo, showing the ciliated lumen of the alimentary canal. The endoderm cells are spreading over the yolk spheres. *end.*, endoderm; *mes.*, mesoderm; *ph.*, pharynx; *y.*, yolk.

In such a case it seems probable that this material would become aggregated at those places where the most rapid dissolving action is going on. This offers an explanation for the relatively enormous size of the nuclei of these three cells. These nuclei do not show evidences of degeneration; instead the chromatin granules can be seen scattered through the nucleus, often along distinct linin threads.

After the ectoderm has covered the lower hemisphere of the egg it begins to invaginate in the region of the four small macromeres. The ectoderm pushes in and forms a small tube, which later becomes the pharynx. Previous to this invagination the endoderm cells derived from the divisions of $4d^{1.1}$ and $4d^{1.2}$ have formed a solid mass of cells in the lower part of the embryo (fig. 36). Soon after the invagination starts, the beginning of a lumen in the endoderm cells is apparent by the separation of the cells (fig. 37). This lumen rapidly becomes large and ciliated throughout (Pl. XL, figs. 38, 39, text fig. 4). The canal is at first bent towards the posterior side of the larva (fig. 38), but with its further development and enlargement it pushes forward under the ganglion (fig. 39). Distinct cell boundaries can seldom be made out in the endodermal portions of the canal. The inner borders of these cells surround the large yolk spherules. In many cases amœboid cells can be seen spread out on the surface of these yolk spheres. In the oldest larvæ which I was able to obtain (fig. 39) the canal showed no indications of the lateral branches which become evident in the adult worm. In these larvæ some of the reduced yolk spheres are still present.

From the account I have given it will be seen that practically all of the alimentary canal is derived from the two primary entoblasts, $4d^{1.1}$ and $4d^{1.2}$. Certainly the larger portion of the canal has such an origin. There are three other possible sources of a portion of the canal, although no one of these forms any considerable amount of it. One is that the pair of small cells, $4d^{2.1.1}$ and $4d^{2.2.1}$, derived from the further division of the mesentoblast, may form a small portion of the endoderm. The chief reason for suspecting this, is that these cells are formed and remain exactly in the path of the future canal. The second possibility is that the three anterior cells of the fourth quartet, $4a$, $4b$, and $4d$, may contribute a small amount to the canal at a late period. I believe, however, that such is not the case. The shrunken nuclei of these three cells, which can be seen at the time the canal is forming (fig. 36), indicate that these cells degenerate without dividing further. That the shrunken condition of these nuclei is not a preparation for karyokinetic division is, I believe, fully established by the fact that these nuclei remain in this shrunken condition for a very long time. Their ability to take up the stain gradually becomes less and less, and the last that can be seen of them (fig. 36) shows a faint, very irregularly outlined nucleus, not at all resembling one about to divide by mitosis.

The third possibility in this connection is that the four small macromeres may, instead of degenerating, contribute a portion to the endoderm. The degenerating character of the nuclei of these cells and the very small amount of cytoplasm seems to me to preclude such a fate in *Planocera*. I cannot find or at least cannot recognize these cells after the ectoderm has overgrown the lower pole of the egg, and so I am unable to follow their later history. Text fig. 3 gives an accurate representation of the condition of the nuclei of these cells at that stage, which is about as late as I am able to follow them. These nuclei have shown this same condensed condition of the chromatin almost from the time of their formation (cf. figs. 17, 19, 20, 25, 26, 27). These cells are probably carried in with the invaginating pharynx and then absorbed by the endoderm. I have sometimes found what I thought were remains of these cells, but of this I cannot be certain.

DISCUSSION.

We may now return to a comparison of the observations of previous students with regard to the fourth quartet, and especially *4d*, in other polyclad eggs. As has been already noted (p. 536) the peculiar bilateral division of the posterior cell, *4d*, has been known since the work of Hallez (79). Hallez believed that this posterior cell divided without an amphiaster, and regarded the product as not equivalent to the other four cells, but in the nature of cell sap. Goette (82) states that in some cases the cells *4a* and *4c* of our nomenclature also divide, so that there are seven cells, on the surface of the embryo, formed from this quartet. This happened only in some of the eggs of *Stylochus* (*Stylochopis*) *pillidium*. In other eggs of the same species only the posterior cell divided. In such cases Goette found that this cell often divided twice, forming four cells, all on the surface of the egg.

Lang (84) finds that in *Discocœlis* all the cells of this fourth quartet divide at about the same time, but in different directions. The posterior cell divides horizontally as described, while each of the other three cells buds into the interior of the egg a cell which he calls upper endoderm. Lang says (p. 337): "Es treten in ihnen [fourth quartet of our system] Richtungsspindeln auf, und zwar wieder in der oft angeführten Reihenfolge. Die Richtungsspindel der grössten Stammzelle des Entoderms [*4a*] verlängert sich excentrisch in der peripherischen Verlängerung der Ebene, welche man sich durch diese Stammzelle und die Hauptachse des Eies gelegt denken kann, und welche der Medianebene entspricht." . . . . (P. 338): "Unmittelbar befor sich die grösste Entodermstammzelle [*4d*] in ihre zwei seitlichen Hälften getheilt hat, zeigen sich auch in den drei Uebrigen, Richtungsspindeln, die aber eine ganz andere Direction haben. Sie liegen nämlich parallel zur Hauptachse, d. h. sie zeigen eine dorsoventrale Richtung. Die drei erwähnten Stammzellen ziehen sich in der That gegen den aboralen Pol zu aus, und schnüren schliesslich je eine kleine Zelle ab, welche unter die Mesodermzellen [second and third quartets] zu liegen kommt." These three cells Lang calls the upper endoderm, while the five cells below he designates as the "mittler Entoderm." Goette (82) (p. 9) also states that six or seven cells are budded into the interior of the embryo of *Stylochus* as upper endoderm, but does not give further information as to their exact origin.

In *Planocera inquilina*, on the other hand, the three anterior cells of the fourth quartet, viz., 4*a*, 4*b*, and 4*c*, do not divide at this time nor for a long time afterwards, if ever. The very large nuclei of these three cells can be traced up until just before the formation of the alimentary canal (fig. 36), and at this time they have not divided. The nuclei of these cells, especially 4*b*, become exceedingly large (fig. 32) and form excellent landmarks in the later stages.

Wilson (98) finds and figures the bilateral division of 4*d*. He states that the division of this cell into equal halves is an exception to the rule, and that in about 90 per cent. of the eggs of *Leptoplana* the division is markedly unequal (cf. his fig. 6, *D*, *E* and *F*). Wilson did not follow the future division of these cells. He says (p. 22): "As regards the fate of these cells, the inequality of $4d^1$ and $4d^2$ [$4d^{1.1}$ and $4d^{1.2}$] (often very marked) is itself indirect evidence that they do not give rise to symmetrical mesoblast bands as in the higher types, and I find no evidence that either of them gives rise to mesoblast cells. Both seem to have the same fate as the other entoblast cells, with which they exactly agree in deutoplasmic structure, and enter into the formation of the archenteron, as Lang has shown in the case of *Discocœlis*."

It is peculiar that Lang should have observed cells budding into the interior of the egg from three cells of the fourth quartet and not from its other member, while I find that it is only this latter cell which divides towards the interior, or in fact the only cell of this quartet that divides at all. Lang gives figures of the spindles in the three anterior cells of the fourth quartet in *Discocœlis* and also a detailed description of these divisions. Although this work was done on living eggs, it does not seem probable that so careful an observer would be mistaken in the facts. We must conclude, then, that the three upper endoderm cells of *Discocœlis* are in fact endoderm, and that this species differs from *Planocera* in the division of the three anterior cells of the fourth quartet. We would not be surprised to find such a coenogenetic difference in different species of polyclads. *Discocœlis* perhaps shows a more primitive condition in this respect, in that cells which are to form part of the alimentary canal arise early from these three cells of the fourth quartet. In *Planocera* apparently most of the protoplasmic material has been separated from the cells 4*a*, 4*b*, and 4*c* in the previous divisions, and they now contain little more than a mass of yolk granules.

Lang, no doubt, overlooked the internal budding of the posterior cell, 4*d*, if such occurs in *Discocœlis*. This internal division of 4*d* in *Planocera* is very evident and striking. In other particulars the cleavage of *Planocera inquilina* is so similar to that of other polyclads that it is difficult to believe that this species differs so fundamentally in respect to 4*d*. As stated before, practically all the previous work on polyclad embryology has been done on the living eggs alone. Such a division as the internal budding of 4*d* might easily be overlooked in the living opaque eggs. On this basis we might well conclude that in all probability such a division was overlooked by Lang and his predecessors.

Wilson, however, who undoubtedly was on the lookout for just such a division, did not find it in *Leptoplana*. Wilson says that he does not attempt to "describe the cleavage of *Leptoplana* in detail, but only indicate its leading features." I cannot but believe that in this statement is contained the reason why Wilson did not find mesoderm arising from 4*d*. A process so evident and significant as these divisions of 4*d* in *Planocera* can scarcely be conceived of as a coenogenetic character of one or even a few species of polyclads. In annelids and mollusks the bilateral division of 4*d* and the origin of mesoderm bands from these cells is without exception in the numerous species so far studied. Both Wilson and myself have now shown that the ectoderm of polyclads is segregated in the first three quartets of micromeres, and that the second quartet gives rise to some mesoderm. This process, so exactly paralleled in mollusks and annelids, can now scarcely be doubted as constant in its main features for all polyclads. Whether such a uniformity in the origin of the mesoderm from 4*d* will be found to hold throughout these Turbellaria can only be proven by further investigations on other species. I believe that certainly the weight of evidence is in favor of this uniformity.

The resemblance in the behavior of 4*d* in the polyclads to the homologous cell in annelids and mollusks becomes only more striking as we consider the details of its divisions. It is true that in annelids and mollusks 4*d* divides into two bilateral halves before it buds cells into the interior, while in *Planocera* 4*d* first buds a single cell into the segmentation cavity and then each of the two divides bilaterally (figs. 19, 25, 26). In either case exactly the same result is reached, and the delay of the bilateral cleavage for one-cell generation can certainly be very easily accounted for as a coenogenetic modification.

Conklin (97) was the first to point out that in the gasteropod *Crepidulas* the cell 4*d* gave rise to both endoderm and mesoderm. In *Crepidula* four approximately equal cells are at first formed from 4*d*. The two lower and external are pure entoblasts. Each of the two upper cells later gives off another entoblastic cell before they give rise to the mesoblast bands. Since that time numerous observers have found that in both annelids and mollusks the cell 4*d* is mesentoblastic. Wilson (98), in the paper so often referred to above, shows that a reinvestigation of *Nereis* proves that a number of small entoblast cells are budded off from the two halves of 4*d* before these form the mesodermal bands. He also shows that a series of stages may be found in different annelids and mollusks, ranging from a single pair of minute "vestigial" entoblast cells in *Aricia* and *Spio* to *Nereis* where from six to ten small cells are budded off, and to the condition in *Crepidula* where more than half the bulk of 4*d* forms endoderm. Around these and other facts Wilson has elaborated a beautiful theory of ancestral reminiscence. To this series, agreeing very closely with *Crepidula*, we may add the polyclad *Planocera inquilina*. Here, as in *Crepidula*, the two lower superficial cells derived from 4*d* are purely entoblastic and, as has been shown, give rise to very nearly all of the alimentary canal. Two more small cells, $4d^{2.1.1}$ and $4d^{2.2.1}$, derived from the two upper cells of 4*d*, are probably added to the endoderm, while the remainder forms mesoderm. This close, almost astonishing, agreement of *Planocera* with annelids and mollusks cannot be without some significance. As Wilson (98) (p. 13) says: "If we accept Lang's view, which is supported by a large amount of evidence, that the platodes are not very far removed from the ancestral prototype of annelids and mollusks, we should expect to find in the polyclad a mode of cleavage to which that of the higher forms can in its main features be reduced."

Before Wilson's work this resemblance between polyclads and higher forms had seemed to be "only in the *form* of cleavage and not, so to speak, in its substance." I believe that now this difficulty has been entirely removed, and the polyclad cleavage not only conforms to the higher types in its "main features" but, as we have seen, in many of its details. These facts here set forth cannot but lend additional weight to the view already expressed on comparative anatomical grounds that the polyclads represent an offshoot from the same ancestral branch which later gave rise to the annelids and mollusks. On the other hand, it is a remarkable and interesting fact that phyla which must have separated from the common stock and from each other long ages ago still show such remarkable resemblances in their early ontogenies. Yet I think this is the only interpretation we can put upon the facts. With our present knowledge of "Entwickelungsmechanik" we cannot interpet these resemblances as due to external, mechanical conditions. Why the ectoblast should be segregated in three and only three quartets in polyclads, annelids, mollusks and, as Biglow (02) has shown, in some crustaceæ, and why in these same groups mesoderm should arise from the posterior or left posterior cell of the fourth quartet and from no other of this quartet, are questions which do not readily lend themselves to a mechanical explanation under our present theories. We must for the present at least regard these resemblances as facts of heredity and hence of phylogentic value.

The origin of the alimentary canal in *Planocera* is unique among animals, so far as I am aware. *The whole of the alimentary canal arises from a portion of the posterior cell of the fourth quartet, while the other three cells of this quartet and all four of the macromeres are used as food or degenerate and give rise to no morphological structure. Not one of the last seven cells mentioned ever divides after its formation at the thirty-two-cell stage.* Surprising and unique as this phenomenon may be, it does not necessarily invalidate our present conception of the development of germ layers or their organs. Since the establishment of cell-lineage work it has become well known that many embryonic cells are formed in early stages which are destined never to divide again, nor to take any further part in the organization of the embryo. Compare for example the "turret" cells of certain mollusks as *Crepidula* (Conklin, 97). As has been pointed out, it is well known that in many annelids and mollusks the cell 4*d* gives rise to a portion of the alimentary canal. In these animals however the other three cells of this quartet as well as the macromeres take part in the formation of the digestive tract. Indeed these latter cells furnish the major portion of the alimentary tissue. With these facts in mind, we must regard the condition of the macromeres and the three anterior cells of the fourth quartet in *Planocera* as reminiscent of a time when all eight of these cells took part in the formation of the alimentary tract. Thus the embryology shows that this worm is specialized in this respect and must long ago have left the track which led on to annelids and mollusks.

This peculiar development of the alimentary canal in the polyclads offers the suggestion that it may be a step toward the development of such forms as the acoelous rhabdocoeles, in which the alimentary canal is altogether absent. But the embryology of these as well as other turbellaria present such great variations from the type found in the polyclads that it is useless to speculate along this line.

SUMMARY.

The cleavage of the eggs of *Planocera inquilina* Wh. until a late stage (forty-four cells) is strictly spiral in the dextral sequence.

Three quartets of ectomeres are given off in alternating dexiotropic and læotropic directions. At the next division a fourth quartet is formed, the cells of which are of very large size and contain most of the yolk. The "macromeres" are very minute cells which remain at the vegetative pole until the closure of the blastopore. The marked degenerative character of their nuclei and the small amount of cytoplasm indicate that they degenerate without giving rise to any structure (p. 529).

At the stage with forty cells there are formed at the animal pole four small "apical" cells, which in their method and time of origin correspond closely to the cells of the same name in annelids and mollusks (p. 530).

At the forty-four-cell stage the posterior cell of the fourth quartet, *4d*, buds a single large cell into the interior of the embryo. Both of these cells, $4d^1$ and $4d^2$, next divide bilaterally (p. 536).

Of these four cells the two upper and inner give rise to a portion of the mesoderm and possibly a small part of the endoderm (p. 537). The lower pair of cells, lying on the surface of the embryo, give rise to practically all of the endodermal part of the alimentary canal (p. 541). Thus the history of this cell, *4d*, shows a remarkable resemblance to its homologue in mollusks and annelids.

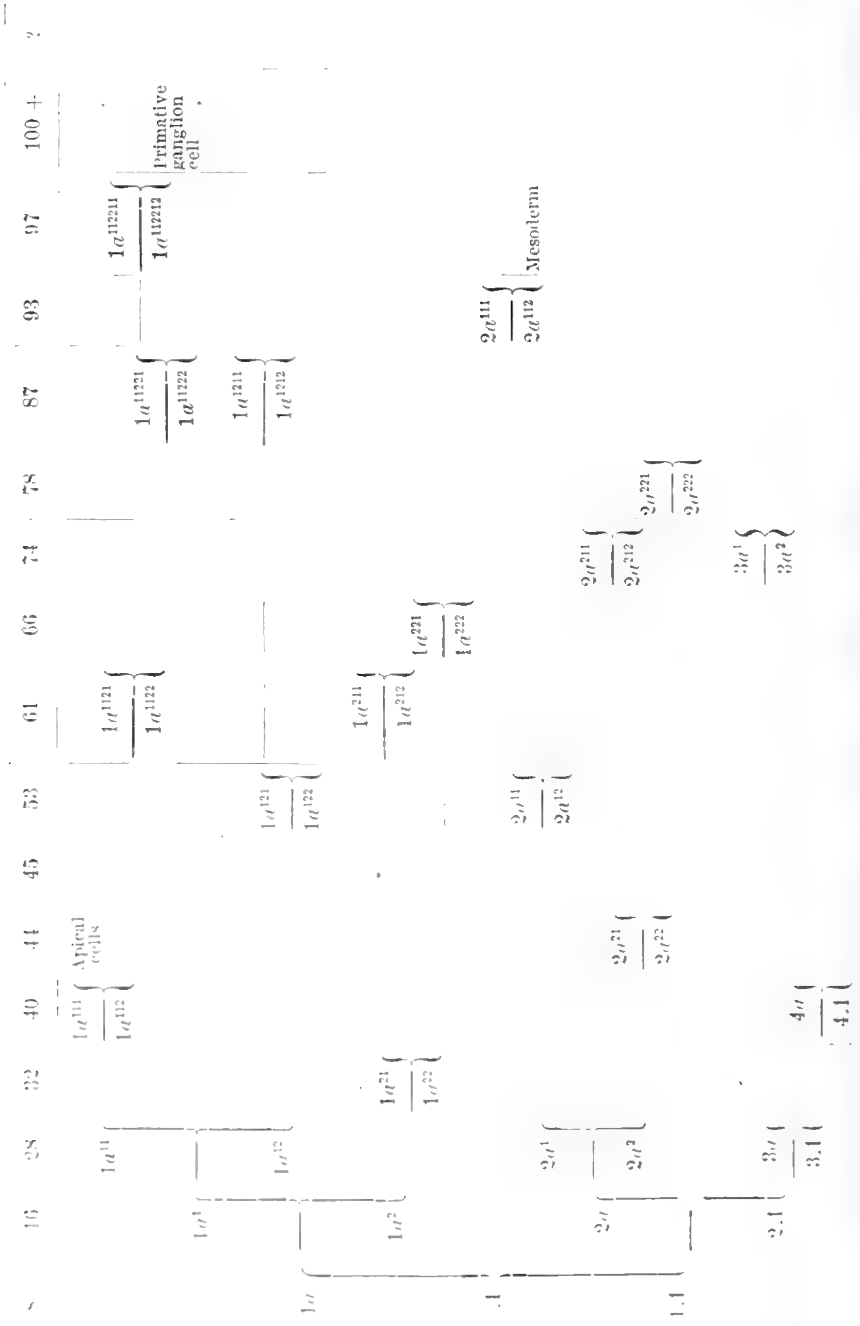
The three anterior cells of the fourth quartet, *4a*, *4b* and *4c*, seem to function only as the bearers of food yolk and apparently give rise to no morphological structure. The very large nuclei of these cells can be followed until the beginning of the pharyngeal invagination. The yolk in these cells breaks up into spherules, probably through the action of enzymes from the large nuclei. This liquified yolk is later absorbed by the endoderm cells (p. 542).

A large portion of the ectoderm is formed by the successive budding or delimination of small cells from larger, deeper lying ones (p. 533).

A portion of the mesoderm, chiefly that part lying around the pharynx, is derived from cells of the second quartet, and thus corresponds with the "secondary" mesoblast or "larval" mesenchyme of annelids and mollusks (p. 535).

In the spiral cleavage, the segregation of the ectoblast in three quartets, the formation of a large part of the mesoderm from *4d*, the formation of the apical cells, and in many other details the development of these platodes corresponds to that of annelids and mollusks. These facts must tend to confirm the view that in their early history these platodes were closely related to the two last mentioned phyla.

On the other hand, in the development of the entire alimentary canal from a portion of the mesentoblast, 4*d*, and in the consequent degeneration of the "macromeres" and of the remaining cells of the fourth quartet, this polyclad is unique. This peculiar development of the alimentary tract shows that the cleavage of the polyclads, while closely resembling that of other groups, is not a generalized type.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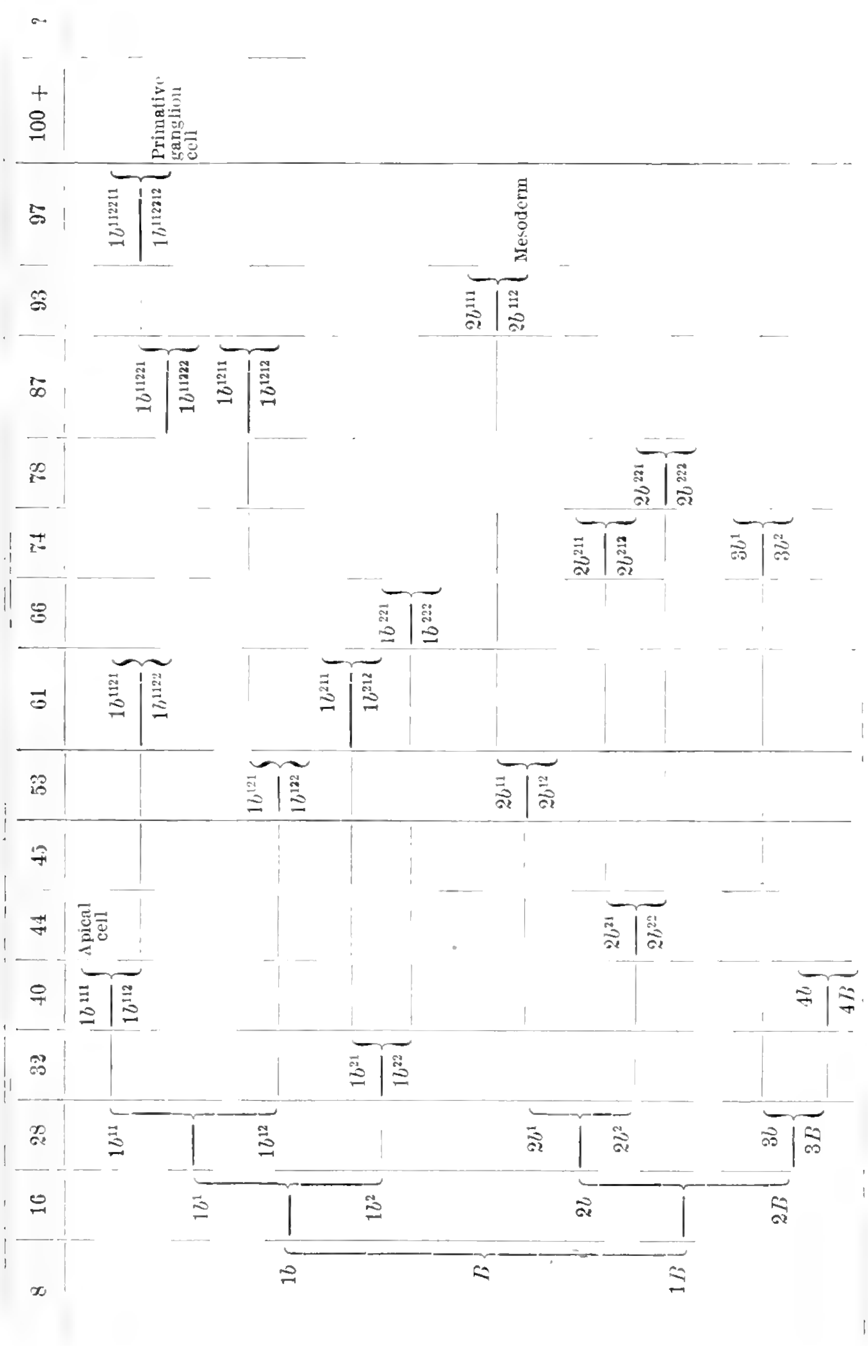
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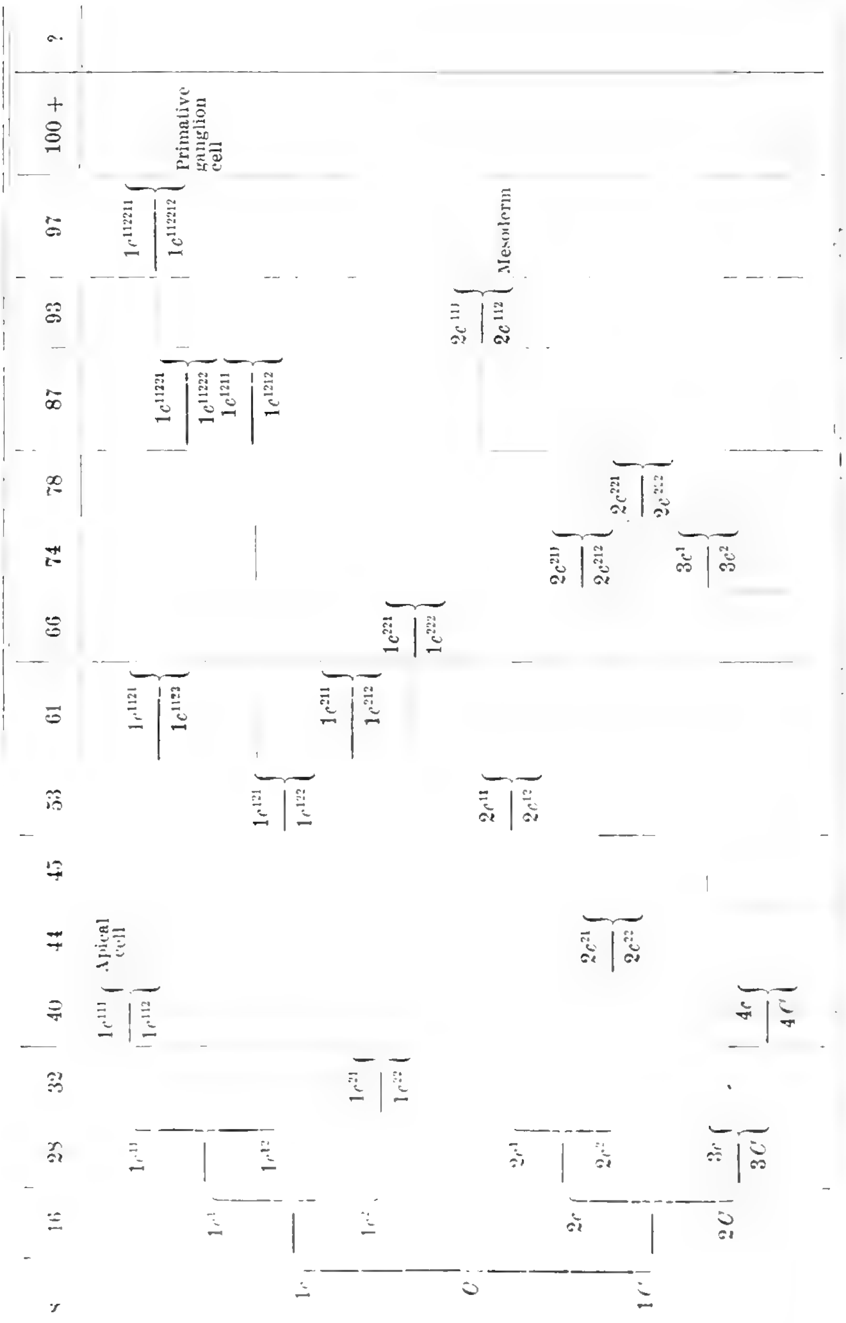
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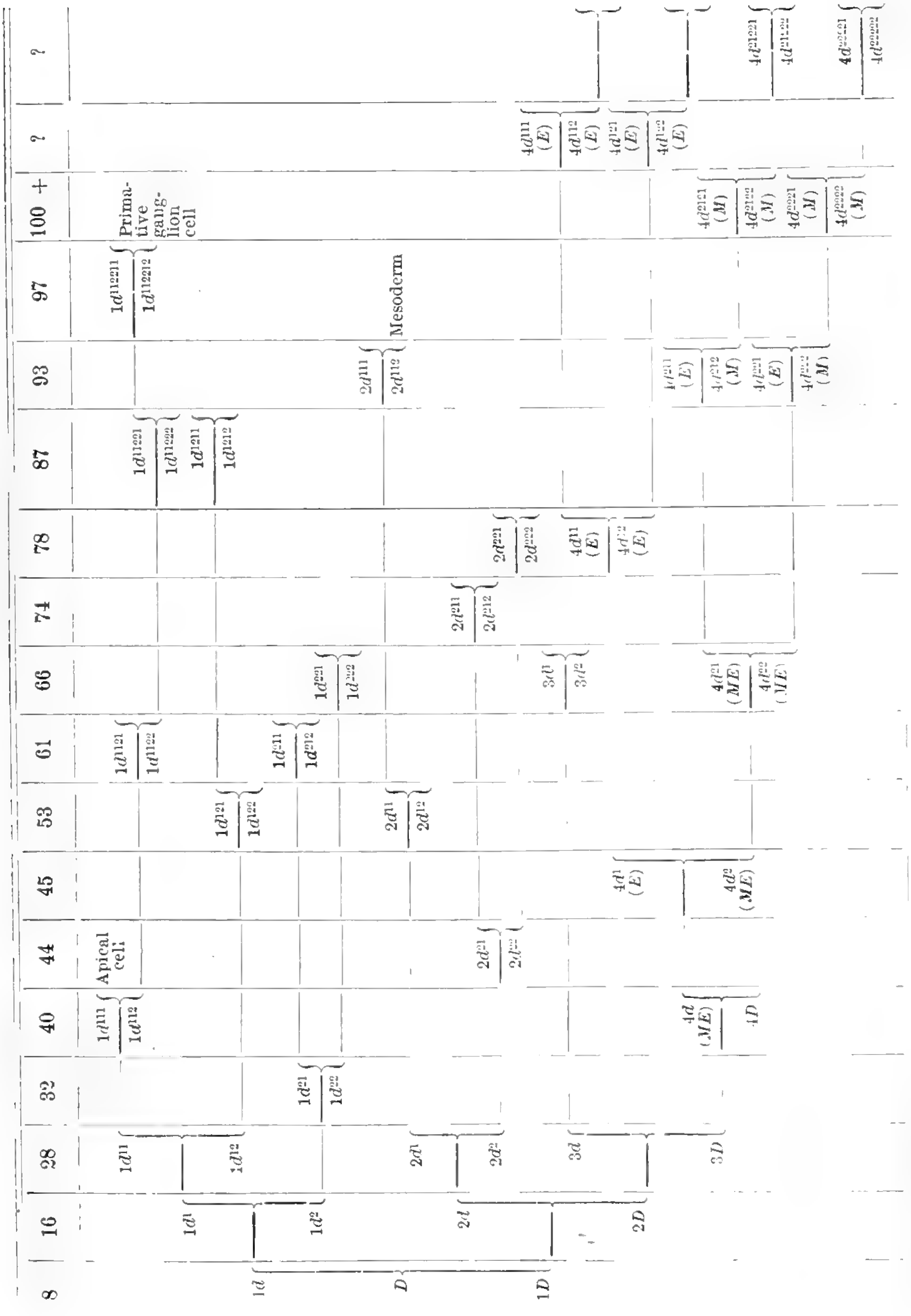
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Literature.

Bigfow, M. A. 1902. The Early Development of Lepas. *Bull. Mus. Comp. Zoo. Harvard College,* XL, No. 2.

Blochmann, F. 1883. Beiträge zur Kenntniss der Entwickelungs der Gasteropoden. *Zeit. f. Wiss. Zool.,* XXXVIII.

Casteel, C. D. 1904. The Cell Lineage and Early Development of Fiona Marine, a Nudibranchiate Mollusk. *Proc. Acad. Nat. Sci. Phila.,* 1904.

Conklin, E. G. 1891. Note on the Embryology of Crepidula fornicata and Urosalpinx cinera. *John Hop. Univ. Circ.,* X, No. 88.

—— 1892. The Cleavage of the Ovum of Crepidula fornicata. *Zool. Anz.,* XV.

—— 1897. The Embryology of Crepidula. *Journ. Morph.,* XIII.

—— 1902. Karyokinesis and Cytokinesis in the Maturation, Fertilization and Cleavage of Crepidula and other Gasteropods. *Journ. Acad. Nat. Sci. Phila.,* 2d Series, XII, 1.

—— 1905. The Organization and Cell Lineage of the Ascidian Egg. *Journ. Acad. Nat. Sci. Phila.,* XIII, pt. 1.

Child, C. M. 1900. The Early Development of Arenicola and Sternapis. *Arch. Entw. Mech.,* IV.

Eisig, Hugo. 1898. Zur Entwickelungsgeschichte der Capitelliden. *Mitth. Zool. Stat. Neap.,* XIII.

Francotte, R. 1898. Recherches sur la Mat. la Fecond. et la segm. chez des Polyclads. *Arch. de Zool. Exp. et Gen.,* 3^e ser., VI.

Gardiner, E. G. 1895. The Early Development of Polychoerus caudatus Mark. *Journ. Morph.,* XI.

—— 1898. The Growth of the Ovum, Formation of the Polar Bodies and the Fertilization in Polychoerus caudatus. *Journ. Morph.,* XV.

Girard, Charles. 1846–7. Sur l'embryogénie des Planaires. *Bull. de la Société des Sci. Nat. de Neuchâtel,* II.

—— 1848. On the Development of Planocera elliptica. *Proc. Bost. Soc. Nat. Hist.,* III.

—— 1854. Researches upon Nemerteans and Planarians. I. Embryological Development of Planocera elliptica. *Journ. Acad. Nat. Sci. of Phila.,* II.

Goette, Alexander. 1878. Zur Entwickelungsgeschichte der Seeplanarian. *Zool. Anz.,* I.

—— 1881. Zur Entwickelungsgeschichte der Würmer. *Zool. Anz.,* 1.

—— 1882. Abhandlungen zur Entw. der Thiere—1: Untersuchungen zur Entw. der Würmer. Leipsig, 8°.

Graff, L. V. 1892. Pelagische Polycladen. *Zeit. f. Wiss. Zool.,* 55.

Hallez, Paul. 1878. *a.* Contributions a l'histoire des Turbellariés, 1re note sur la développement. *Bull. Scient. du Départ. du Nord.* 2^{me} sér., 1re annee, pp. 193–195.

—— 1878. *b.* Considérations au sujet de la segmentation des œufs. *Ibidem,* pp. 227–229.

—— 1878. *c.* Contributions a l'histoire des Turbellariés. *Ibidem,* pp. 250–260.

—— 1878. *d.* Considerations sur la determination des plans de segm. dans l'emb. du Leptoplana tremellaria. *Ibidem,* pp. 264–266.

—— 1879. Contributions a l'histoire nat. des Turbellariés. *Lille;* also in *Trovaux de l'Instit. Zool. de Lille et de la Stat. marit. de Wimereux,* Fas. II.

Heath, Harold. 1899. The Development of Ischnochiton. *Zool. Jahrb.,* Abth. f. Anat. u. Ontog., XII.

Heymons, Richard. 1893. Zur Entwick. von Umbrella medit. Lam. *Zeit. f. Wiss. Zool.,* 56.

Holmes, S. J. 1897. Secondary Mesoblast in the Mollusca. *Science,* N. S., VI.

—— 1900. The Early Development of Planorbis. *Journ. Morph.,* XVI.

Jennings, H. S. 1895. The Early Development of Asplanchna Herricki DeGuerne. *Bull. Mus. Comp. Zool. Harv. Coll.,* XXX.

Keferstein, Welh. 1868. Beiträge zur Anat. u. Entw. einiges Seeplanarian von St. Malo. *Abhand. d. Königl. Gesell. der Wiss. zu Göttingen,* XIV.

Kofoid, C. A. 1894. On Same Laws of Cleavage in Limax. *Proc. Am. Acad. Arts and Sci.,* N. S., XXI.

KORSCHELT, E., and HEIDER, K. 1893. Lehrbuch der vergleichenden Entw. der Wirbellossen Thiere. Sp. Theile, Jena.

LANG, ARNOLD. 1884. Die Polycladen, des Golfes von Neapel. *Fauna. u. Flora d. Golfes v. Neap.*, XI.

LILLIE, F. R. 1895. The Embryology of the Unionidæ. *Journ. Morph.*, X.

MEAD, A. D. 1897. The Early Development of Marine Annelids. *Journ. Morph.*, XIII.

MEYER, E. 1887. Studien uben den Körperbau der Anneliden. *Mith. Zool. Stat. Neap.*, VII.

—— 1890. Die Abstammung der Anneliden. *Biol. Cent.*, Bd. X.

NELSON, J. N. 1904. The Early Development of Dinophilus. *Proc. Acad. Nat. Sci. Phila.*, October, 1904.

PEREYASLAWYEW, MLLE. S. 1885. Sur le développement des Turbellariés. *Zool. Anz.*, VIII.

REPIACHOFF, W. 1885. Nachtrag zu Pereyaslawyew's Devel. des Turbel. *Zool. Anz.*, VIII.

SELENKA, EMIL. 1881. *a.* Die Keimblätter der Planarien. *Sitzungsber. der Physik-Medic. Soc. zu Erlanger*, No. 14. Trans. in *Bull. Sci. Dépt. du Nord.*

—— 1881. *b.* Tur Entwickelungsgeschichte der Seeplanarien. *Biol. Cent.*, Bd. 1.

—— 1881. *c.* Zool. Studien—II: Zur Entw. der Seeplanarien. Ein Beitrag zur Keimblätterlehre und Descendenz Theorie. Leipsig.

—— 1881. *d.* Ueber eine eigen thümliche Art der Kernmetamorphose. *Biol. Cent.*, Bd. 1.

SURFACE, F. M. 1907. Note on the Origin of the Mesoderm of the Polyclad Planocera inquilina Wh. *Science*, N. S., Vol. XXV, p. 732.

TORREY, J. C. 1902. The Early Development of the Mesoblast in Thalassema. *Anat. Anz.*, XXI.

—— 1903. The Early Embryology of Thalassema Mellita (Conn). *Ann. N. Y. Acad. Sci.*, XIV.

TREDWELL, A. L. 1901. The Cytogeny of Podarke obscura Ver. *Journ. Morph.*, XVII.

VAILLANT, LEON. 1866. Sur le développement du Polycelis lævigatus, Quatref. *L'Institute*, I Sect., Tome XXXIV.

—— 1868. Remarques sur la développement d'une Planariée dendrocéle de Quatref. *Mem. de l'Acad. des Sci. et Lettres de Montpellier*, T. VII.

VAN BENEDEN, EDOUARD. 1870. Reserches sur la composition et la Signification de l'œuf. *Mémoires, couromés et mem. des Savants étranger publiés par l'Acad. Royal. de Belgique*, Tome 34, Bruxelles.

WHEELER, W. M 1894. Planocera inquilina, a Polyclad inhabiting the Branchial Chamber of Sycotypus canaliculatus Gill. *Journ. Morph.*, IX,

WHITMAN, C. O. 1878. The Embryology of Clepsine. *Quart. Journ. Micr. Sci.*, XVIII.

—— 1891. Spermatophores as a means of Hypodermic Impregnation. *Journ. Morph.*, IV.

WILSON, E. B. 1892. The Cell Lineage of Nereis. *Journ. Morph.*, VI.

—— 1894. The Embryological Criterion of Homology. *Woods Holl Biol. Lect.*, 1894.

—— 1898. Considerations on Cell Lineage and Ancestral Reminiscences. *Ann. N. Y. Acad. Sci.*, XI.

—— 1899. Cell Lineage and Ancestral Reminiscences. *Woods Holl Biol. Lect.*, 1899.

EXPLANATION OF PLATES XXXV–XL.

All figures of fixed and stained eggs, except fig. 35, were drawn with Zeiss Camera lucida at table level under Leitz obj. $\frac{1}{12}$; oc. 2. Figures of living eggs (viz., figs. 1, 2, 3, 4, 6, 8, 10 and 11) were drawn as above, but with Leitz obj. 7; oc. 2. Fig. 35 was drawn with B and L. obj. $\frac{1}{12}$; oc. 1. All drawings have been reduced one-third.

Reference Letters.

e., entoblasts $4d^{2.1.1}$ and $4d^{2.2.1}$.
end., endoderm.
ey., eye.
g., ganglion.
mes., mesoderm.
n.4b., nucleus of the cell $4b$.
ph., pharynx.
r., rhabdites.
y., yolk.

Plate XXXV.—Fig. 1.—Living egg before first maturation division, showing large germinal vesicle.

Fig. 2.—Living egg during the second maturation division, showing amœboid processes.

Fig. 3.—Living egg after second maturation division.

Fig. 4.—Living egg during the first division. The cell *C–D* is slightly larger than *A–B*.

Fig. 5.—Stained egg in the second division. From left side, showing the crossing of the spindles.

Fig. 6.—Living egg in the four-cell stage, from the animal pole.

Fig. 7.—Formation of the first quartet. From right side, showing dexiotropic cleavage.

Fig. 8.—Living egg in the eight-cell stage. From animal pole.

Plate XXXVI.—Fig. 9.—Læotropic division of the preceding eight cells. The spindles in the *D* quadrant show an advance over the others. From the animal pole.

Fig. 10.—Living egg with sixteen cells. From the animal pole.

Fig. 11.—Same as fig. 10, but from vegetative pole.

Fig. 12.—Dexiotropic divisions of cells $1a^{1}$–$1d^{1}$ and of $2a$–$2d$. From animal pole.

Fig. 13.—Thirty-two cells. Dexiotropic divisions of $1a^{2.1}$–$1d^{2.1}$. From animal pole.

Fig. 14.—Thirty-two cells, showing dexiotropic formation of $3a$ and $3c$. Vegetative pole.

Fig. 15.—Thirty-two cells from vegetative pole, showing spindles for formation of $4b$ and $4d$.

Plate XXXVII.—Fig. 16.—Same as Fig. 15, from right side.

Fig. 17.—Thirty-six cells from near vegetative pole. Spindle in $2c^{2}$. $2a^{2}$ and $2d^{2}$ have divided.

Fig. 18.—Thirty-nine cells. From animal pole, showing læotropic formation of apical cells.

Fig. 19.—Forty-five cells, from the right posterior side. Shows the first division of the mesentoblast $4d$. $2d^{1}$ also dividing.

Fig. 20.—Forty-seven cells. From vegetative pole.

Fig. 21.—About the same stage as fig. 20, drawn from the right side, shows the unequal division of $2c^{1}$ and $2b^{1}$. Also spindles in $1c^{2.1}$ and $1b^{2.1}$. $1a^{1.2}$–$1d^{1.2}$ have divided dexiotropically (see fig. 22).

Plate XXXVIII.—Fig. 22.—Slightly older egg than fig. 21, drawn from left upper side. Shows division of $1a^{1.1.2}$–$1d^{1.1.2}$ and of $1b^{1.2}$. $1a^{1.2}$ and $1b^{1.2}$ have divided previously. Also shows læotropic division of $1a^{2.1}$–$1d^{2.1}$.

Fig. 23.—Still older egg, showing the same division as fig. 22, but more advanced. From animal pole.

Fig. 24. Egg from animal pole, showing preceding divisions completed and dexiotropic division of $1d^{2.2}$. Also the bilateral division of $4d^{2}$.

Fig. 25.—Similar stage from vegetative pole. Shows spindle for bilateral division of $4d^{2}$. Also læotropic division of $2a^{2.1}$–$2d^{2.1}$. $3d$ preparing to divide.

Fig. 26.—Shows division of $4d^{2}$ completed and spindle in $4d^{1}$. Also shows division of $2d^{2}$ and $2b^{2}$, of $3d$ and $3b$, and of $2a^{2.1}$.

Fig. 27.—Similar stage from the left side. Shows division of $2a^{2.1}$, $4d^{1}$ and $2b^{2.2}$; also of $1a^{1.2.1}$.

Plate XXXIX. Fig. 28.—Egg from animal pole, showing divisions of $1a^{1.1.2.2}$–$1d^{1.1.2.2}$; also of $1a^{1.2.1}$ and $1c^{1.2.1}$.

Fig. 29.—Similar view of slightly older egg, showing preceding divisions completed and the resulting small superficial cells $1a^{1.1.2.2.2}$–$1d^{1.1.2.2.2}$.

Fig. 30.—Egg from near the vegetative pole, showing division of $4d^1$ completed and budding in of the cells $2b^{1.1}$ and $2d^{1.1}$.

Fig. 31.—Egg from animal pole at slightly later stage than fig. 29. Shows divisions of $4d^{2.1}$ and $4d^{2.2}$. The resulting small cells $4d^{2.1.1}$ and $4d^{2.2.1}$ are probably entoblasts.

Fig. 32.—Optical section from animal pole, showing the cells $2a^{1.1}$–$2d^{1.1}$ budding mesoderm to the interior. Also shows the large nuclei of 4*b*, 4*a* and 4*c*.

Fig. 33.—Later stage, showing the internal divisions of the entoblasts $4d^1$ and $4d^2$. Not all the cells on the interior of the egg are shown.

Plate XL.—Fig. 34.—Optical section of egg from the posterior side. The entoblasts $4d^{1.1}$ and $4d^{1.2}$ have divided once and possibly twice. The two small entoblasts $4d^{2.1.1}$ and $4d^{2.2.1}$ are shown with dark nuclei. Above these are the two small mesoblasts, while the larger mesoblasts $4d^{2.1.2.2}$ and $4d^{2.2.2.2}$ are again dividing. Above these are a number of cells from the first quartet which later form the ganglion. The large nuclei of 4*a*, 4*b* and 4*c* are shown in dotted outlines.

Fig. 35.—Optical section of an egg viewed from near the vegetative pole. The derivatives of $4d^2$ are stippled. The division of $4d^{2.1.2.1}$ and $4d^{2.2.2.2}$ indicated in fig. 34 are now completed and the beginning of the mesodermal bands is evident. In many eggs the divisions are not so regular as shown here. Instead the mesoderm tends to form clusters of cells rather than bands.

Fig. 36.—Optical section of a much later stage. From the left side. The mass of endoderm derived from $4d^1$ lies just above the future pharynx. The mesoderm cells have passed to the periphery and the centre of the egg is filled with the homogeneous yolk spheres (*y*), in which the shrunken nucleus of 4*b* can be seen (*n*.4*b*.). The two small cells marked (*e*) are probably the entoblast $4d^{2.1.1}$ and $4d^{3.2.2}$.

Fig. 37.—Optical section of an older embryo. From the posterior side. Shows ectodermal pharynx and beginning of lumen in the endoderm.

Fig. 38.—Actual longitudinal section of a still older embryo, showing the backward turn of the alimentary canal in this stage.

Fig. 39.—Longitudinal section of a Muller's larva. Nearly all the yolk spheres have disappeared by this time and the alimentary canal is greatly enlarged but still unbranched.

OBSERVATIONS MADE IN 1907 ON GLACIERS IN ALBERTA AND BRITISH COLUMBIA

BY GEORGE, JR., AND WILLIAM S. VAUX.

But few vital changes are to be noted from year to year in the glaciers of these regions, and yet a careful observation of what is taking place may in time throw some additional light on the problems of glacier action which as yet remain unsolved. This can be our only apology for again presenting to the Academy of Natural Sciences of Philadelphia the results of the work done on the several glaciers in Alberta and British Columbia in August, 1907, which is a continuation of that first begun on the Illecillewaet Glacier twenty years ago.

As a preliminary it may be stated that the winter and early spring of 1907 were cold and backward. Immense banks of snow collected in the valleys and even covered the glacier tongues till the spring was fully opened; snow fell much later than usual at normal elevations, and much larger banks were noted on the mountainsides than for many years. Rain and a deficiency of sunlight retarded melting, so that much more snow remained in the fall, both in the valleys and the higher slopes, and it is probable that many snowbanks had not entirely disappeared before the winter falls set in.

Illecillewaet Glacier.

Glacier House, British Columbia.

Recession.—With the above conditions in mind, it is interesting to note that on August 12, 1907, the tongue of ice of the Illecillewaet Glacier was 382 feet above the marked rock "C," which has been the datum point since August 17, 1898, or a recession of fifty-five feet since July 24, 1906. The above measurement was made from the datum rock to the ice along a line parallel with the axis of the glacier.

Measurements made to the nearest ice farther to the east of this line, which was established several years ago, would doubtless show a much smaller recession, but it would seem that in fairness the measurement points should be kept as nearly as possible in the same straight line from year to year. It, however, appears to be a fact that the tongue or point of greatest extension of this glacier lies many feet to the east of the position of ten years ago.

Test Picture.—The annual test picture was taken from Rock W, on August 19, 1907, and shows a continued shrinkage on both sides and in depth of the tongue. This last feature is particularly marked when walking over the slopes of ice on a line with the test plates. When the location for these was selected it was largely on account of the even slope and uncrevassed surfaces. Now great crevasses are found, but particularly on the left side, and the slope in places approximates 35 degrees, whereas ten years ago it was but 22 degrees. A careful study of the rock at the sides of the ice stream and the probable form of the bed on which the glacier flows would indicate that the tongue has now almost reached the upper edge of the nearly flat bed moraine which has been gradually uncovered for at least twenty years, and should recession continue the ice edge will begin to mount over ledges of bed rock which have been worn and polished for ages beneath the glacier mass.

Flow of the Glacier above the Tongue.—The six steel plates laid out on July 12, 1906, were located again on August 12, 1907, after a period of exactly thirteen months or 396 days. After a good deal of difficulty they were all found, but it was not possible to triangulate the position of No. 6 on the extreme left of the glacier, which had taken a position on a blade of ice between two very deep crevasses, and so far below the general level of the glacier that a tower forty feet high would have been required to bring the stadia within the field of view of the transit.

The following table gives the total motion of the five plates during the interval of thirteen months, and the average daily motion computed from this total. In the last column has been repeated the observed daily motion of these plates laid out on July 12, 1906, and located again twelve days later.[1]

Motion of 1906 *Plates on Surface of Illecillewaet Glacier, July* 12, 1906, *to August* 12, 1907.

Number of Plate.	Total motion 396-day interval (inches).	Average daily motion 396-day interval (inches).	Average daily motion twelve-day interval summer of 1906 (inches).
1	960	2.45	Plate lost.
2	1,056	2.67	7.00
3	2,136	5.39	11.33
4	2,664	6.73	9.75
5	2,436	6.15	10.25
6	——	——	8.85

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[1] Compare "Observations made in 1906," *Proc. Acad. Nat. Sci. Phila.*, December, 1906, pp. 573, 574.

ASULKAN GLACIER.

GLACIER HOUSE, BRITISH COLUMBIA.

Changes in Tongue.—The same record of breaking down and recession must be made of this glacier, and indeed the changes noted are more marked than for several years. The right side is melting rapidly, with the result that the stream of ice is becoming narrower. On the left side there is not so much change, owing to the mantle of moraine which retards melting. There is much less ice at the tongue than last year and recession is marked. The general surface of the ice is rougher and there are many crevasses at the line of plates where last year even slopes were found. The large rock marked in 1899 was found to rest in its original position, though heaped all around with fresh moraine. The distance from this rock on August 15, 1907, to the thin tongue of ice was found to be 54 feet 6 inches, showing that amount of recession since last year.[2]

The Flow of Glacier above Tongue.—On August 15, 1907, the position of the plates laid out on July 13, 1906, was determined, giving the motion of the ice for a period of about thirteen months or 398 days. The results are given in the following table, to which have been added the data obtained in 1906 of the rate of summer motion of the same plates, covering a ten-day interval.

Motion of 1906 *Plates on Surface of Asulkan Glacier, July* 13, 1906, *to August* 15, 1907.

Number of Plate.	Total motion 398-day interval (inches).	Average daily motion 398-day interval (inches).	Average daily motion ten-day interval summer of 1906 (inches).
7	Lost.	——	2.40
8	449	1.13	3.90
9	Lost.	——	5.50
10	1,147	2.88	6.70
11	1,231	3.10	6.70
12	1,245	3.13	6.30
Bowlder.	———	——	8.90

VICTORIA GLACIER.

LAKE LOUISE, ALBERTA, CANADA.

This glacier was visited on August 8, 1907, during a long period of

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[2] Compare "Observations made in 1906," *Proc. Acad. Nat. Sci. Phila.*, December, 1906, p. 575.

storm. The changes, though not marked, are all in the line of shrinkage and recession. The tongue, still buried in moraine, is not different from previous years, but the steep slopes of ice on the left side are gradually retreating and depositing masses of bowlders on the ground moraine below. The large angular blocks which fell from the ice in 1899 are now 126 feet from the edge of ice, which indicates a further retreat of fifty-two feet since July 30, 1906. The large boulder on the ice surface has moved many feet down with the ice, but owing to the bad weather and dense fog which obscured the line points it was not possible to determine the changes with any accuracy.

Yoho Glacier.

Yoho Valley, Field, British Columbia.

This glacier was visited on August 19, 1907. It has receded very appreciably the past year, particularly on the left side, where many acres of *roches moutonné* have been left bare or covered with masses of moraine. Some of these are glaciated and graved most beautifully, and many small spherical quartzite pebbles about the size of marbles and quite as true were found in pockets where they had been deposited.

The right side of the glacier does not appear to have changed so greatly, probably owing to the form of glacier bed and the increased pressure of ice on this side.

As with other examples in this region, the point of greatest extension of the glacier is a very long blade-like tongue extending in one of the trough-like grooves parallel with the axis of the glacier. Measuring from the bed rock marked on August 17, 1901, to this ice the distance was found to be 147 feet 4 inches, or a recession of 70 feet for the year. If, however, the line is taken in the same direction as previous years the distance was 423 feet, or 346.3 feet recession. This is the greatest change which has been noted in any glacier in this region since observations were recorded.

As a conclusion it may be noted that the yearly average flow of the ice streams continues about as in previous years, but the recession of the tongues, shrinkage and breaking down is increasingly marked. The Asulkan Glacier, which for several years was stationary or slightly advancing, has this year showed marked retreat and shrinkage, and the same is the case with the Victoria Glacier. Preceded by a cold and stormy winter and a summer with low average of sunshine and low temperature, these conditions point to an interesting series of changes which may ultimately throw some light on the relation between weather conditions and glacier change.

The following reports were ordered to be printed:

REPORT OF THE RECORDING SECRETARY.

Fifteen meetings of the Academy were held during the past year, with an average attendance of thirty-seven. Communications, many of which were illustrated by lantern slides, were made by Messrs. George, Jr., and William S. Vaux, H. A. Pilsbry, H. E. Wetherill, Henry Leffman, Howard W. DuBois, E. G. Conklin, S. G. Dixon, A. E. Brown, P. P. Calvert, Henry Skinner, J. W. Harshberger, Joseph Willcox, Burnett Smith, Witmer Stone, F. L. Garrison and Benjamin Sharp.

Forty papers have been presented for publication by the following authors: Clarence B. Moore, 4; H. A. Pilsbry, 4; Henry W. Fowler, 3; James A. G. Rehn, 3; Thomas H. Montgomery, 2; J. Percy Moore, 2; Burnett Smith, 2; R. W. Shufeldt, 2; H. E. Wetherill, 1; H. A. Pilsbry and James H. Ferris, 1; C. P. Gillette, 1; George, Jr., and William S. Vaux, 1; James A. Nelson, 1; Theodore Gill, 1; Harold Heath, 1; Arthur M. Edwards, 1; J. Chester Bradley, 1; Howard Crawley, 1; E. G. Vanatta, 1; J. A. G. Rehn and M. Hebard, 1; Helen Dean King, 1; H. E. Enders, 1; E. G. Conklin, 1; Clayton F. Palmer, 1; W. H. Dall, 1; and Witmer Stone, 1. Four of these have been accepted for publication in the JOURNAL, twenty-nine for the PROCEEDINGS; six have been returned to the authors, and one is still held under advisement.

One hundred and ninety pages of the PROCEEDINGS for 1906, with fourteen plates and two maps, and four hundred and sixteen pages and thirty plates, constituting Part 3 of Vol. 58 and Parts 1 and 2 of Vol. 59, have been published and distributed. The four papers by Mr. Moore form the third number of Vol. XIII of the JOURNAL, one hundred and forty-three beautifully illustrated pages, for which we are indebted to the author who defrays the entire cost of publication.

The Entomological Section has published four hundred and fifty-eight pages of the ENTOMOLOGICAL NEWS, with seventeen plates, and two hundred and ninety-seven pages, with four plates, of the TRANSACTIONS OF THE AMERICAN ENTOMOLOGICAL SOCIETY (Entomological Section of the Academy). Of the MANUAL OF CONCHOLOGY two hundred and twenty-six pages and thirty-seven plates have been issued.

Six members and four correspondents have been elected. The deaths of eight members and three correspondents have been announced.


FERDINAND VANDEVEER HAYDEN
M.DCCCLXXXVIII


THE ACADEMY OF NATURAL SCIENCES OF PHILADELPHIA
AWARDED
TO
CHARLES
DOOLITTLE
WALCOTT
M.C.M.V

Eight resignations of membership have been received as follows: Judson Daland, W. P. Stokes, George M. Woodward, Marian G. Nimlet, Lightner Witmer, L. H. Carpenter, R. D. Barclay, and Henry Emerson Wetherill.

Although the improved design for the Hayden-Memorial Medal was accepted in 1906, as stated in my last annual report, the engraved dies were not received from the Gorham Company until last April. The medal, the work of John Flanagan, of New York, was then cast by Messrs. Krider & Co., of Philadelphia, and has met with general approval, the portrait and the emblematic reverse being regarded as improvements on the design of the token formerly awarded. The Academy has been forced by a variety of circumstances to defer the actual presentation of the medal to Dr. Wolcott until the first meeting of January, when a reception will be tendered the distinguished recipient.

The President was authorized to appoint representatives to the Centenary Celebration of the Geological Society of London, and to the observance of the two hundredth anniversary of the birthday of Linnæus by the New York Academy of Sciences.

EDWARD J. NOLAN,
Recording Secretary.

REPORT OF THE CORRESPONDING SECRETARY.

The Corresponding Secretary regrets the necessity of recording the death during the past year of the following named correspondents: Mr. Frederick C. Stearns, Sir Joseph Fayrer, Prof. Edmund von Mojsisovics, and Prof. Lucien M. Underwood. There were elected Mr. P. Chalmers Mitchell, of the Zoological Society of London; Prof. J. W. van Wijhe, of the University of Groningen; Prof. Otto zur Strassen, of the University of Leipzig, and Dr. R. Bowdler Sharpe, of the British Museum.

Notices announcing the deaths of five scientific men of prominence were received and suitably acknowledged on behalf of the Academy. Upon the receipt of official invitations delegates representing the Academy were appointed by the President as follows: To the Tricentennial Anniversary of the birth of Ulisus Aldrovandi, Prof. Giovanni Capellini, a correspondent; to the Seventh International Zoological Congress, Prof. E. G. Conklin, Dr. Henry A. Pilsbry, Dr.

Benjamin Sharp, Mr. Witmer Stone and Dr. J. Percy Moore; to the Centenary Anniversary of the founding of the Geological Society of London, Sir Archibald Geikie, a correspondent; and to the exercises in New York commemorating the two hundredth anniversary of the birth of Linnæus, Mr. Witmer Stone. Invitations to participate were received for the dedication exercises of the Carnegie Institute in Pittsburg, the eightieth anniversary of the Imperial Geographical Society of Russia, the Fourth International Fishery Congress, the Prehistoric Congress of France, the Delegation for the Choice of an International Auxiliary Language, the Fiftieth Anniversary of the founding of the Parsony Medical and Physical Society, and a memorial meeting to the late Samuel Pierpont Langley. Suitable letters or addresses were in each case forwarded.

A noteworthy event of late summer was the meeting in this country of the Seventh International Zoological Congress. Upon the invitation of a committee representing many of the scientific and educational institutions of Philadelphia, and which held its meetings at this Academy, a large delegation from the Congress, including upwards of seventy foreign members, visited this city on September 2 and 3. Among the visitors were many distinguished zoologists, including two correspondents of the Academy, Dr. Raphael Blanchard, of Paris, and Prof. A. A. W. Hubrecht, of Utrecht. The programme of entertainment was very successfully carried out, both at the Academy and the other institutions that were visited, and was very enjoyable to visitors and hosts alike.

An increased number of letters requesting information on subjects of scientific interest were received and answered.

Statistics of the correspondence follow:

Communications Received.

Acknowledging receipt of the Academy's publications,	162
Transmitting publications,	72
Requesting exchanges or the supply of deficiencies,	2
Invitations to learned gatherings,	9
Notices of death of scientific men,	5
Circulars relating to the administration of scientific institutions, etc.,	11
Biographies of correspondents,	6
Photographs of correspondents,	5
Miscellaneous letters,	117
Total received,	389

Communications Forwarded.

Acknowledging gifts to the Library,	1,022
Acknowledging gifts to the Museum,	77
Acknowledging photographs and biographies,	7
Requesting the supply of deficiencies in journals,	85
Correspondents' diplomas and notices of election,	2
Letters of sympathy or congratulation and addresses,	9
Miscellaneous letters,	136
Copies of annual reports sent to correspondents,	213
Circular letters,	95
Total forwarded,	1,646

Respectfully submitted,

J. Percy Moore,
Corresponding Secretary.

REPORT OF THE LIBRARIAN.

Additions to the Library have been received during the year as follows:

Pamphlets and parts of periodicals,	5,790
Volumes,	941
Maps,	157
Photographs,	21
Total,	6,909

They were received from the following sources:

I. V. Williamson Fund	2,406
Societies, Museums, etc.	2,377
Editors	640
United States Department of Agriculture	438
United States Department of the Interior	230
General Appropriation	211
Authors	138
James Aitken Meigs Fund	86
Wilson Fund	29
Pennsylvania State Department of Agriculture	25
Geological Survey Department, Canada	23
United States Department of Commerce and Labor	20
Ministère des Travaux Publics, France	18
Comité Géologique Russe	16
Imperial Geological Survey, Japan	13
United States Treasury Department	12
Ministerio de Colonizacion y Agricoltura, Bolivia	11
United States War Department	10
Department of Mines, Victoria	10
Department of the Interior, Canada	9
Department of the Interior, Philippines	9
Geological Survey of India	9
Ministerio de Fomento, Peru	8
Trustees of British Museum	8

Department of Agriculture in India	8
United States Bureau of Fisheries	7
International Bureau American Republics	7
Department of Agriculture, Jamaica	7
Cape of Good Hope, Department of Agriculture	7
Commission Géologique de Finlande	6
Department van Landbouw, Java	6
Western Australia Geological Survey	6
Facultad de Agronomia y Veterinaria, La Plata	5
Maryland Geological Survey	5
Observatoire Centrale Nicholas	5
United States Public Health and Marine Hospital Service	4
Dr. Thomas Biddle	4
Publication Committee Academy	4
Connecticut Geological and Natural History Survey	4
Wisconsin Geological and Natural History Survey	4
Commission de la Belgica	4
Bureau of American Ethnology	3
Biuroului Geologicu, Roumania	3
Geological Commission, Cape of Good Hope	3
Geological Survey of New Jersey	3
Agricultural College Survey of North Dakota	2
Dr. S. Solis-Cohen	2
Department of Fisheries, New South Wales	2
Pennsylvania Department of Fisheries	2
Instituto Geologico de Mexico	2
Illinois Bureau of Labor Statistics	2
Trustees of the Indian Museum	2
Missouri Bureau of Geology and Mines	2
Department of Mines, New South Wales	2
Dr. H. A. Pilsbry	2
Commissioners of Fisheries and Game, Massachusetts	2
Dr. E. J. Nolan	2
New Zealand Geological Survey	2
Library of Congress	1
Board of Agriculture and Forestry, Hawaii	1
South African Government	1
Department of Marine and Fisheries, Canada	1
Arthur Dransfield	1
Bentham Trustees, Kew Gardens	1
New Zealand Government	1
Iowa Geological Survey	1
Witmer Stone	1
Kommission zur Wissenschaftliche Untersuchungen der Deutschen See in Kiel	1
Francis R. Abbot	1
Department of Mines, Nova Scotia	1
Forestry Commissioner of Minnesota	1
Geological Survey of Natal and Zululand	1
Board of Scientific Advice for India	1
Secretaria de Agricultura, Cuba	1
Geological Survey of Alabama	1
Louisiana Geological Survey	1
East Indian Government	1
Ministerio de Agricultura, Buenos Aires	1
P. Caledon Cameron	1
Department of Geology and Natural Resources, Indiana	1
Dr. Henry Skinner	1

They were distributed to the several departments of the Library as follows:

Journals	5,132
Agriculture	455
Geology	330
Botany	230
Geography	138
General Natural History	121
Voyages and Travels	78
Entomology	77

Ornithology	55	Bibliography	15
Anatomy and Physiology	38	Chemistry	14
Mammalogy	37	Physical Science	11
Helminthology	33	Mineralogy	9
Conchology	32	Mathematics	6
Ichthyology	24	Herpetology	5
Medicine	23	Unclassified	25
Anthropology	21		

Two thousand and twenty volumes have been bound during the year, making a notable improvement, especially in the department of journals and periodicals. The shelf list in this department has been completed and will be of use, not only in taking stock, but in any rearrangement of the volumes which may be hereafter necessary. The general card catalogue has of course been kept up to date. In connection with the preparation of work for the binders constant effort is made to secure supplies of deficiencies, in many cases with gratifying success.

The necessity for more room becomes every day more urgent. The growth of certain departments has heretofore been provided for by encroachment on the study rooms. This has been so manifestly to the inconvenience of those occupying the rooms that some of these books have been removed to shelving placed above the cases. These shelves have to be reached by ladders, and the arrangement is only tolerable as a temporary relief from crowding. It is believed that ample provision for at least storing accessions will be provided in the proposed new building, a large part of which will be designed for the erection of tiers of stacks.

The proofs of the Union List of periodicals in the libraries of Philadelphia have been read, and the work will be issued early in March under the auspices of the Free Library. It will be of the first importance in coöperative work.

It is gratifying to know that the present arrangement of the Library was warmly commended by the members of the International Congress of Zoologists, who were entertained here last September.

The Librarian read a paper on the use of books on Natural History at the Conference of the American Library Association, held at Asheville in May. The paper has been published in the first volume of the *Bulletin* of the Association.

Acknowledgment is again gladly made of indebtedness to the Assistant Librarian, William J. Fox, for efficient service both in the Library and the Publication Office.

Edward J. Nolan,
Librarian.

REPORT OF THE CURATORS.

The collections in the care of the Curators remain in an excellent condition and progress has been made in their study and classification.

In June an appropriation of $150,000 was made to the Academy by the State of Pennsylvania, for the erection of a new fireproof Library and Auditorium. Plans for this new building, to be erected south of the present Museum, and for the remodeling of the old Library building for Museum purposes, have been adopted and work will begin early in the coming year.

The rearrangement of the collections in the old Museum building, which was closed to the public while the new roof was being constructed, has been practically completed, but until the new exhibition cases now under construction are installed, it is thought best to keep the building closed.

In rearranging the collections, the fossil Vertebrates and the Lea collection of Eocene fossils occupy the main floor. The first gallery, where birds were formerly displayed, now contains the collections of fossil Invertebrates arranged in geological sequence. The exhibit of recent mollusks is to remain on the second gallery.

A temporary partition shuts off the east end of the main floor, forming a room for the arrangement of the rapidly increasing study collection of mollusks.

One hundred white pine cabinets were purchased during the year for the accommodation of this collection. In addition 720 cubic feet of exhibition cases, uniform with those previously purchased, have been ordered, and a number of moth-proof metal cases for the entomological and ornithological study collections.

Mr. Clarence B. Moore has made additional explorations among the Indian mounds of the Southern States, and added valuable specimens to his collection.

Dr. Skinner, at the instance of the Canadian Government, accompanied Dr. Fletcher on a trip through Saskatchewan during the summer, and made extensive entomological collections for the Academy. Mr. Rehn, through the liberality of Mr. Morgan Hebard, was enabled to accompany him on a trip through New Mexico, Arizona and California, collecting Orthoptera and reptiles. All of the latter and half of the Orthoptera became the property of the Academy.

Numerous local trips to various parts of Pennsylvania and New Jersey by other members of the Museum staff have added largely to the herbarium and the collections of fishes reptiles and mollusks.

Among the more important accessions to the Museum during the year may be mentioned a series of earthenware vessels from Colombia; a series from the Wollaston collection of Mollusca from Madeira, the Canaries, Cape Verdes and St. Helena; a collection of Brazilian birds presented by Mrs. Thomas Gummey; a number of valuable mammals presented by the Zoological Society of Philadelphia, and a series of Cirripedes from the United States National Museum.

In addition to the services rendered by the Museum staff, the Curators are indebted to Mr. S. S. Van Pelt for the care and enlargement of the local herbarium, and to Dr. P. P. Calvert, Messrs. E. T. Cresson, Jr., and H. W. Wenzel for aid in the entomological department.

Details of the work in several departments are appended. In addition Dr. J. P. Moore has continued the study and arrangement of the helminthological collections, and Mr. H. W. Fowler of the fishes, while Miss H. N. Wardle has devoted considerable time to the care of the archæological department.

The collections have been consulted by many visiting specialists and specimens have been loaned to Dr. F. W. True, H. W. Henshaw, E. W. Nelson, H. C. Oberholser, Dr. W. H. Dall, Dr. James P. Smith, Miss Mary J. Rathbun, Robert T. Young, Dr. G. A. Boulenger, Dr. Burnett Smith, W. H. Osgood, M. W. Lyon, Dr. C. H. Gilbert, and Dr. C. H. Eigenmann.

Samuel G. Dixon,
Executive Curator.

Report of the Special Curator of the Department of Mollusca.

During the year the collection of mollusks which was stored in 1906 has been returned to the second gallery and in part rearranged. All of the fresh-water shells have been placed in dust-proof cases on the main floor of the Museum, where space has been partitioned off for the temporary accommodation of such part of the collection as is not exhibited.

Large accessions have been made to the collections. Among the more extensive series are 250 trays of Florida shells collected by C. B. Moore; 100 lots from Victoria, Australia, from Mrs. A. F. Keynon; a series of Mexican shells from A. A. Hinkley, and a series of 1,320 trays from the Quadras collection of Philippine land shells. A series from the Lowe-Wollaston collection from the Atlantic Islands, Madeira, Canaries, St. Helena, etc., was purchased.

The Special Curator has been occupied chiefly with the preparation of the Manual of Conchology, the volume for the year dealing with the family *Oleacinidæ*. Studies have also been made of the snails collected in Arizona in 1906, an account of which will shortly be ready for publication.

Mr. E. G. Vanatta has given careful and efficient assistance in the work of the department.

H. A. Pilsbry,
Special Curator.

REPORTS OF THE SECTIONS.

The Biological and Microscopical Section.

Nine stated and several informal meetings have been held during the year with the usual attendance.

The following communications were made:

On *Filaria sanguinis hominis*, by Dr. T. S. Stewart.

On *Amphigyra alabaminensis*, and on an apparatus for showing polarized light, by Mr. F. J. Keeley.

On motion of diatoms, by Mr. T. Chalkley Palmer.

A paper "On Consciousness of Micro-Organisms," by Mr. John G. Rothermel, was presented to a large audience by request in the Library Hall.

Dr. Sylvester J. Deehan, by invitation, read a paper "On the House Fly and Its Relation to Public Health."

Shorter communications on various subjects were made by Messrs. J. A. Shulze, William B. Davis, Silas L. Schumo, Hugo Bilgram, Dr. J. C. Morris and C. S. Boyer.

The semi-centennial anniversary of the founding of the Section will occur on March 30, 1908. Of the twenty-seven original members but few are now living; it is hoped, however, that the occasion may be the means of some commemoration of the work of the Section.

The following officers were elected for the year 1908:

Director,	J. Cheston Morris, M.D.
Vice-Director,	T. Chalkley Palmer.
Recorder,	Charles S. Boyer.
Corresponding Secretary,	Silas L. Schumo.
Treasurer,	Thomas S. Stewart, M.D.
Conservator,	F. J. Keeley.

Charles S. Boyer,
Recorder.

MINERALOGICAL AND GEOLOGICAL SECTION.

The Section has this season continued its meetings and excursions with renewed vigor and success.

There have been nine meetings, with an average attendance of ten. Communications were made by Mr. Lynwood F. Garrison on gold in pegmatite and related rocks, and on metallic sulphides in volcanic tuffs; by Mr. E. T. Wherry on luminescent minerals, and on his summer observations in northern New Jersey; by Mr. T. Chalkley Palmer on the geography and geology of the region around Richmond, Va.; by B. S. Lyman on a trip to the Philippines, and on a new rock-section grinding machine; by Dr. Florence Bascom on some Mexican volcanoes; by Dr. William J. Sinclair on the geology of the Yosemite Valley. There were a number of shorter communications, besides active discussions.

There were nine field excursions, with an average attendance of over twenty-eight. The parties examined: (1) The structure of Plymouth Valley, between Camp Hill and Chestnut Hill, Montgomery County; (2) The crystalline rocks and their minerals near Media, Delaware County; (3) The structure of Plymouth Valley, between Fort Washington and Glenside, Montgomery County; (4) The crystalline rocks and their minerals between Swarthmore and Lansdowne, Delaware County; (5) The Cambrian and Precambrian rocks between Edge Hill and Paper Mills, Montgomery County; (6) The New Red rocks in the Perkiomen Valley, Montgomery County; (7) The crystalline rocks between Chester and Morgan Station, Delaware county; (8) The New Red and Cambrian conglomerates between Yardley and Fallsington, Bucks County; (9) The crystalline rocks and their minerals between Bethayres and Bustleton, Montgomery and Philadelphia Counties. The excursions are occasionally enlivened by interesting and instructive discussions of the phenomena observed.

The membership of the Section has increased by two associates, at least one of whom will doubtless next month become a member. Another associate has already this year become a member.

The following officers of the Section have been elected for the year 1908:

Director, ...	Benjamin Smith Lyman.
Vice-Director, ...	George Vaux, Jr.
Recorder and Secretary, . . .	Edgar T. Wherry.
Treasurer, ...	Miss Emma Walter.
Conservator, ...	Frank J. Keeley.

Respectfully submitted by order of the Section,

BENJAMIN SMITH LYMAN, *Director.*

The Entomological Section.

The regular monthly meetings have been held, except during the months of July and August. Valuable communications by the members have been permanently recorded in the *Proceedings* of the Section and published in the *Entomological News*. The average attendance was twelve persons, not including visitors. Eight tin cases containing two hundred Schmitt boxes have been purchased to accommodate the growth of the collection and any new arrangement found necessary. Over 11,000 specimens have been added to the cabinet during the year. The most noteworthy additions have been 2,083 insects of all orders from Paramaribo, Surinam; 3,424 Hymenoptera, presented by Mr. Henry L. Viereck; 700 Orthoptera from Florida and 2,500 from the Southwestern United States, captured by Mr. J. A. G. Rehn and Mr. Morgan Hebard; two specimens of the very rare butterfly, *Argynnis astarte*, from Mt. Athabasca, were presented by Mrs. Charles Schäffer.

The Conservator of the Section spent five weeks collecting for the Academy in the Canadian provinces of Manitoba, Saskatchewan and Alberta, and brought home a large amount of material. Quite a number of the species collected were new to our cabinets, and it is not unlikely that new species will be found when time permits the proper study of this collection. A large part of the additions came unmounted, and a considerable portion of the Conservator's time was occupied in preparing it for the cabinet. The usual and necessary work for the care and preservation of the collections has been done, and new and better methods of technic have made this work very much more satisfactory. The *Entomological News*, the journal published under the direction of the Section, has been continued and Volume XVIII completed with 458 pages and 17 plates. Two hundred and ninety-eight pages and 4 plates of the *Transactions of the American Entomological Society* have been published. The Conservator wishes to acknowledge valuable assistance in the care and arrangement of special collections from Dr. Philip P. Calvert, Mr. J. A. G. Rehn and Mr. E. T. Cresson, Jr.

Director, ...	Philip Laurent.
Vice-Director, ...	H. W. Wenzel.
Treasurer, ...	E. T. Cresson.
Conservator, ...	Henry Skinner, M.D.
Secretary, ...	J. H. Ridings.

Recorder, ...	Henry Skinner, M.D.
Publication Committee, ...	E. T. Cresson,
	J. H. Ridings.

Respectfully submitted,

HENRY SKINNER,
Conservator.

THE BOTANICAL SECTION.

During the past year the work of placing the sheets in species covers has been completed for about three-fourths of the herbarium; pressure of other work and lack of assistance have delayed progress for the time being; it is hoped, however, that the arrangement may be completed during the coming year.

Early in the year six new metal cases were received and have been placed in the north gallery room for the accommodation of the ferns and fern allies with the mosses and lichens, the change of arrangement being required by the rapid growth of the local herbarium.

Additions to the collections amount to about 5,500 sheets. Of these, exchanges have been received from the New York Botanical Gardens of 174, principally from the Bahamas, and the University of Pennsylvania, 147 from Bermuda. Gifts have been received from the St. Louis Botanical Gardens, 565 numbers of Lindheimer's Texan plants, and about 750 from the following individuals: Edwin B. Bartram, Stewardson Brown, Joseph Crawford, Mrs. Thomas P. Hill, Bayard Long, C. F. Saunders, Benjamin H. Smith, Edward G. Vanatta, Samuel S. Van Pelt and Charles S. Williamson.

The Academy's expedition to Arizona and New Mexico under Dr. Pilsbry added 238 sheets, and the following have been added by purchase: By the Academy, a small collection of Surinam plants, and by the Botanical Section, 425 sheets of the Pere Duss herbarium from Martinique and Guadeloupe; from A. A. Heller, 470 sheets of California plants, and from C. G. Pringle, 300 Mexican plants.

An increasing interest has been manifested during the year in the meetings of the Philadelphia Botanical Club, its members having added 2,500 sheets to the local herbarium. Acknowledgment is here made of the efficient work rendered by its Curator, Mr. Samuel S. Van Pelt.

At the annual meeting of the Section, held December 5, the following were elected as officers for the ensuing year:

Director, ...	Benjamin H. Smith.
Vice-Director, ...	Joseph Crawford.
Recorder, ...	Charles S. Williamson.
Treasurer and Conservator, . .	Stewardson Brown.

Respectfully submitted,

STEWARDSON BROWN,
Conservator.

THE ORNITHOLOGICAL SECTION.

During the past year the remainder of the mounted collection of birds, comprising the ostriches and their allies and the song birds, have been arranged on the new Ornithological floor in cases provided for them, and the work of relabelling the Picariæ, Passeres, etc., has been begun.

The greater part of the Conservator's time, apart from general museum work, has been devoted to a thorough revision of the study series of bird skins. Before installing the extensive Tristram collection it was found necessary to reidentify the old material and bring the nomenclature up to date. At the same time all species represented in the collection have been checked up in Sharpe's Hand List of Birds, so that it is possible to ascertain at a glance the Academy's desiderata. This work has been completed from the Parrots to the Song Birds, this portion of the collection occupying eighty of the standard metal cases.

Mr. J. A. G. Rehn has spent about six months' time in relabelling the Tristram collection, amplifying the tags from the manuscript catalogue, and has completed about one half of this material. He has also relaxed many of the old unmounted specimens and greatly improved their appearance.

Numerous accessions have been received during the year, among which may be mentioned a collection of Brazilian birds from Mrs. Thomas Gummey, a raven's nest and other specimens for the Delaware Valley Club collection.

A special mahogany and plate glass case was finished early in the year for the display of the Great Auk and the Labrador Ducks, and twelve additional metal cases have been purchased for the study collection.

The Delaware Valley Ornithological Club and Pennsylvania Audubon Society have held their meetings at the Academy during the year, and many visiting ornithologists have made use of the collections.

WITMER STONE,
Conservator.

The annual election of Officers, Councillors and Members of the Committee on Accounts to serve during 1908 was held with the following result:

PRESIDENT, ...	Samuel G. Dixon, M.D.
VICE-PRESIDENTS, . . .	Arthur Erwin Brown, Sc.D. E. 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, ...	Arthur Erwin Brown, Sc.D. Samuel G. Dixon, M.D., Henry A. Pilsbry, Sc.D. William S. Vaux, Jr.
COUNCILLORS TO SERVE THREE YEARS,	Thomas H. Fenton, M.D., John Cadwalader, Edwin S. Dixon, Henry Skinner, M.D.
COMMITTEE ON ACCOUNTS, . .	Charles Morris, Samuel N. Rhoads, Dr. C. Newlin Peirce, John G. Rothermel, Howard Crawley, Ph.D.

COUNCIL FOR 1908.

Ex-officio.—Samuel G. Dixon, M.D., Edwin G. Conklin, Ph.D., Arthur E. Brown, Sc.D., Edward J. Nolan, M.D., J. Percy Moore, Ph.D., George Vaux, Jr., Henry A. Pilsbry, Sc.D., William S. Vaux, Jr.

To serve Three Years.—Thomas H. Fenton, M.D., John Cadwalader, Edwin S. Dixon, Henry Skinner, M.D.

To serve Two Years.—Dr. C. Newlin Peirce, Philip P. Calvert, Ph.D., Thomas Biddle, M.D., and Frederick Prime.

To serve One Year.—Charles B. Penrose, M.D., Charles Morris, Benjamin Sharp, M.D., and Henry Tucker, M.D.

CURATOR OF MOLLUSCA,	Henry A. Pilsbry, Sc.D.
ASSISTANT LIBRARIAN,	William J. Fox.
ASSISTANTS TO CURATORS,	Witmer Stone, Henry Skinner, M.D., Stewardson Brown, J. Percy Moore, Ph.D., Edward G. Vanatta, Henry W. Fowler, J. A. G. Rehn, H. Newell Wardle.
TAXIDERMIST,	David McCadden.
Jessup Fund Students,	H. Newell Wardle, James A. G. Rehn.
Janitors	Charles Clappier, Daniel Heckler, James Tague, Jacob Aebley.

ELECTIONS DURING 1907.

MEMBERS.

January 15.—Edwin J. Simpson, Mary W. James.
March 19.—C. C. Bedoes.
April 16.—Richard H. Harte, M.D.
October 15.—Dr. F. Creighton Wellman, Edgar T. Wherry.

CORRESPONDENTS.

April 29.—P. Chalmers Mitchell, F.R.S., of London.

November 19.—Otto zur Strassen of Leipzig, J. W van Wijhe of Groningen, R. Bowdler Sharpe of London.

ADDITIONS TO MUSEUM.

MAMMALS.

CHRISTOPHER GALLEGHER. Skull of *Balænoptera,* Cape May, N. J.

S. H. HAMILTON. Mink, *Putorius vison,* and Georgia Bat, *Pipistrellus,* Warren County, N. J.

MORGAN HEBARD. Three Bats, Arizona and New Mexico.

J. W. HOLMAN. Jumping Mouse, *Zapus hudsonius,* West Creek, Ocean County, N. J.

DAVID MCCADDEN. Six embryos of the Gray Fox, *Urocyon cinereo-argenteus.*

JOSEPH E. SAPP. Franklin's Spermophile, *Citellus franklinii,* Tuckerton, N. J.

LEWIS SHEPPARD. Skull of Opossum.

R. W. SHUFELDT. Skeleton of *Vulpes macrotis.*

H. L. VIERECK. Jumping Mouse, *Zapus hudsonius,* Devon, Pa.

GEORGE WILKINSON. Skull and teeth of horse.

ZOOLOGICAL SOCIETY OF PHILADELPHIA. Prepared for mounting: White-handed Gibbon, *Hylobates lar* (with skull); European Wild-cat, *Felis catus* (with skull); South American Tapir, *Tapirus terrestris* (with skull); Beisa Antelope, *Oryx beisa.*

Prepared as skins with shulls: Gray's Paradoxure, *Paradoxurus grayi*; Dorcas Gazelle, *Gazella dorcas*; Texan Deer-mouse, *Peromyscus* sp., Seymour, Tex.

Prepared as skins with skeletons: Brazilian Ocelot, *Felis pardalis chibigouazou*; Dorcas Goat, *Capra dorcas.*

Prepared as skin without skull: Crab-eating Raccoon, *Procyon cancrivorus.*

Prepared as skeleton: Red River-hog, *Pomatochœrus porcus.*

Prepared as an alcoholic specimen: Pygmy Marmoset, *Hapale pygmæa.*

BIRDS.

HERMANN BEHR (for Delaware Valley Ornithological Club Collection). Nest of Raven, *Corvus corax principalis,* Garrett County, Md.

J. G. DILLIN. Horned Owl, *Bubo virginianus,* Pennsylvania.

THOMAS EAKINS. Bald Eagle (*Haliætus leucocephalus*) for skeleton, New Jersey.

MRS. THOMAS GUMMEY. Collection of mounted birds, Brazil.

H. W. HAND. Gannett, *Sula bassana,* Cape May, N. J.

J. W. HOLMAN. Bald Eagle, *Haliætus leucocephalus,* West Creek, Ocean County, N. J.

MARY VAUX. Ruffed Grouse, *Bonasa umbellus,* Bryn Mawr, Pa.

ZOOLOGICAL SOCIETY OF PHILADELPHIA. White-crested Guan, egg of ***Guira,*** White Gerfalcon.

PURCHASED. Seven Wild Pigeons, *Ectopistes migratoria,* seven Sandhill Cranes, *Grus mexicana,* five exotic birds.

REPTILES AND AMPHIBIANS.

H. W. FOWLER. Collection of reptiles and amphibians, Holmesburg, Philadelphia.

H. W. FOWLER, B. W. GRIFFITH and T. D. KEIM. Collection of reptiles and amphibians, Tullytown, Bucks County, Pa.

H. W. FOWLER and A. H. GROSH, Collection of amphibians, Bacon Hill, Md.

H. W. HAND. *Scaphiopus holbrooki*, Cape May, N. J.

MORGAN HEBARD. Fifty-four reptiles and amphibians, collected in Arizona and New Mexico by Hebard and Rehn.

J. W. HOLMAN. Two Pine Snakes, *Pituophys melanoleucus*, West Creek, Ocean County, N. J.; Red Salamander, *Spelerpes ruber*, West Creek, Ocean County, N. J.

MISS N. HOLMAN. *Sceloporus undulatus*, West Creek, Ocean County, N. J.

T. D. KEIM and W. STONE. Collection of reptiles and amphibians, Garrett County, Md.

DAVID McCADDEN. *Rana pipiens*, Ocean City, N. J.

CLARENCE B. MOORE (collected by H. A. Pilsbry). Two *Anolis*, Florida Keys.

T. CHALKLY PALMER. *Typhlops lumbricalis*, West Indies.

JOSEPH PARKER. King Snake, *Ophibolus getulus*, West Creek, Ocean County, N. J.

J. A. G. REHN. Hog-nosed Snake, *Heterodon platyrhinus*, and Green Snake, *Ophiodryas æstivus*, West Creek, Ocean County, N. J.

G. S. ROBINSON, M. D. *Spelerpes ruber*, Holmesburg, Philadelphia.

E. G. VANATTA. Several amphibians, Chestertown, Md.

GEORGE B. WOOD. Several reptiles, West Palm Beach, Fla.

ZOOLOGICAL SOCIETY OF PHILADELPHIA. Skeleton of giant tortoise, Galapagos; *Boa imperator*.

FISHES.

W. J. EPTING. Two skins of *Salmo fontinalis*.

ERIE FISH CO. Collection of fishes from Lake Erie.

W. J. FOX. *Phycis regius* and *Ammodytes*, Sea Isle City, N. J.; skull of codfish, Sea Isle City, N. J.

H. W. FOWLER. Collection of fishes, Chester and Monocacy Creeks, Pa.

H. W. FOWLER, C. J. HUNT and T. D. KEIM. Collection of fishes, Rancocas Creek, N. J.

H. W. FOWLER and H. W. HAND. Collection of fishes, Cape May, N. J.

H. W. FOWLER and R. F. MILLER. Collection of fishes from Port Richmond, Philadelphia.

H. W. FOWLER and A. H. GROSH. Collection of fishes, Bacon Hill, Cecil County, Md.

H. W. FOWLER and T. D. KEIM. Collections of fishes from Pensauken and Neshaminy Creeks, Pa.

H. W. FOWLER and F. W. PENNELL. Collection of fishes, Wawa, Pa.

H. W. FOWLER and DR. C. C. ABBOTT. Collection of fishes, Trenton, N. J.

H. W. FOWLER, B. W. GRIFFITH and T. D. KEIM. Collection of fishes, Tullytown, Bucks County, Pa.

H. W. HAND. Specimen of *Lophius*, Cape May, N. J.

P. H. HARTMAN. Collection of fishes, Erie, Pa.

T. D. KEIM. Several fishes, Garrett County, Md.

AGNES F. KENYON. Collection of dried fishes, Melbourne, Australia.

DAVID McCADDEN. Sand Eel, *Rissola marginata* and *Ammodytes*, Ocean City, N. J.

Clarence B. Moore (collected by H. A. Pilsbry). Sea Catfish, Florida Keys.

U. S. Fish Commission. *Lumpinus longirostris* and *Icelinus burcharni*, cotypes.

E. G. Vanatta. Collection of fishes, Chestertown, Md.

George B. Wood. Collections of fishes, West Palm Beach, Florida, and Cristine, Me.

Insects.

F. Austin. Mole-cricket, New Jersey.

W. Beutenmuller. Sixteen specimens, United States.

C. R. Biederman. Three Heterocera, Arizona.

H. Bird. Three Heterocera, United States.

C. R. Boerner. Fourteen Coleoptera, Pennsylvania.

P. Biolley. Thirty-seven Orthoptera, Costa Rica.

C. S. Braddock. Eighteen Rhopalocera, Siam.

W. E. Britton. Five Diptera, United States.

Stewardson Brown. Two hundred and ninety-three specimens, British America.

L. Bruner. *Jodacris costaricensis*, Costa Rica.

T. D. A. Cockerell. *Xyela lutei picta* (type), New Mexico; *Holocaspis arizonica* (type), Arizona.

N. Criddle. Forty-four specimens, Manitoba.

E. Daecke. Two Odonata, New Jersey.

Mrs. J. S. Durham. Six Orthoptera, Cuba.

G. M. Greene. Ten Coleoptera; eighty-eight Orthoptera; seventy-six Hymenoptera, United States.

C. T. Greene. Fourteen Diptera, Pennsylvania.

F. Haimbach. Six Heterocera, New Jersey.

M. Hebard and J. A. G. Rehn. Seven hundred Orthoptera, Florida.

C. W. Johnson. Forty-three Diptera, United States.

F. M. Jones. Six specimens insect architecture; seven Heterocera, South Carolina.

H. Kaeber. Sixteen Orthoptera; one Hemiptera, Arizona.

Bayard Long. Various small lots of Orthoptera, United States.

K. Mayo. Two thousand four hundred and twenty-one specimens, Surinam (purchased).

Mrs. Charles Schaeffer. Two *Argynnis astarte*, British America.

Henry Skinner. Seven Lepidoptera, New Mexico; sixty-five Odonata, Saskatchewan; twenty-four Coleoptera, Canada; seventy-four Rhopalocera, Canada; one *Syntomedia befana* (type), Arizona; two *Chrysophanus arethusa* (cotypes).

A. J. Snyder. Fifty-six specimens, Idaho (purchased).

W. Stone. Two Heterocera, Pennsylvania; fifty Diptera; sixty Hemiptera; thirty Coleoptera, Maryland.

E. S. Tucker. Fifteen Diptera, Colorado.

H. L. Viereck. Twenty specimens, United States; six bees, Europe; three thousand four hundred and twenty-four Hymenoptera; *Perdita novangliæ* (type).

University Museum, Oxford, England. Thirty-five Orthoptera, Borneo (exchange).

University of Kansas Seventy-five Orthoptera, Arizona and Texas.

H. W. Wenzel. Two Coleoptera, Arizona; two *Aphodius*, Georgia; fourteen Coleoptera, United States.

W. G. Wright. One hundred and forty-three Coleoptera, California.

P. R. Young. One mole-cricket, New Jersey.

Recent Mollusca.

Jacob Aebly. *Saxicava arctica*, taken from a sponge.

John A. Allen. Twenty-four trays of shells from Ohio and Maine.

Rev. E. H. Ashmun. *Fluminicola minutissima* Pils., Price Valley, Idaho.

Joshua Baily, Jr. Six sets of American land shells.

Carl F. Baker. Eighty-five species of mollusca from Cuba and Nicaragua.

F. H. Baker. Thirty species of marine shells from Australia and New Zealand.

Florence Balentine. *Ancylus borealis* Morse, from Orono, Maine.

Owen Bryant. *Melampus coffea*, Mangrove Bay, Andros, Bahamas.

P. P. Calvert. Seven species of Mexican land and freshwater shells.

Charles F. Cavenaugh. Twenty-two species of Philippine Islands marine shells.

Dr. H. C. Chapman. Nineteen species of marine mollusca from Maine and Italy.

George H. Clapp. Twelve species of American land shells.

T. D. A. Cockerell. Two land shells from Colorado.

C. H. Conner. Six species of freshwater and marine shells from Pennsylvania and New Jersey.

Mrs. A. V. B. Crumb. Forty-eight species of shells from Burma.

Dr. William H. Dall. *Buccinum percrassum* Dall from Bering Island.

L. E. Daniels. Five freshwater shells from Indiana.

H. Grace Eaton. Four species of land shells from New Mexico and California.

J. H. Ferriss and Dr. H. A. Pilsbry. One hundred and forty-seven trays of land shells from Western States.

H. W. Fowler, T. D. Keim and Dr. C. C. Abbott. Twelve trays of Pennsylvania and New Jersey land shells.

William J. Fox. *Littorina irrorata* and *Nassa trivittata* from Sea Isle City, N. J.

M. Grabham. Eighty-seven trays of land shells from Madeira.

Harold Heath. *Ommastrephes californica* from Monterey, California.

M. Hebard and J. A. G. Rehn. Four species of fresh water shells from California.

J. B. Henderson, Jr. Twenty-four trays of shells from the Southern States.

J. B. Henderson, Jr., and Dr. H. C. Chapman. *Polygyra albolabris* Say Bald Porcupine Island, Frenchman's Bay, Maine.

Junius Henderson. Nine species of Colorado land shells.

Dr. H. M. Hiller. Eight species of Cuban marine shells.

A. A. Hinkley. Seventy-two trays of Mexican shells.

Y. Hirase. Three species of Japanese marine mollusca.

Mrs. Anna G. Hubbell. Fourteen marine shells.

Henry Jackson, Jr. *Fulgur canaliculata* Say.

Howard Jones. Two species of bivalves from Atlantic City, N. J.

Mrs. Agnes F. Kenyon (in exchange). One hundred and four species of marine shells from Australia.

Philip Laurent. *Limax maximus* L., Mt. Airy, Philadelphia, Pa.

BAYARD LONG. Five marine shells from Bailey's Island, Maine.

N. W. LERMOND. Two land shells from Maine.

O. S. LEWIS. *Polygyra t. juxtidens* Pils., Dorchester Mt., Morton, Va.

MISS MAYO. Four species of land shells from Dutch Guiana.

CLARENCE B. MOORE. Two hundred and sixty-one trays of shells from Florida.

F. W. PENNELL. *Agriolimax agrestis* L., from Wawa, Delaware County, Pa.

H. A. PILSBRY. Thirty-three species of shells.

J. A. G. REHN. *Quadrula trapezoides* Lea, Pearl River, Jackson, Miss.

S. N. RHOADS. Eleven species of shells from England and Panay Island.

SLOMAN ROUS. Forty species of marine mollusca from South Africa.

SILAS L. SCHUMO. Six species of marine shells from Hammerfest, Norway.

BURNETT SMITH. Six freshwater shells from Skaneateles, N. Y.

H. H. SMITH (purchased). Three hundred and sixteen trays of freshwater shells from Georgia and Alabama.

SOWERBY and FULTON (purchased). Twenty-two East Indian shells.

F. STEARNS. One hundred and eleven marine shells from Honolulu, Hawaiian Islands.

WITMER STONE. Twenty-two land shells from Maryland and Pennsylvania.

L. H. STRENG. Eight marine shells from Panama.

D. THAANUM. Thirty-five land shells from the Hawaiian Islands.

T. VAN HYNING. *Polygyra monodon* Rack., near Des Moines, Iowa.

S. S. VAN PELT. Three marine shells from Cape May County, N. J.

J. C. VERCO. Three sets of *Glycimeris sordidus* Tate, South Australia.

BRYANT WALKER. Five land and freshwater shells from the United States.

WARD'S NATURAL SCIENCE ESTABLISHMENT. *Conus* sp.

W. F. WEBB. Eight land shells from the East Indies.

W. H. WEBSTER. Five New Zealand marine shells.

J. WILLCOX. Two land shells from Italy.

GEORGE B. WOOD. One *Octopus* from West Palm Beach, Fla.

JAMES ZETECK. *Opeas mauritianum* Pfi. from a greenhouse in Garfield Park, Chicago, Ill.

CRUSTACEA.

C. H. CONNER. One jar of crabs from off Angelsea, N. J.

H. W. FOWLER, T. D. KEIM, G. W. GRIFFITH, O. H. BROWN and H. W. WOOD. Eight jars of Crustacea from the Middle Atlantic States.

S. H. HAMILTON. Two sets of Crustacea from Santiago Province, Cuba.

A. A. HINKLEY. Two Crustacea from Tampico, Mexico.

MRS. AGNES F. KENYON. Eight crabs from Victoria, Australia.

CLARENCE B. MOORE. Ten jars of Crustacea from the Florida Keys.

F. W. PENNELL. *Cambarus bartoni* from Wawa, Delaware County, Pa.

UNITED STATES NATIONAL MUSEUM. Sixty-eight jars of barnacles.

GEORGE B. WOOD. Two crabs from West Palm Beach, Fla.

WORMS.

H. W. FOWLER. Two specimens Mermes.

MR. HARVEY. *Tænia* and *Oxyurus* from porcupine.

MRS. AGNES F. KENYON. Fourteen bottles of *Polychæta*.

J. P. Moore. Forty-eight bottles of *Polychæta*, one *Nectonema agile*, ninety-five of *Syllidæ*.

H. A. Pilsbry. One earthworm.

Paymaster Spear. Specimens of Pololo worms.

H. L. Viereck. Three bottles of *Oligochæta*, one Nematode.

Other Invertebrates.

Jacob Aebly. A set of *Iulus* from Philadelphia, Pa.

F. H. Baker. *Waldheimia flavescens* from Western Port, Victoria, Australia.

H. W. Fowler, T. D. Keim and H. W. Hand. Seven jars of invertebrates from Delaware and New Jersey.

George Hartman. One jar of *Caudina* from Palermo, Cape May County, N. J.

Mrs. Agnes F. Kenyon. Seven marine invertebrates from Victoria, Australia.

Clarence B. Moore. Three jars of invertebrates from the Florida Keys.

H. A. Pilsbry. Three jars of invertebrates from the Strait of Magellan.

Witmer Stone. *Iulus* from Jennings, Md.

George B. Wood. Starfish and anemone from Castine, Maine.

Fossil Invertebrates.

T. D. A. Cockerell. Seven fossils from New Mexico.

Dr. S. G. Dixon. Fossil *Brachiopoda* from Dundaffboro, Pa.

Dr. William Drayton, Jr. Two fossils from the Cascade Range, British Columbia.

D. K. Greger (in exchange). Twenty-four fossils from Missouri.

Burnett Smith. Twenty-two Devonian fossils from Skaneateles, N. Y.

Mrs. Sarah Clay Macfarlane. Several specimens of fossils.

Percy C. Madeira. Fossil plant in coal slate, Pottsville, Pa.

Plants.

Edwin B. Bartram. Collection of Vermont plants.

Stewardson Brown, Bayard Long and Samuel S. Van Pelt. Collection of plants from Newton and other New Jersey localities and from the Delaware Peninsula in Delaware and Virginia.

George M. Green. Faciated specimen of *Rudbeckia hirta*.

Mrs. H. Richards Harris. *Colluna vulgaris*, *Erica tetrolix* and *Erica cinerea* from Nantucket.

Mrs. Thomas R. Hill. Double spathed specimen of *Arisæma triphyllum*.

Miss K. Mayo. Collection of Surinam plants. Purchased.

New York Botanical Gardens. Collection of West Indian plants. Exchange.

Philadelphia Botanical Club. Through various members, 2,500 local plants.

W. A. Poyser. *Polypodium falcatum* and *Polypodium Scouleri*.

C. F. Saunders. Collection of plants from Mojave Desert.

Mrs. Charles Schaeffer. Collection of plants from Saskatchewan region of Alberta.

UNIVERSITY OF PENNSYLVANIA. Collection of Bermuda plants. Exchange.

WESTTOWN BOARDING SCHOOL. Collection of plants from Cherokee, Kan. Exchange.

CHARLES S. WILLIAMSON. Collection of plants from Pennsylvania and New Jersey.

MRS. WRIGHT. Collection of California sea weeds.

BOTANICAL SECTION. Plants purchased: Heller's California collections for 1907; Pringle's Mexican collections for 1905 and 1906.

MINERALS AND ROCKS.

J. P. LABOW. Copper ore, Frisco, Beaver County, Utah.

MISS FRANCES M. LAMBERT. Small collection of minerals.

S. H. HAMILTON. Several rock specimens, Cuba.

WILLIAM S. VAUX COLLECTION. Sixty-four specimens purchased.

ARCHÆOLOGY.

CLARENCE B. MOORE. Numerous specimens for the Clarence B. Moore Collection from Indian mounds of Florida and the Gulf Coast.

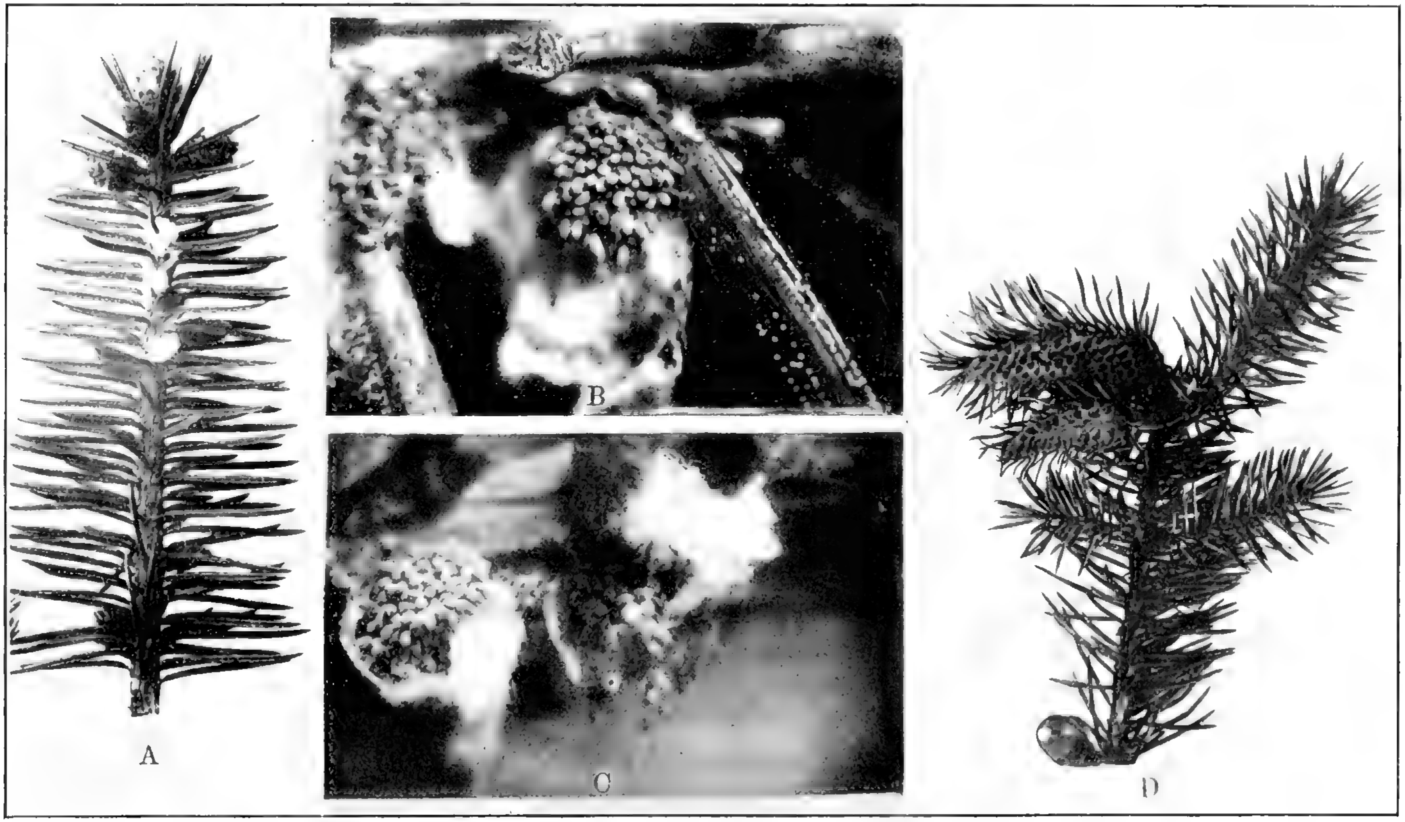
PURCHASED. Two hundred and forty-three specimens of Colombian earthenware.

INDEX TO SPECIES, ETC., DESCRIBED AND REFERRED TO IN THE PROCEEDINGS FOR 1907.

Species described as new are indicated by heavy-faced; synonyms by italic numerals.

GENERAL INDEX.

1907.



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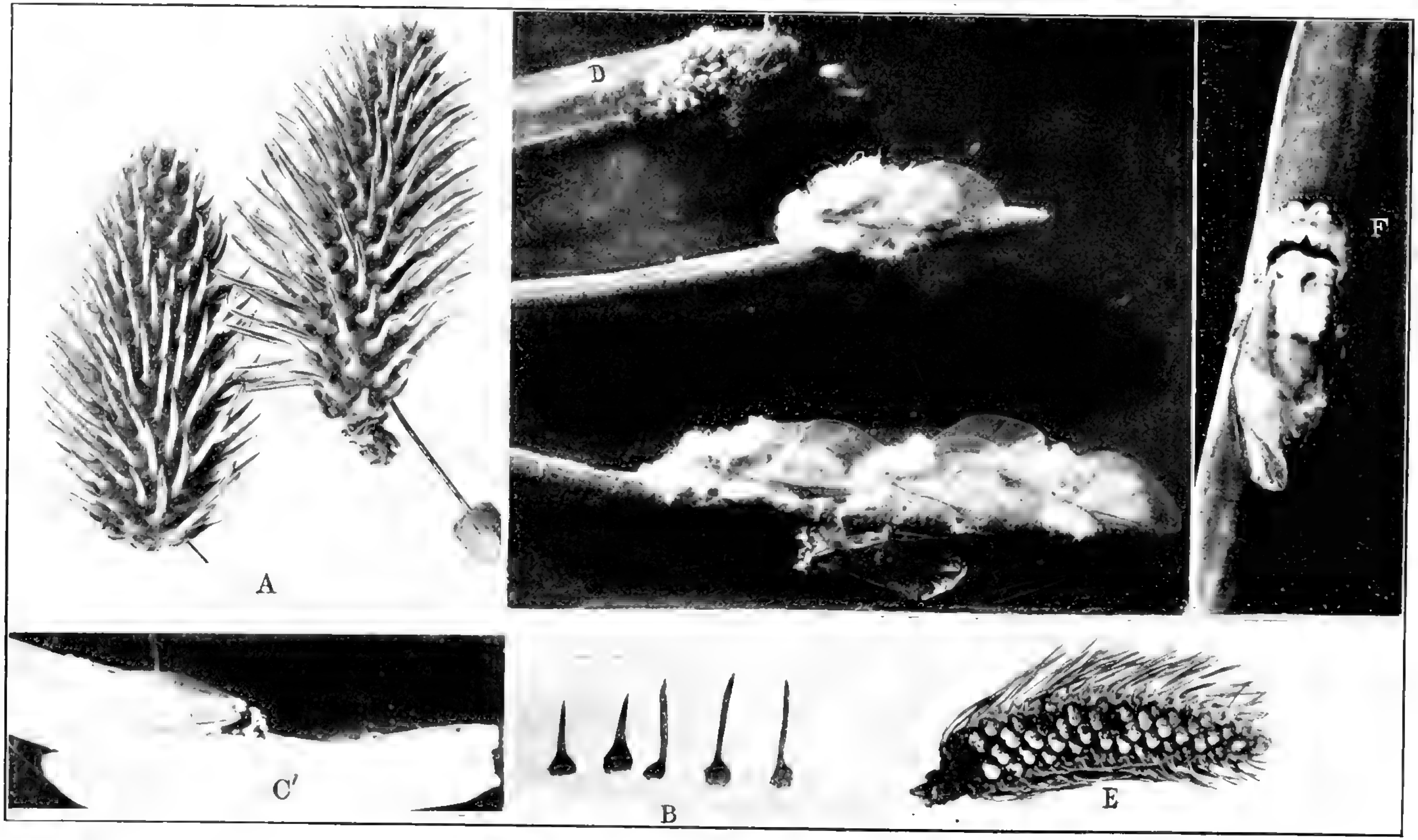

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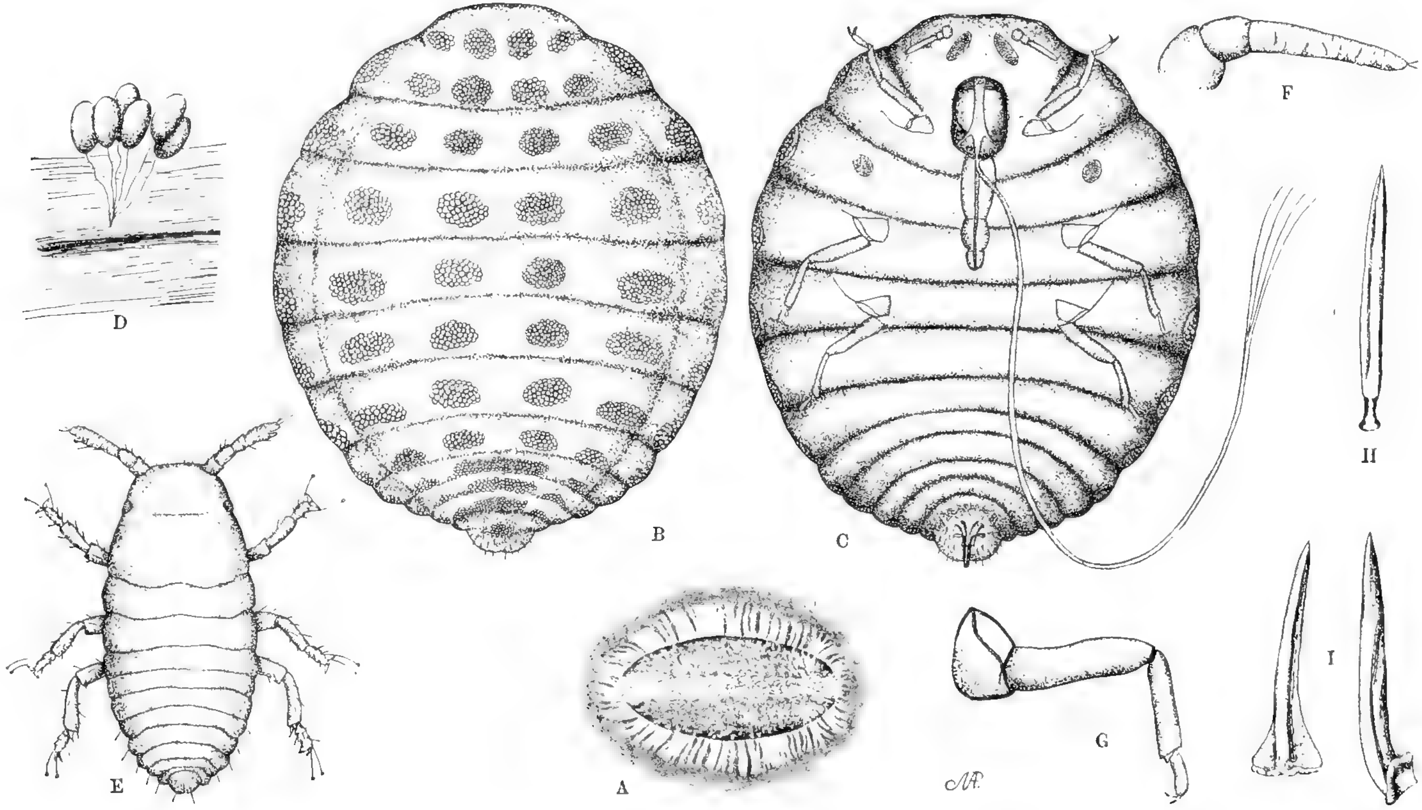

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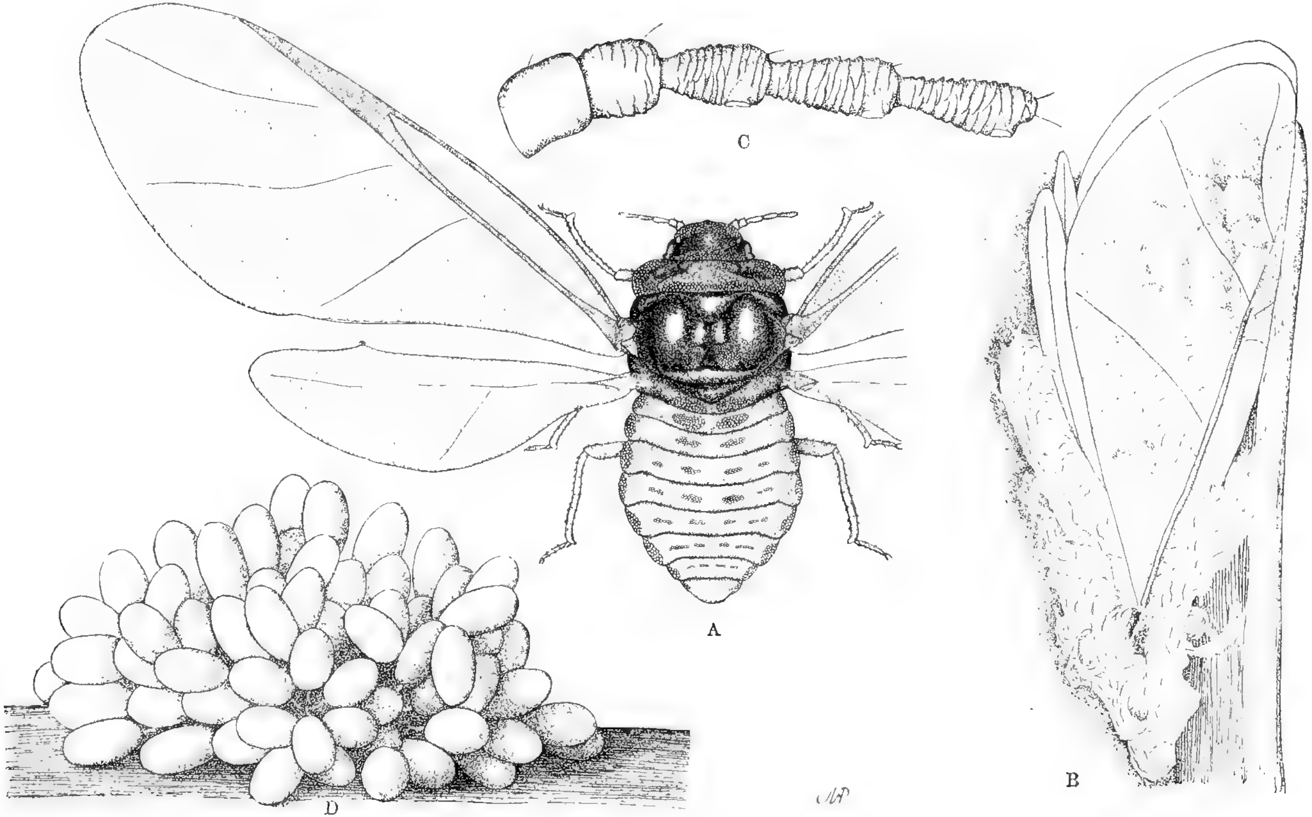
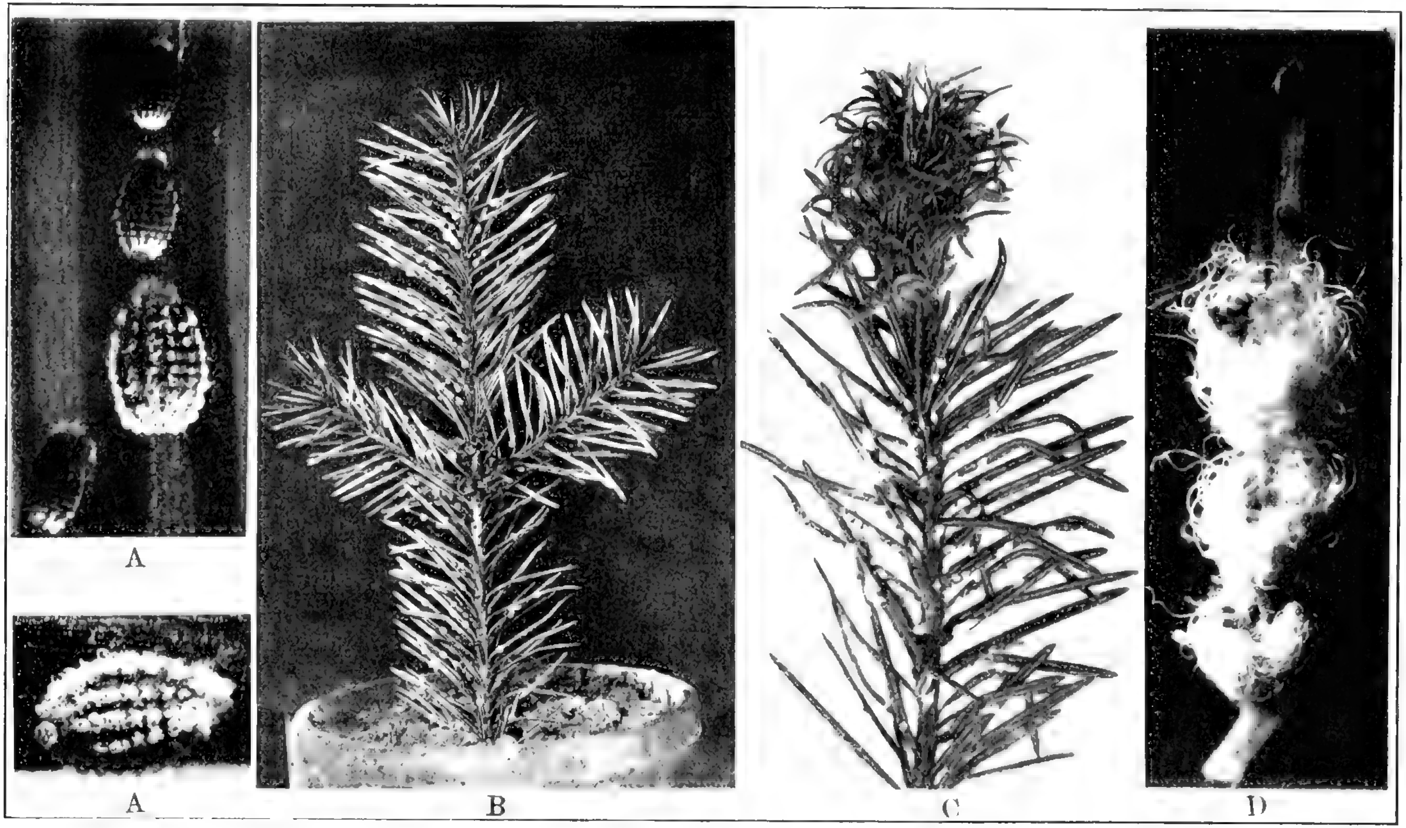


GILLETTE ON CHERMES.

PLATE V.



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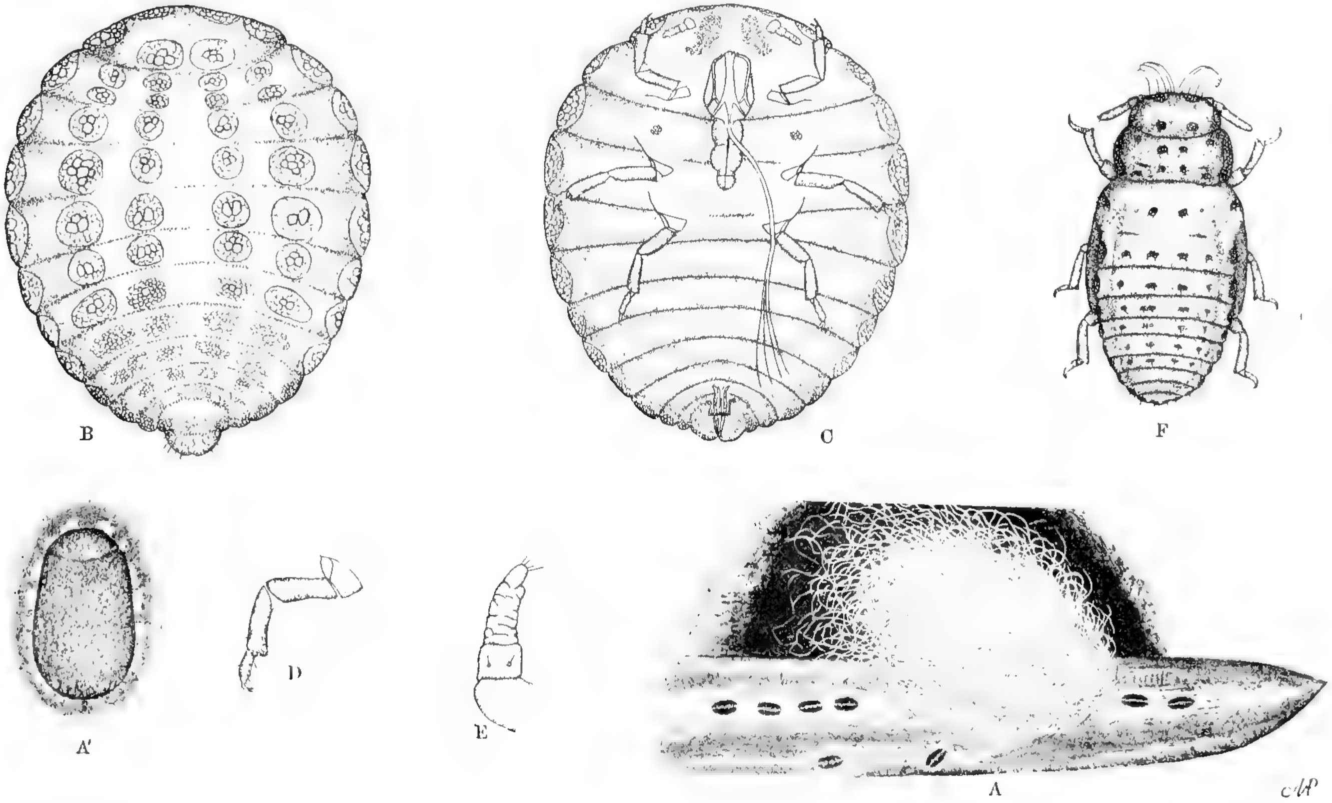

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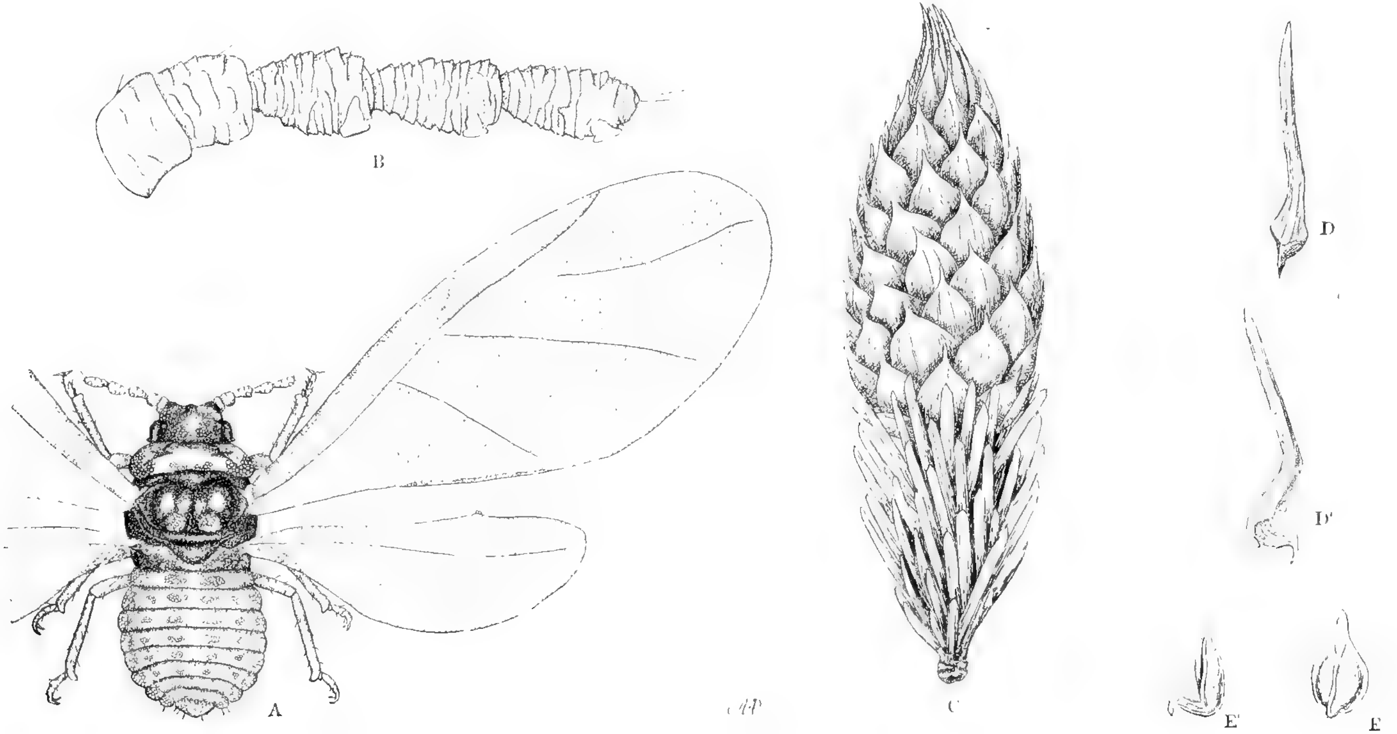

GILLETTE ON CHERMES.

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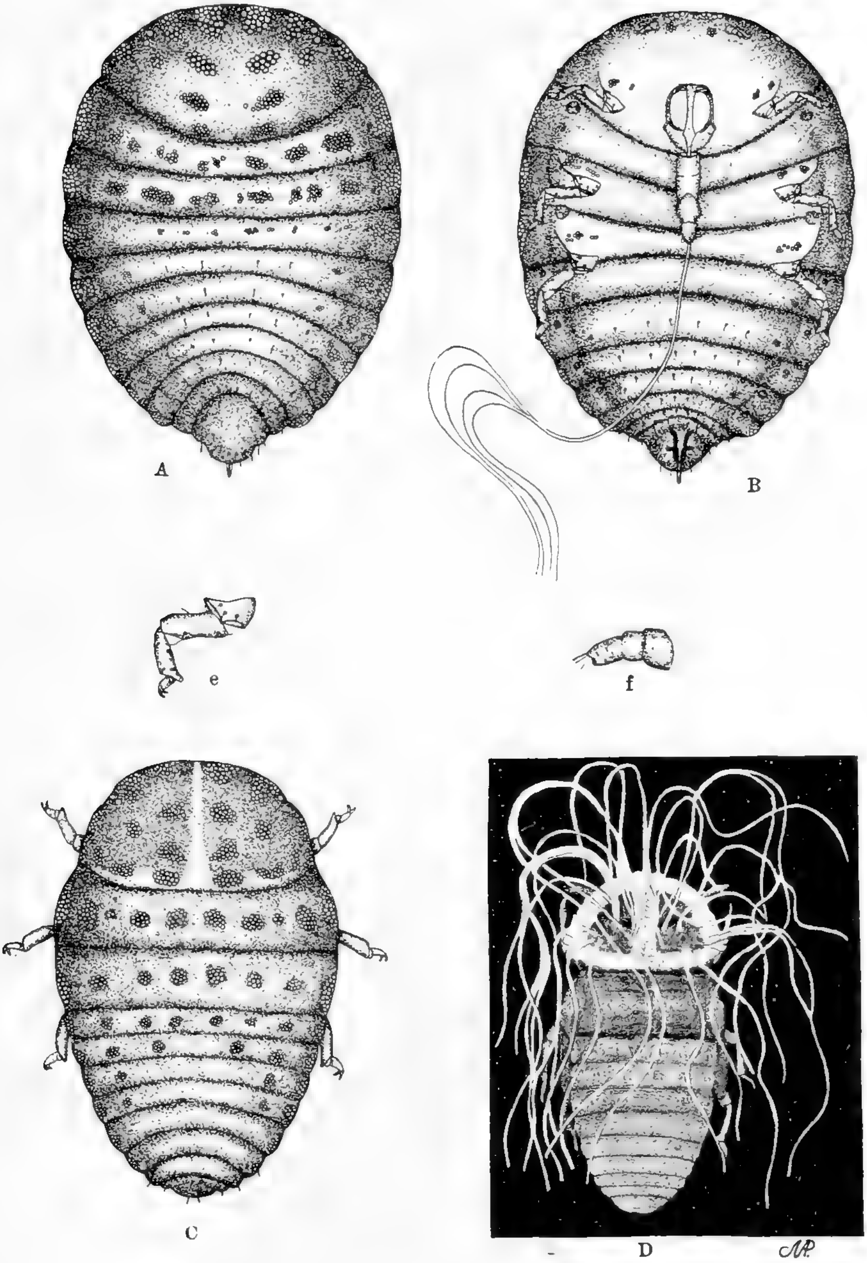
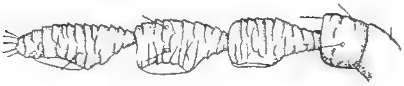


GILLETTE ON CHERMES.



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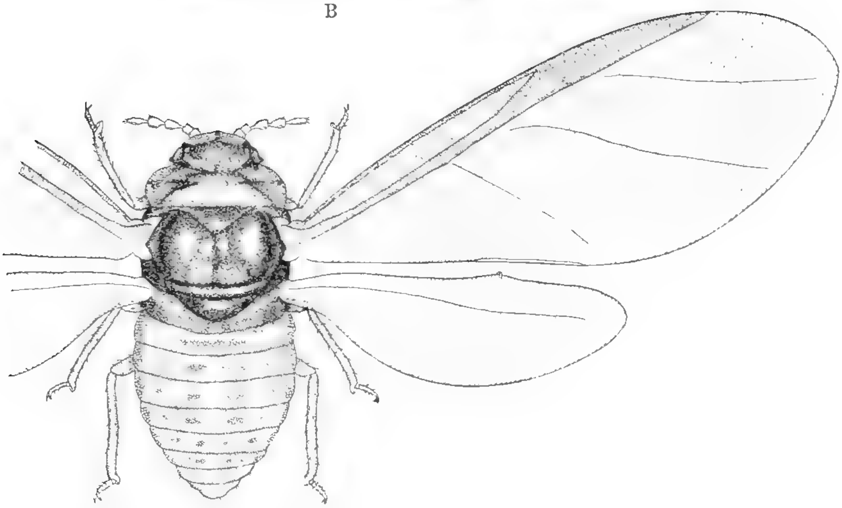

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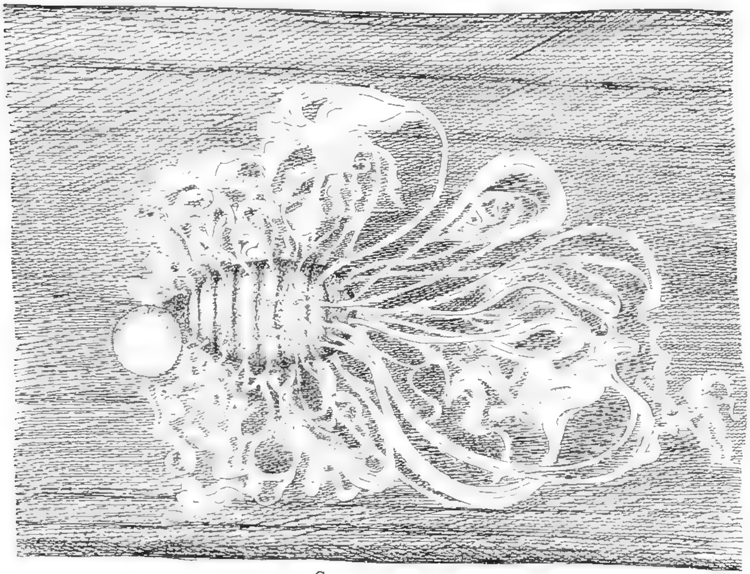

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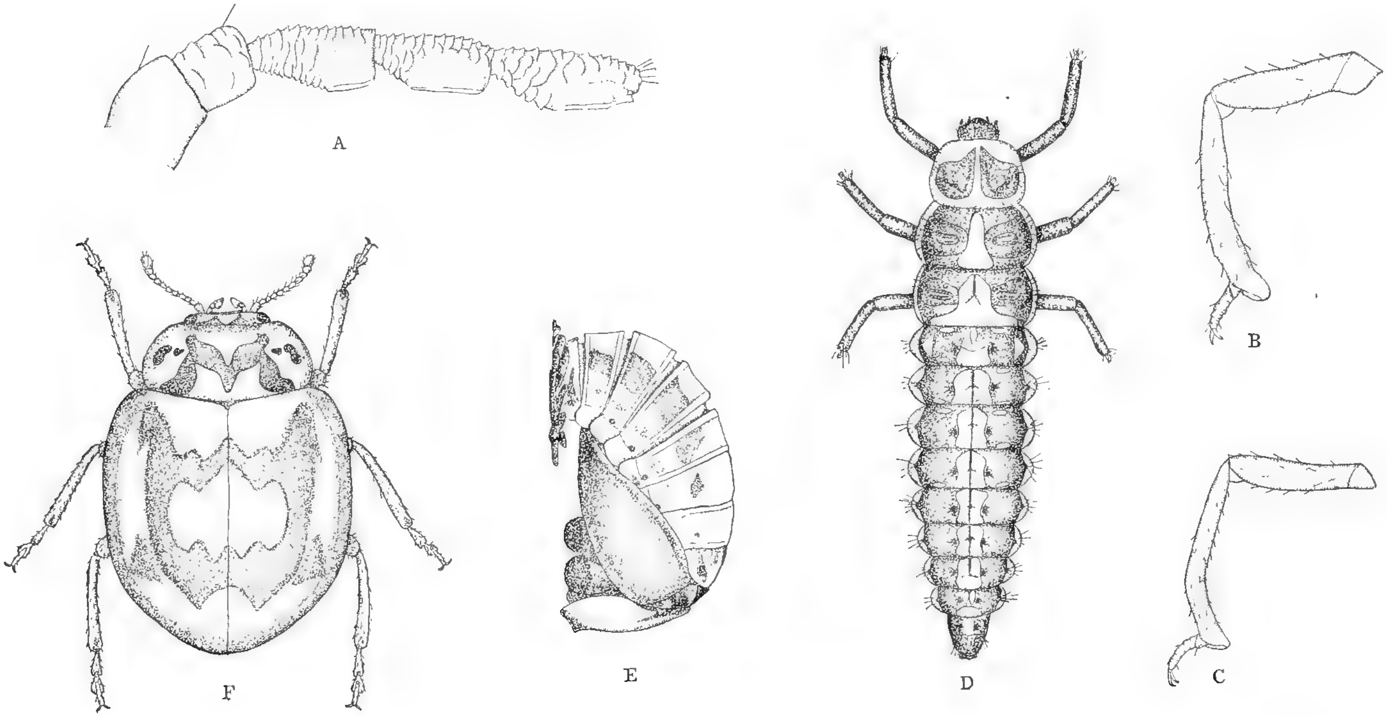
GILLETTE ON CHERMES.

PLATE XI.



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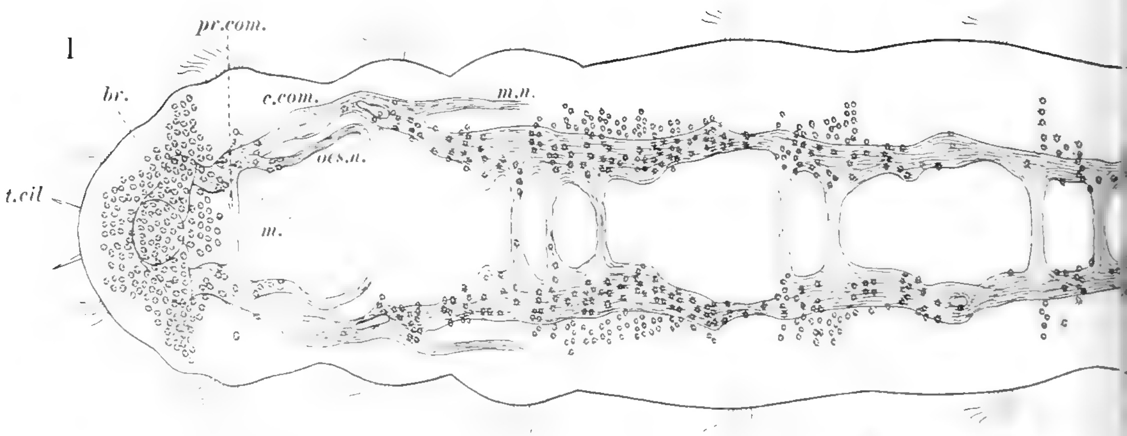
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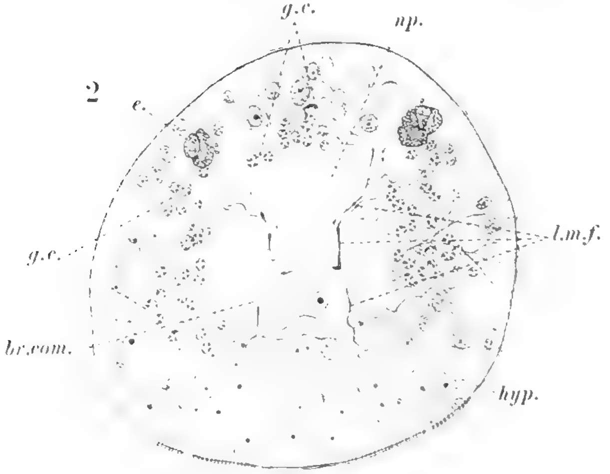
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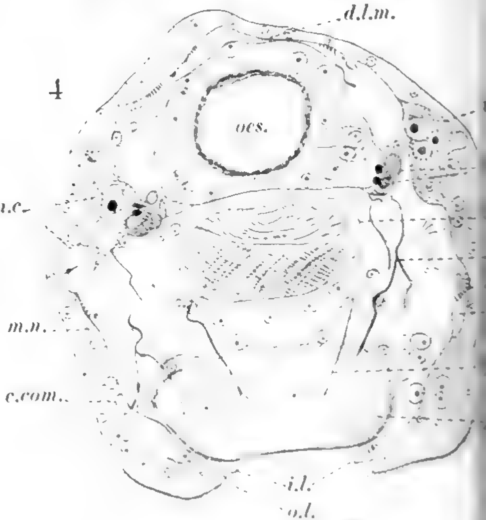
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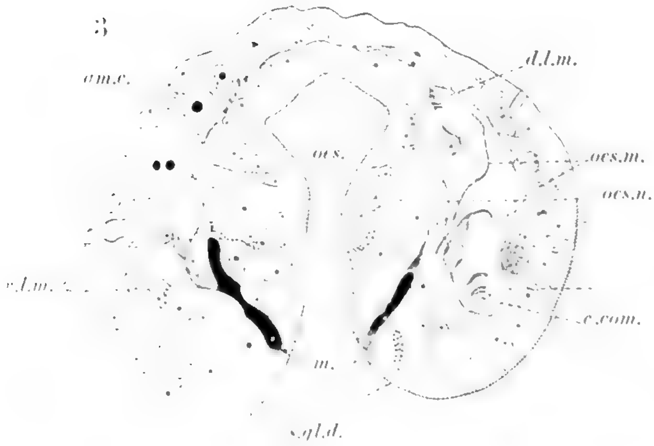
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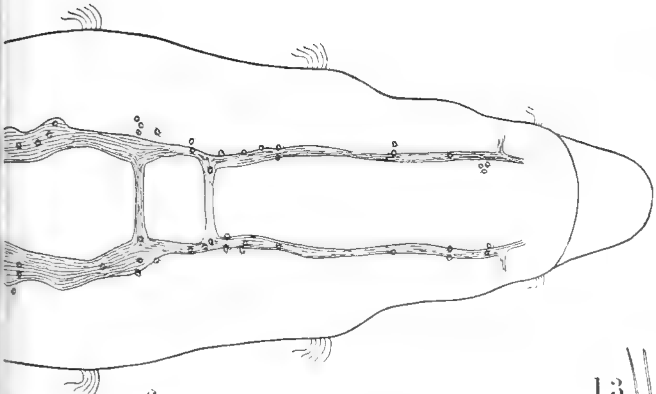
PLATE XII.



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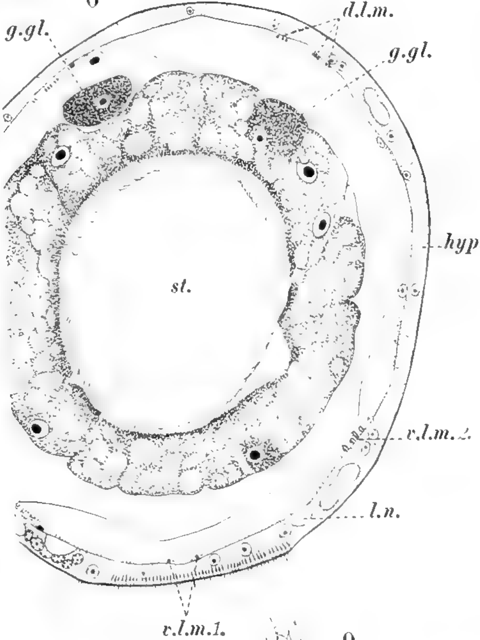

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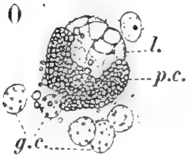

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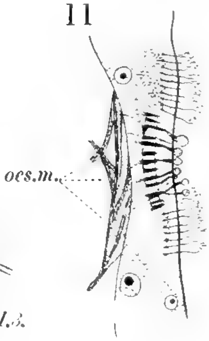

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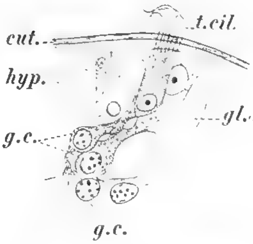

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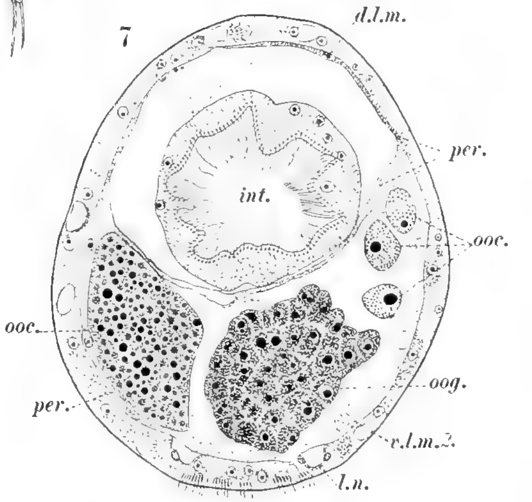

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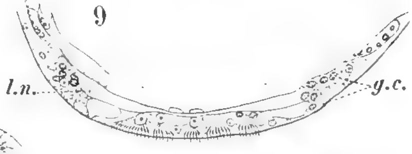

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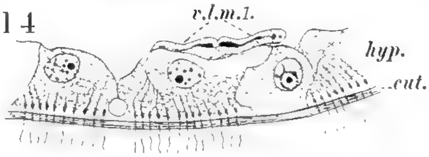

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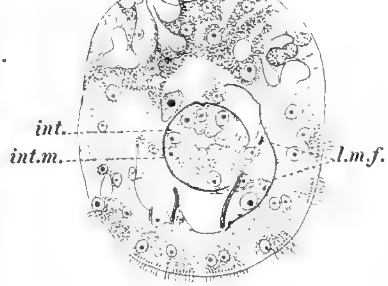

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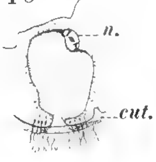

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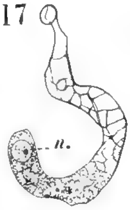

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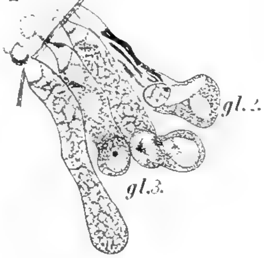

HILUS CONKLINI.

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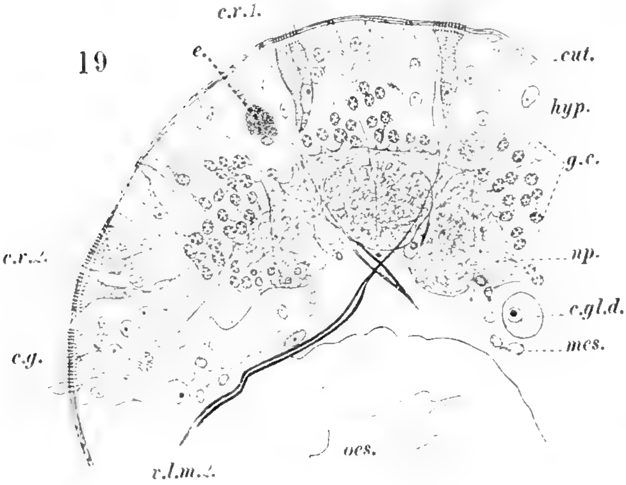

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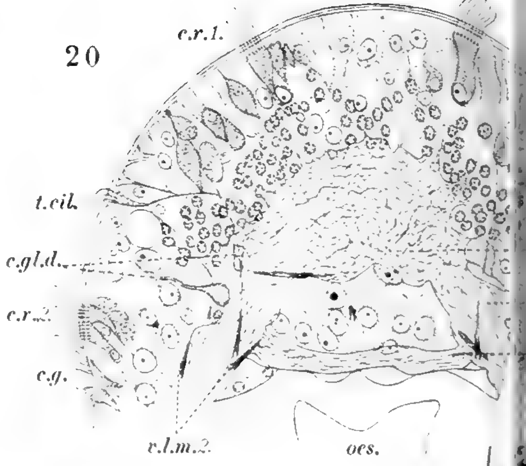

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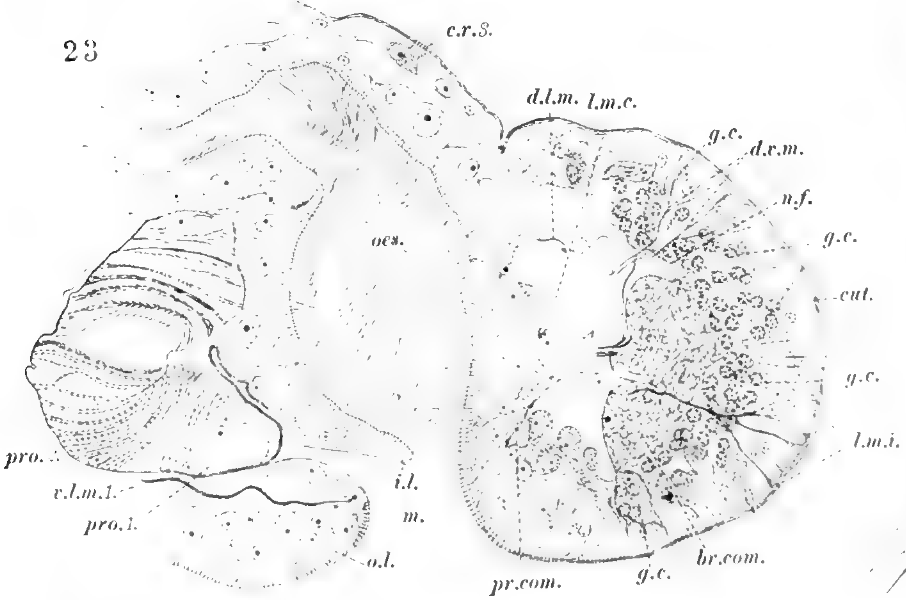

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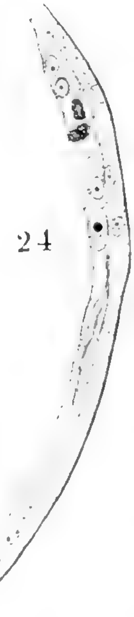

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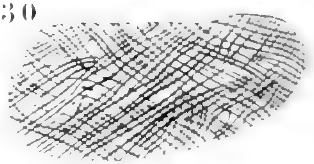

PLATE XIII.

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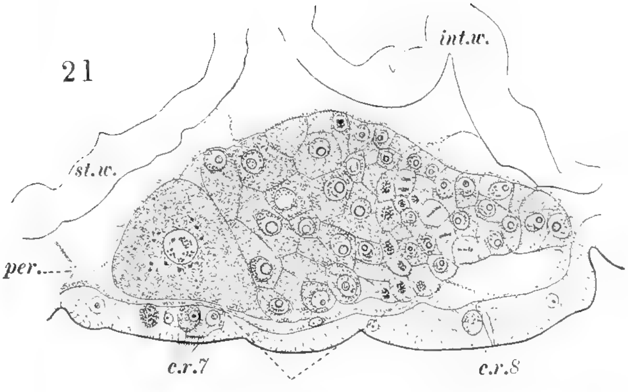

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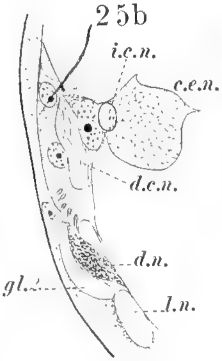

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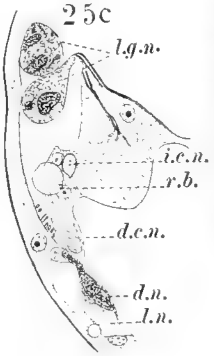

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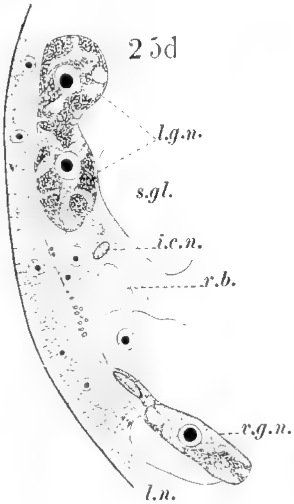

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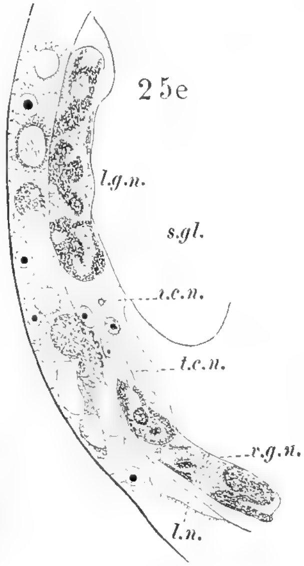

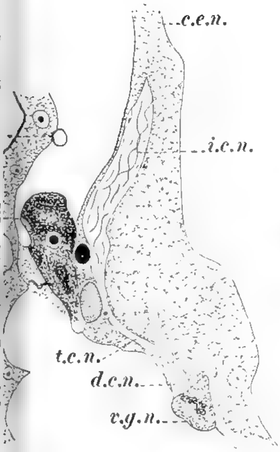

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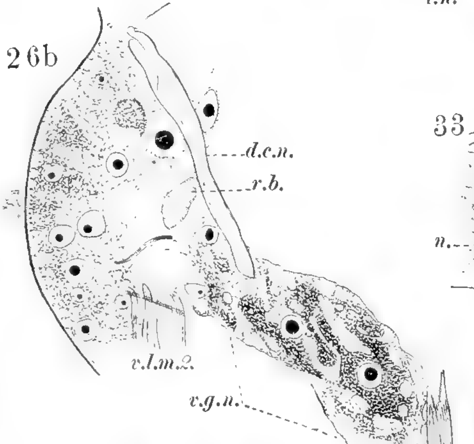

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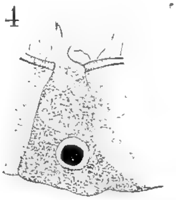

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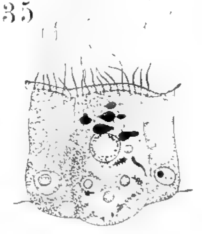

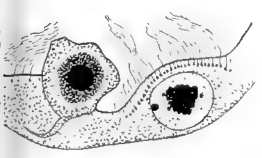

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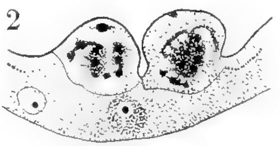

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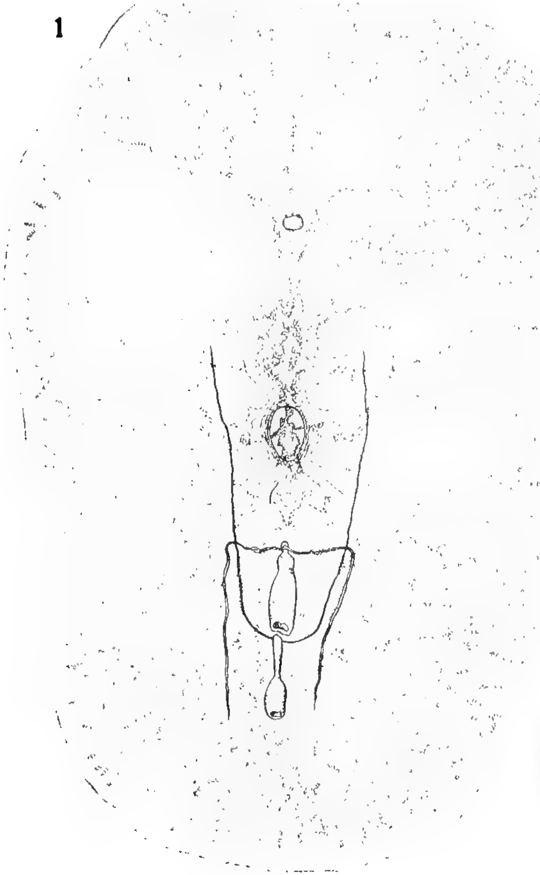

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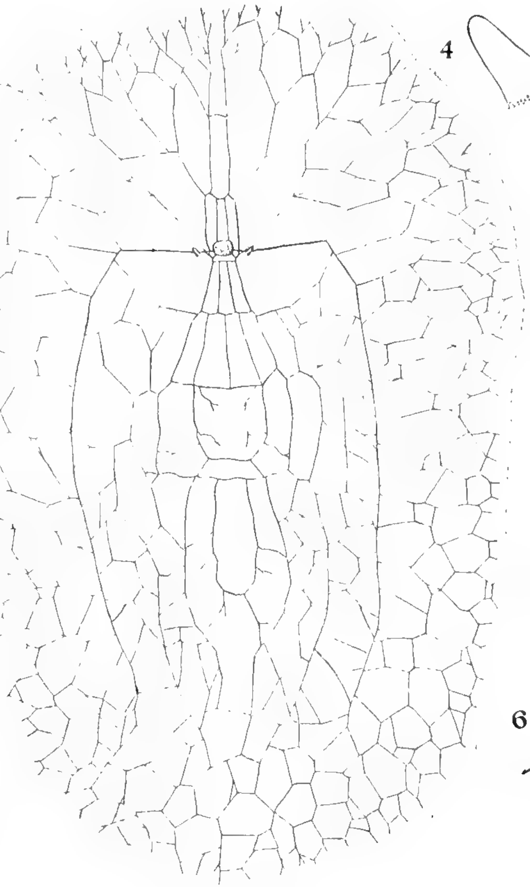

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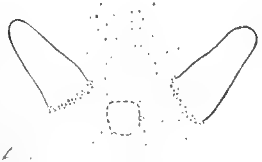

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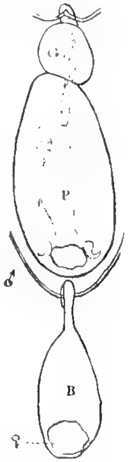

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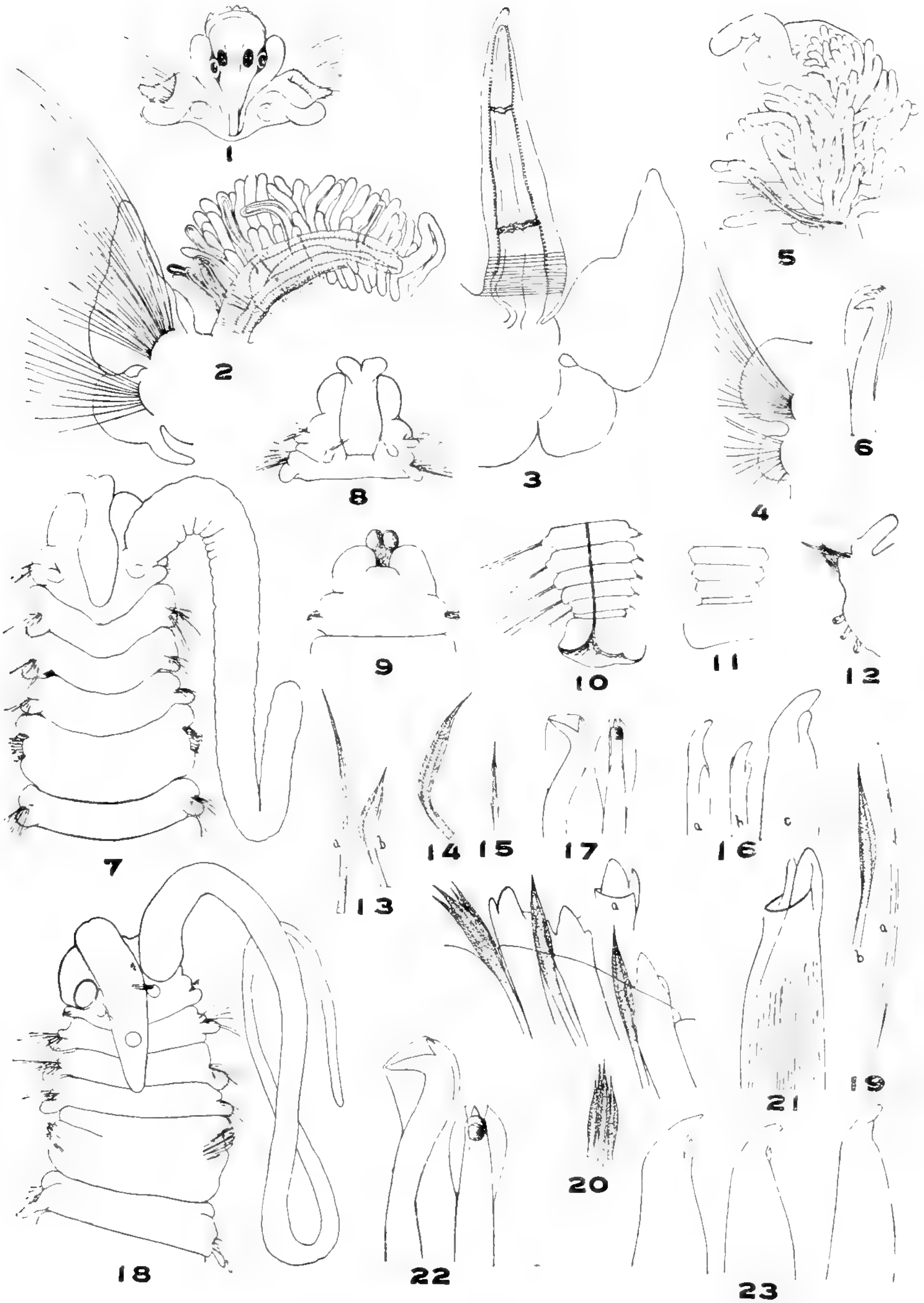
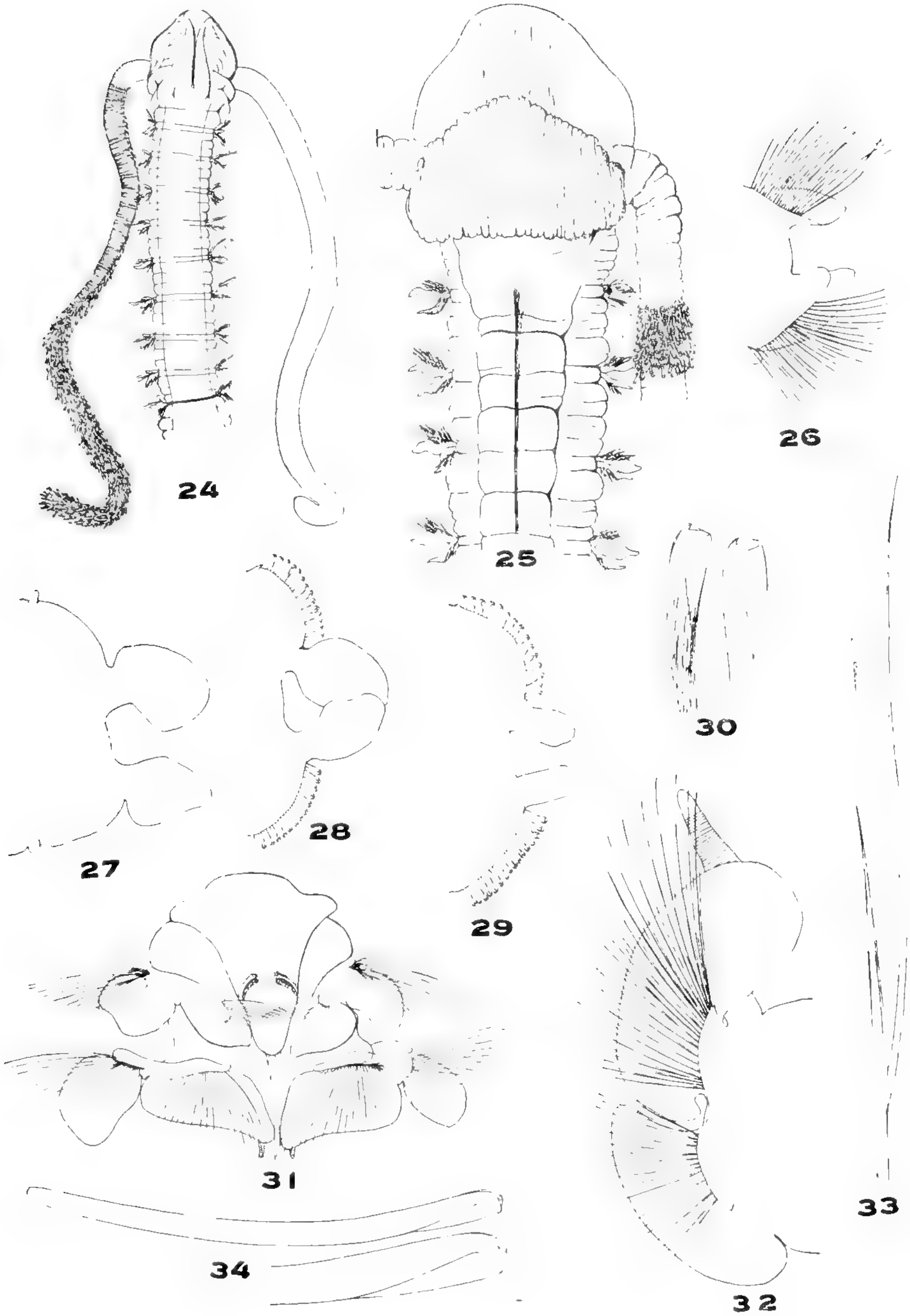


MOORE. NEW SPIONIFORMIA.



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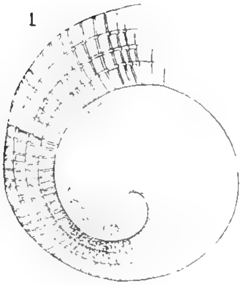

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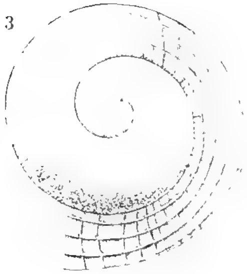

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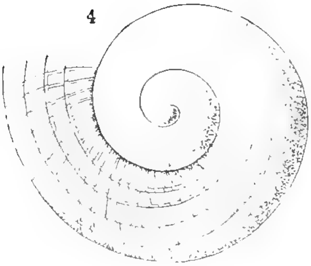

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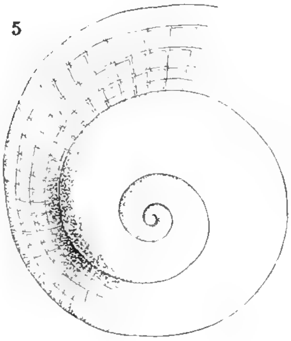

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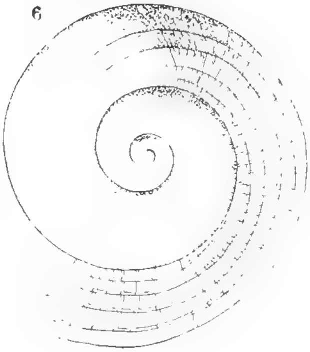

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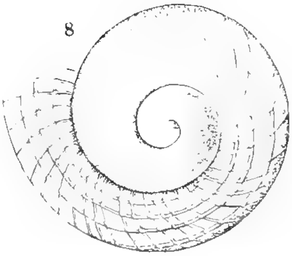

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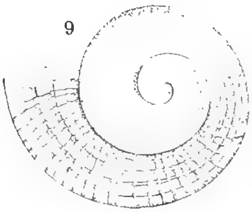
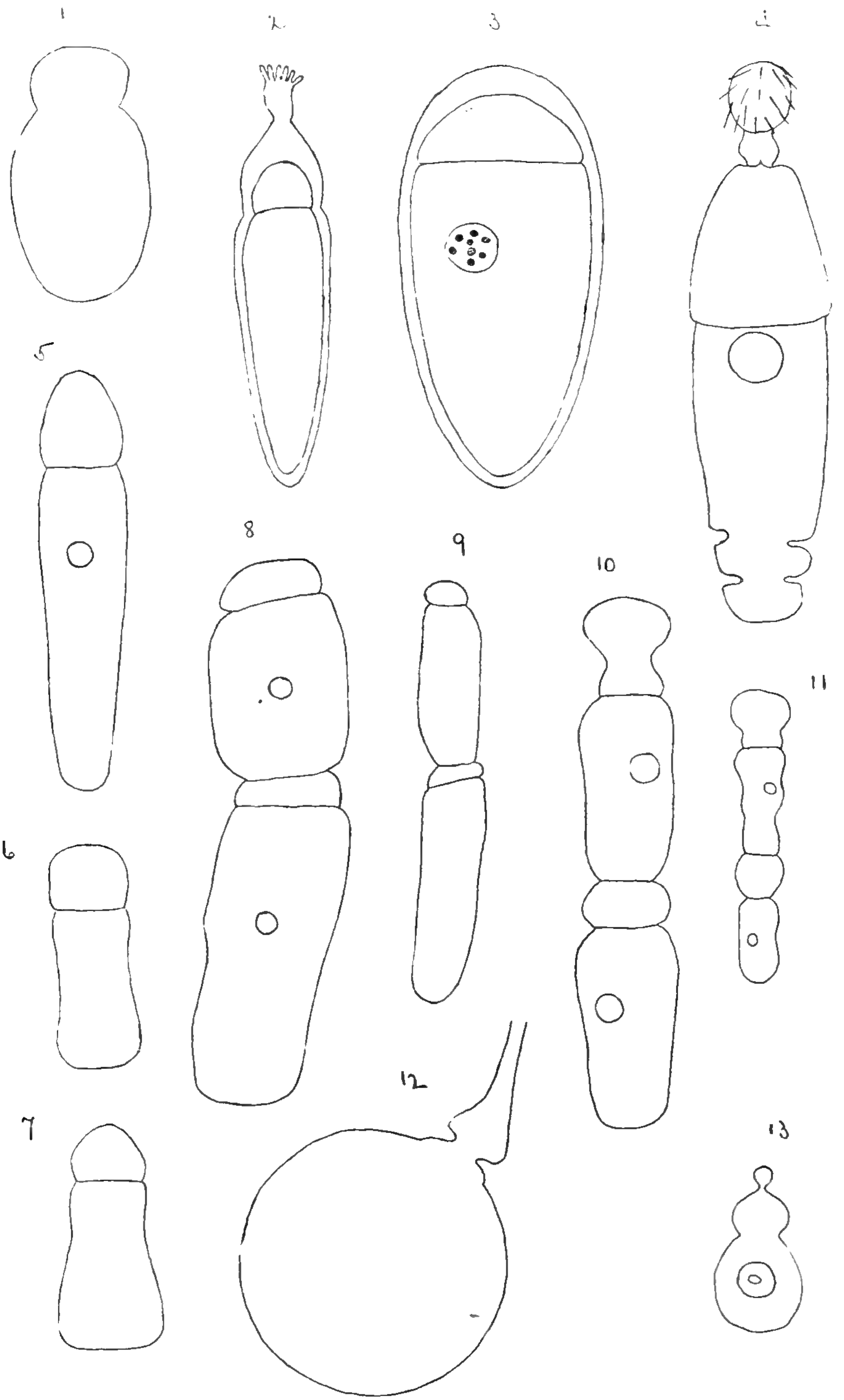
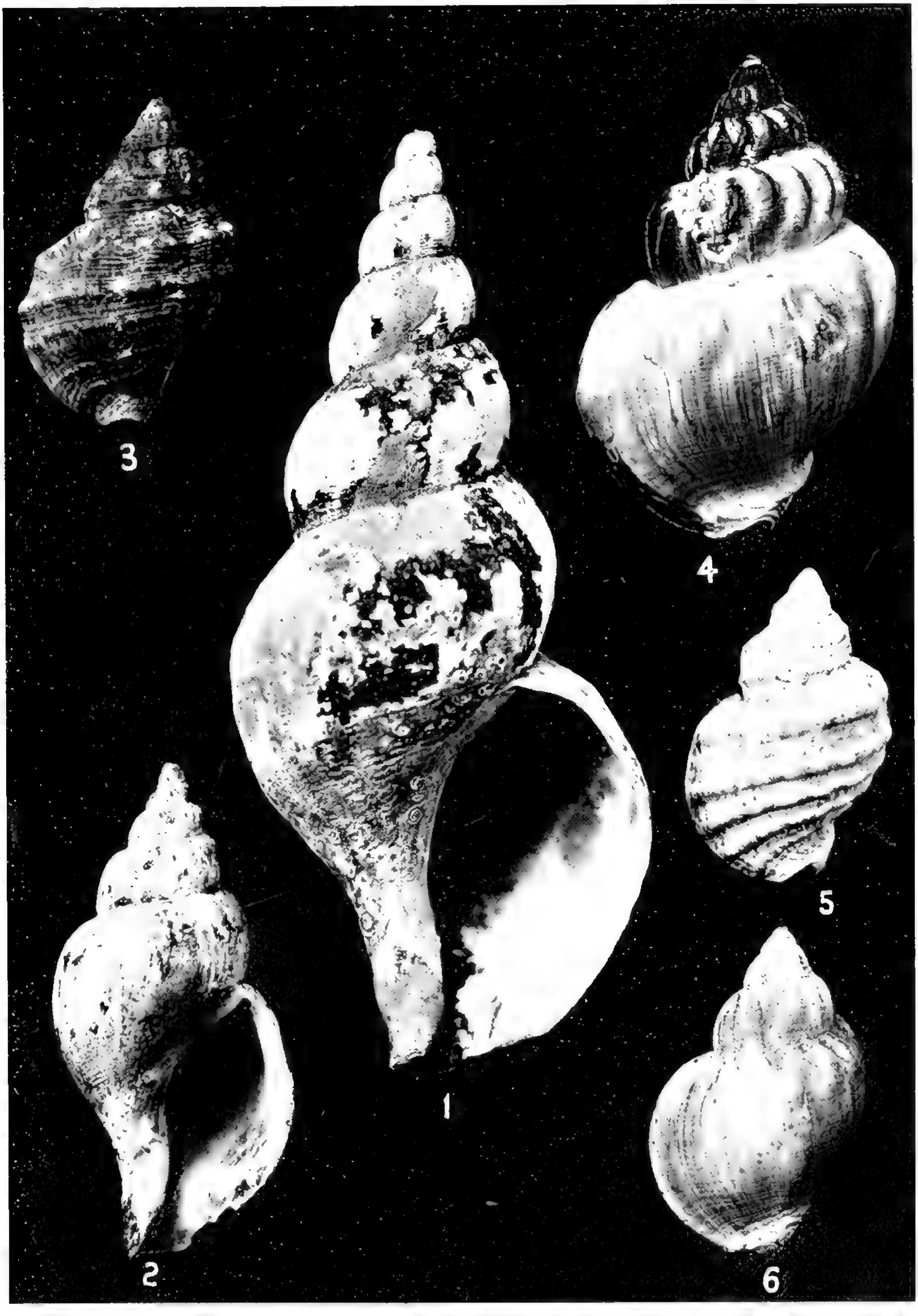


BURNETT SMITH ON PYRULA.



CRAWLEY ON GREGARINES



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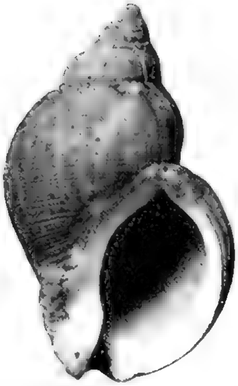
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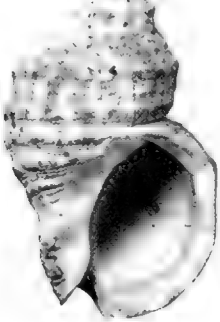
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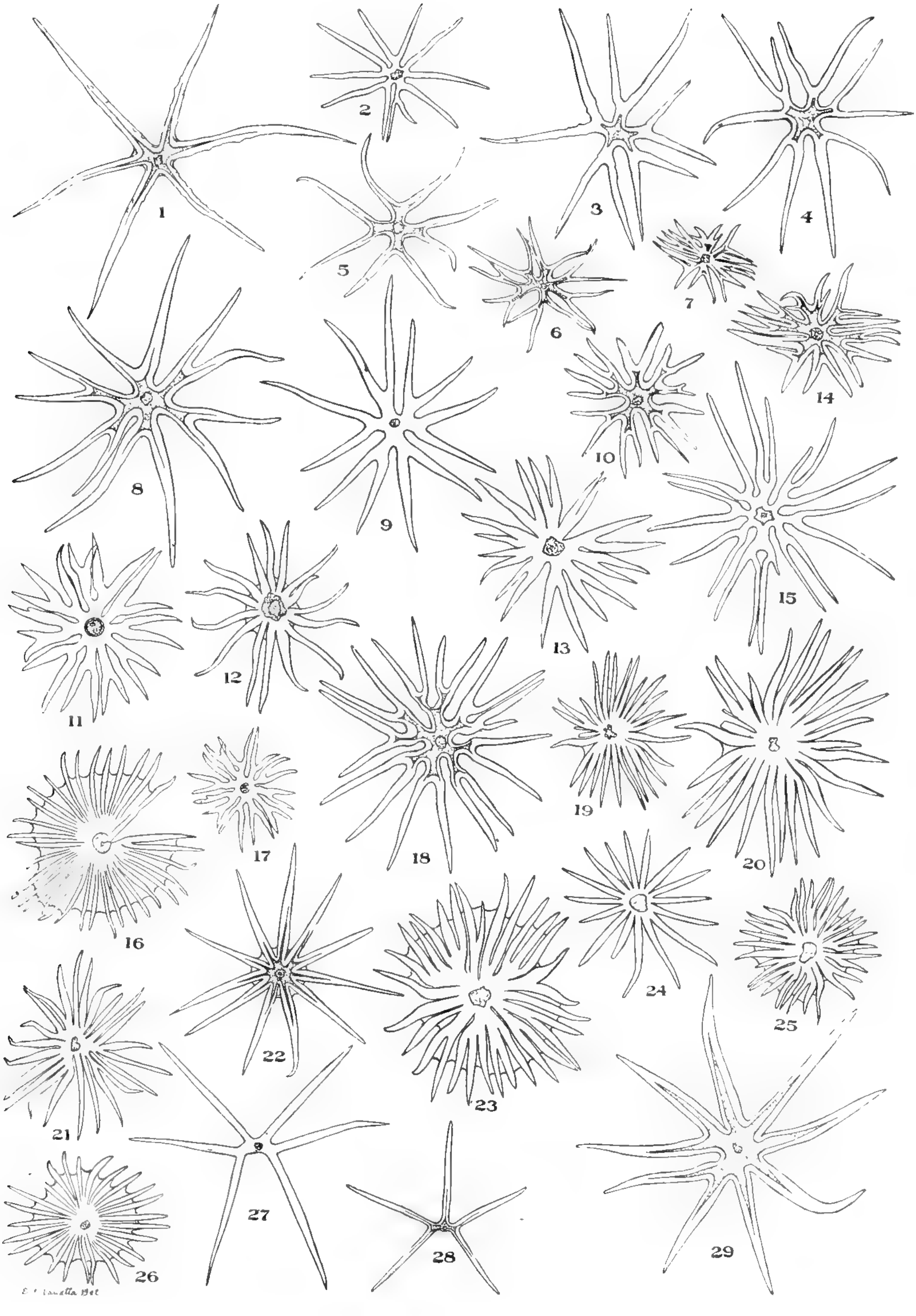
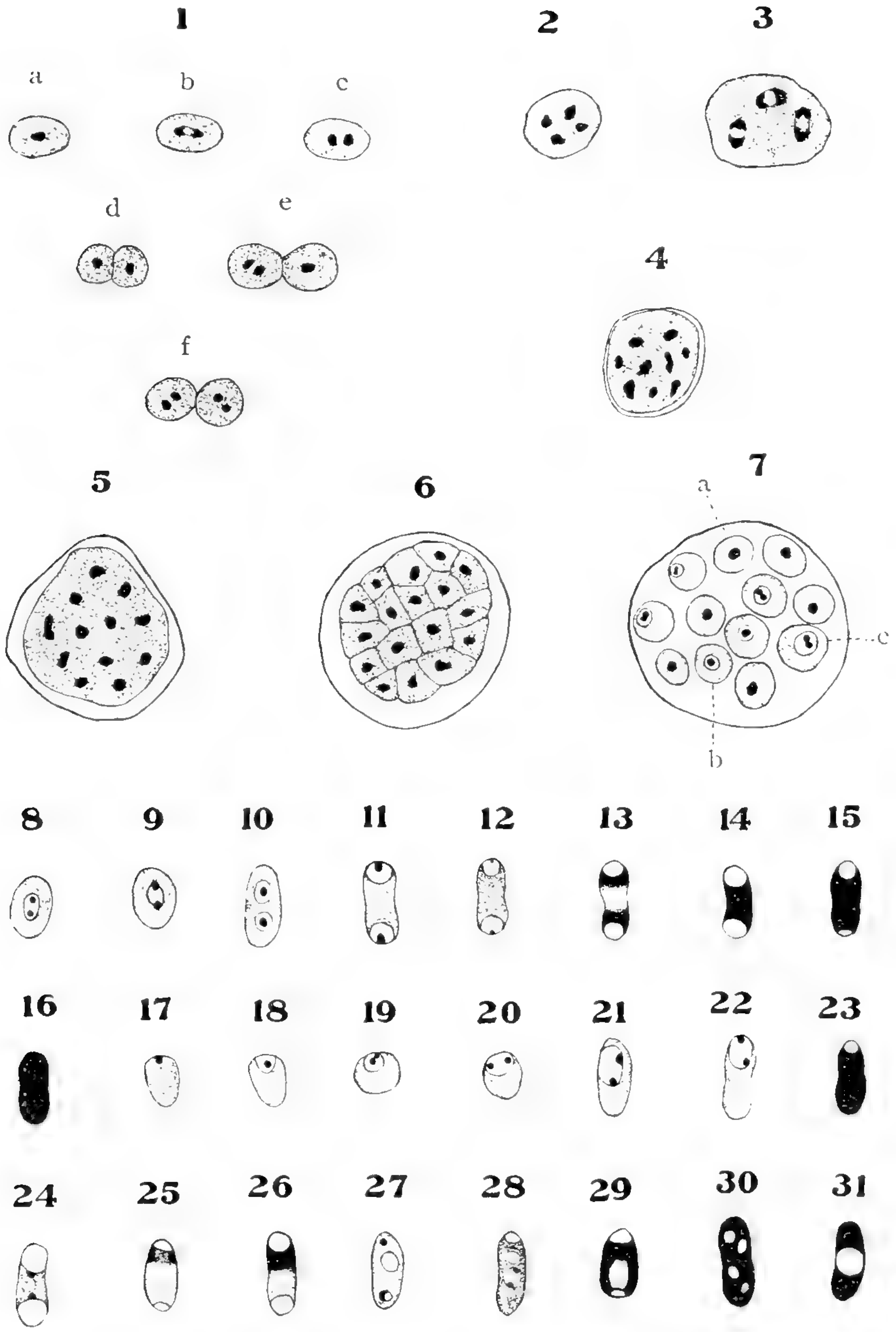
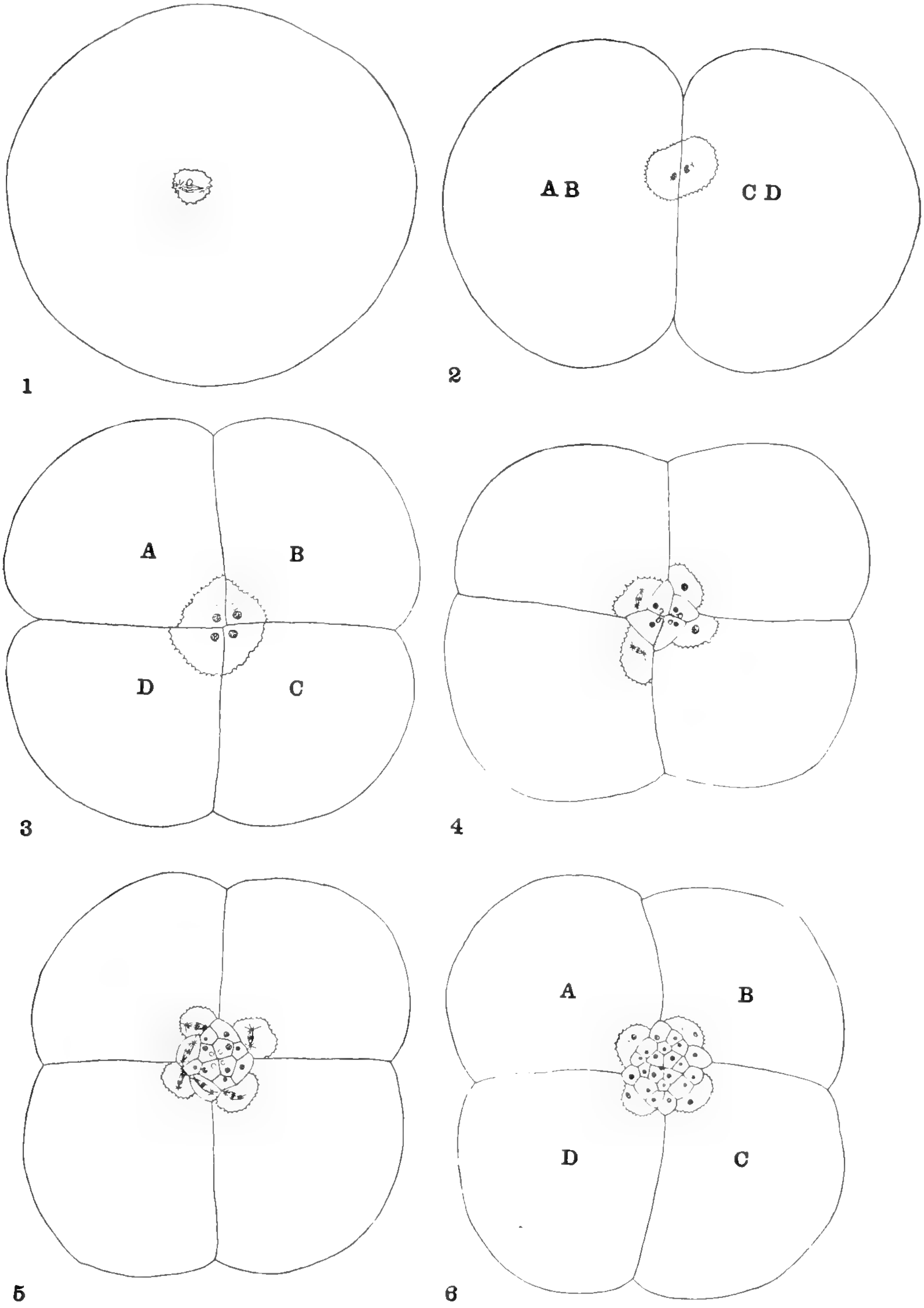


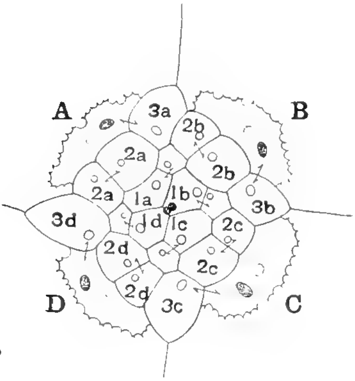
VANATTA. LEAF HAIRS OF LESQUERELLA.



KING. BERTRAMIA BUFONIS



CONKLIN. EMBRYOLOGY OF FULGUR.



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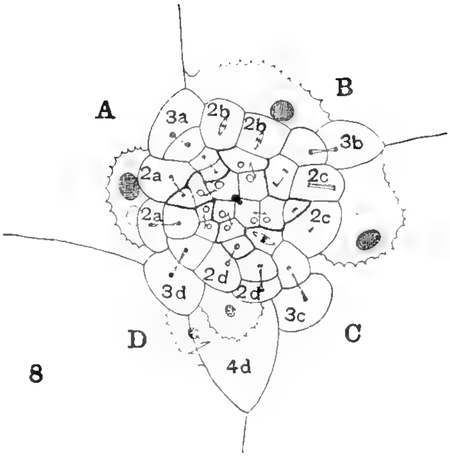

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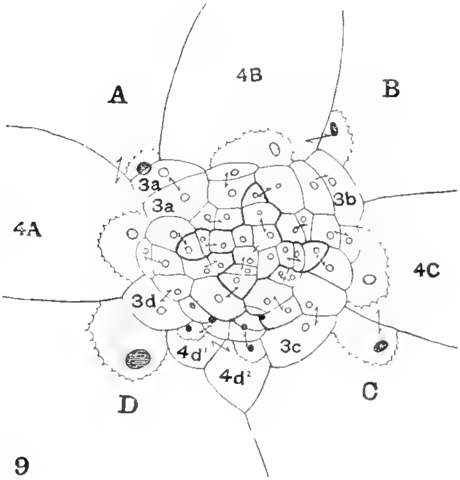

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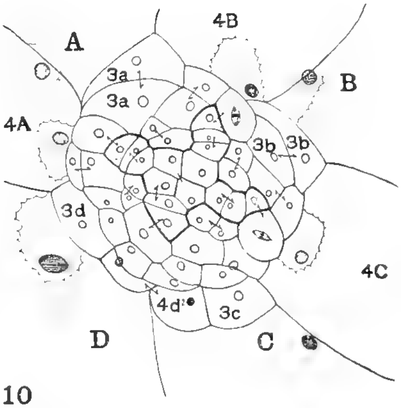

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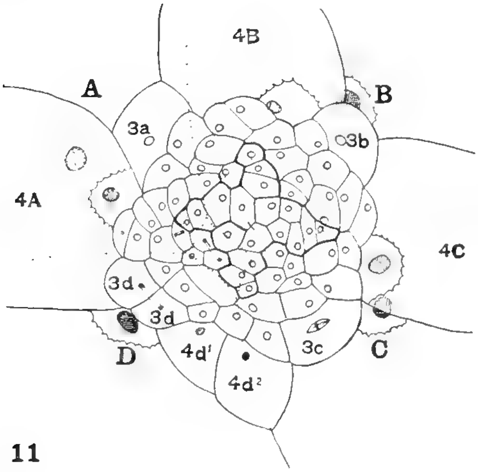

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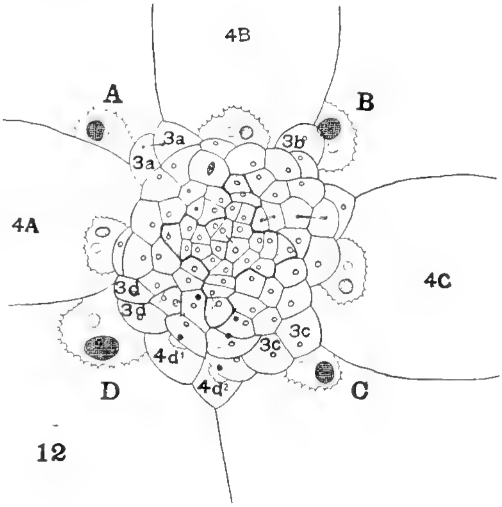

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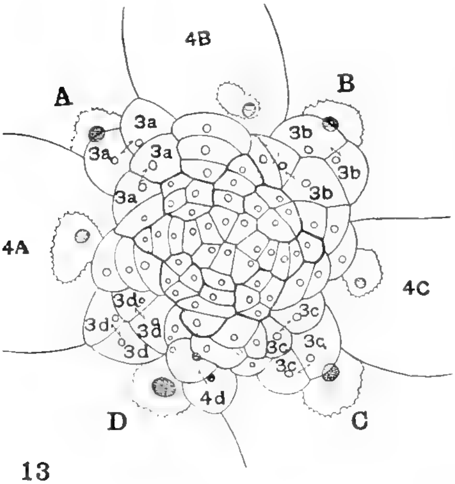
CONKLIN. EMBRYOLOGY OF FULGUR.



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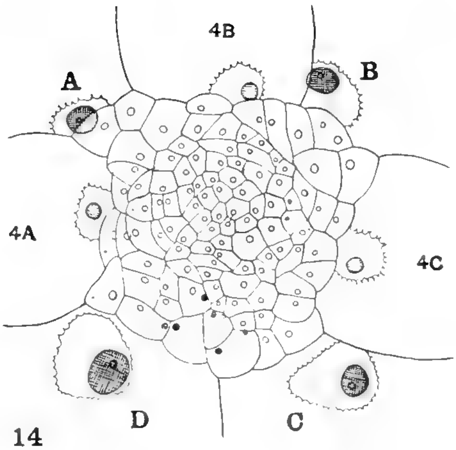

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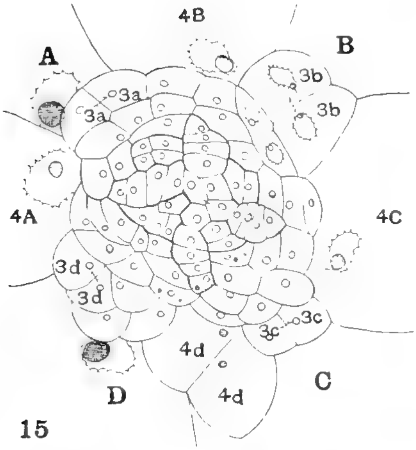

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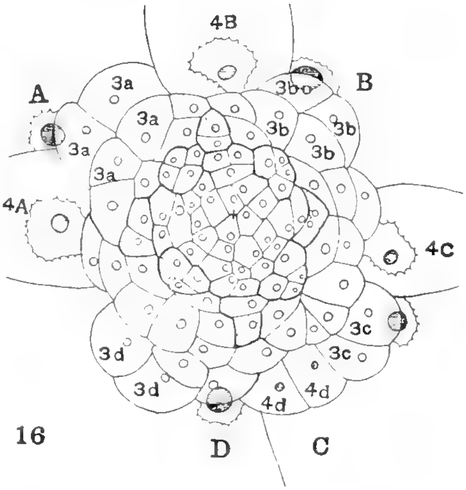

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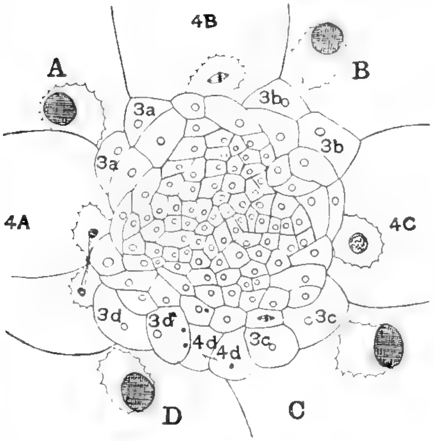

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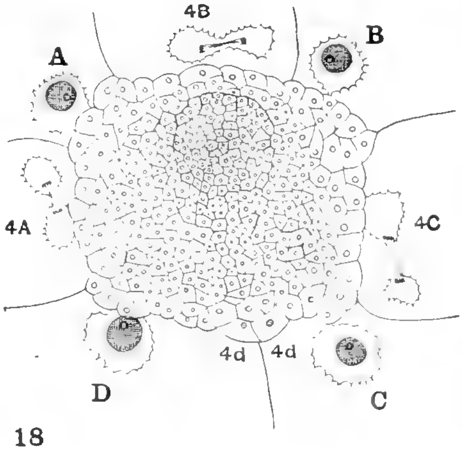

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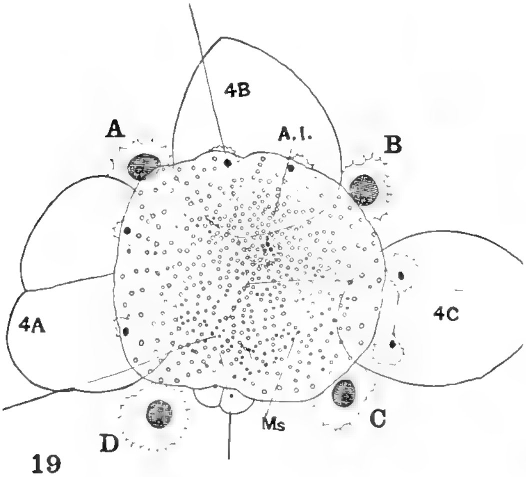

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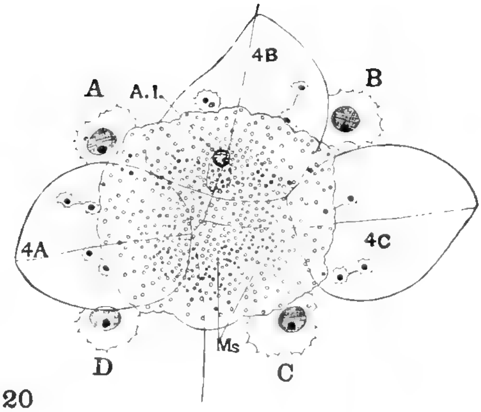

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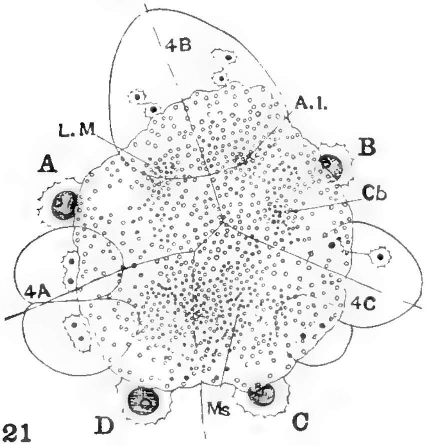

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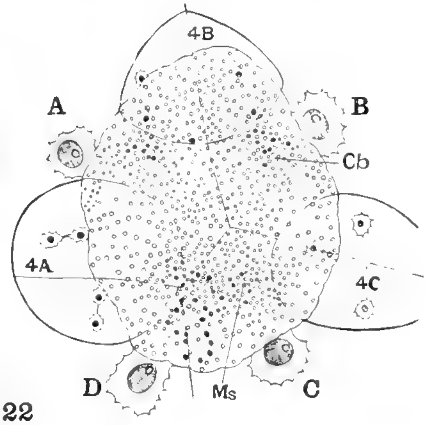

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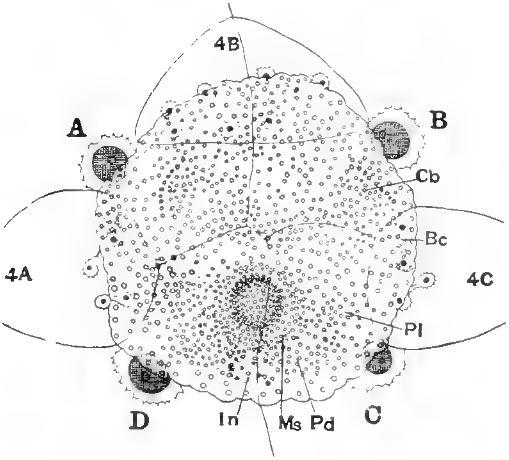

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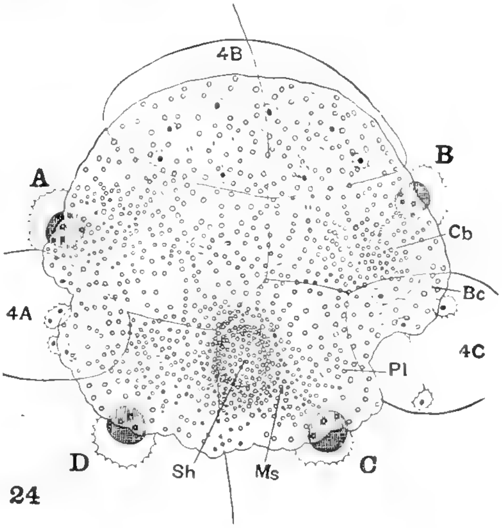

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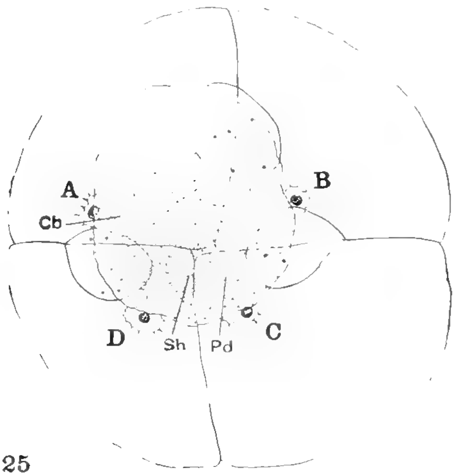

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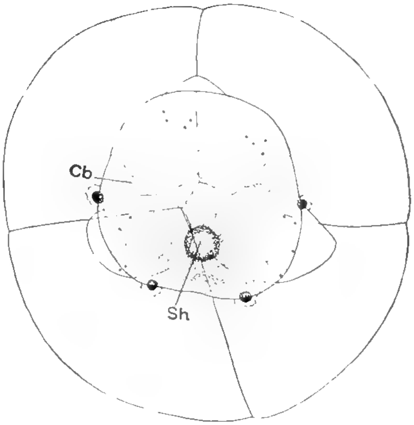

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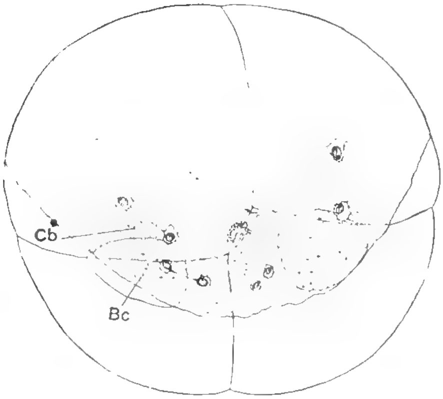

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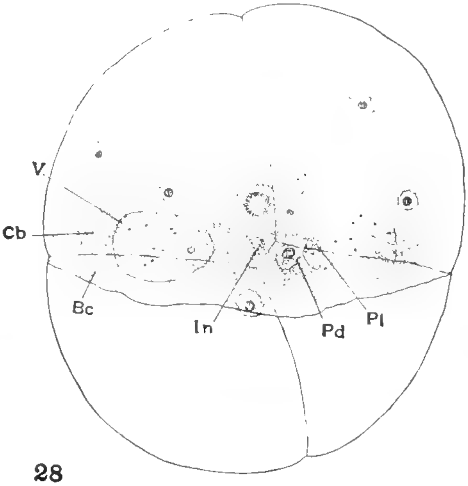

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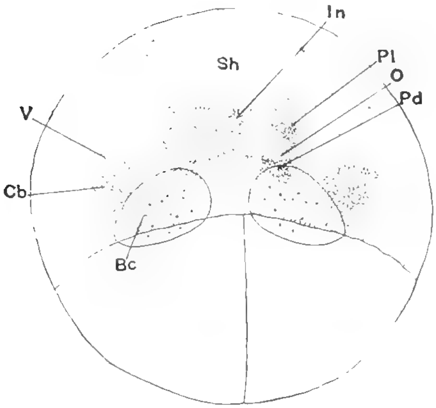

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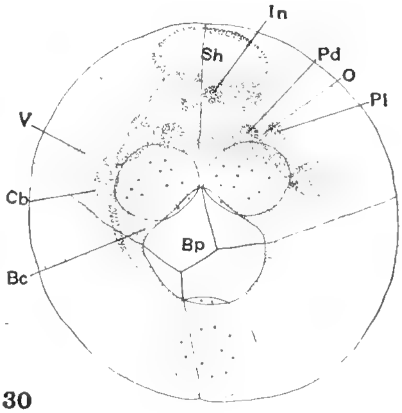

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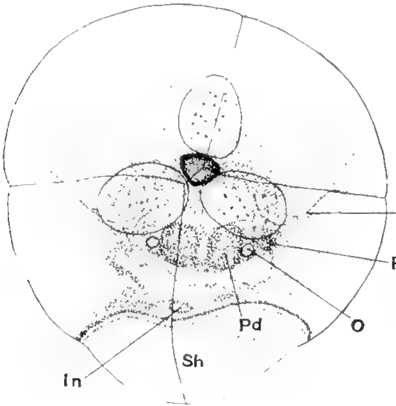

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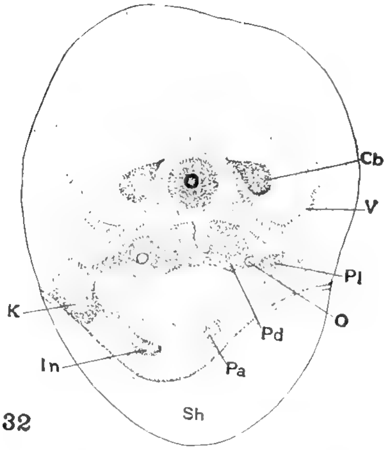

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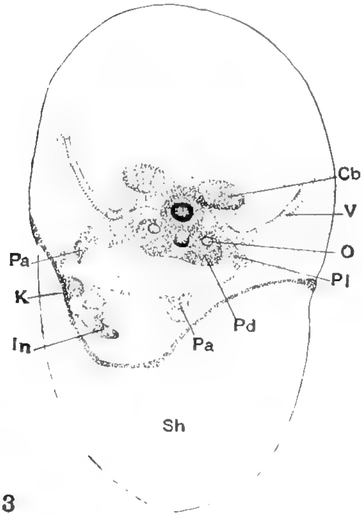

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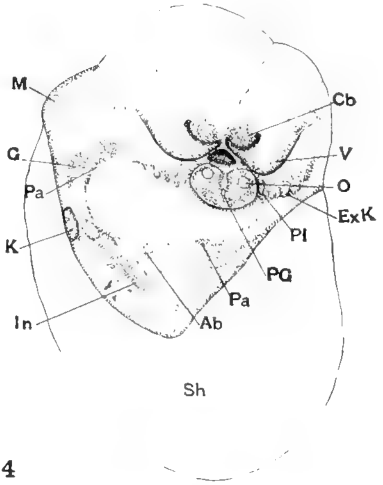

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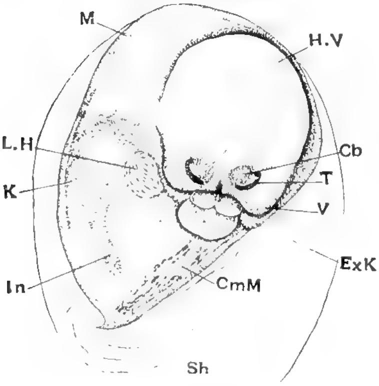

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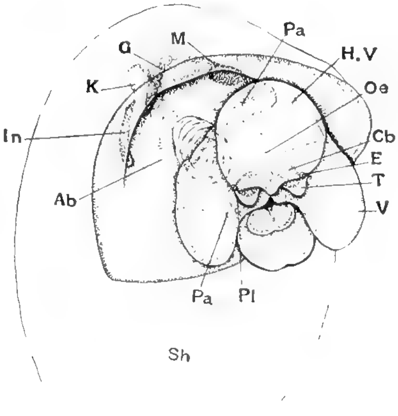

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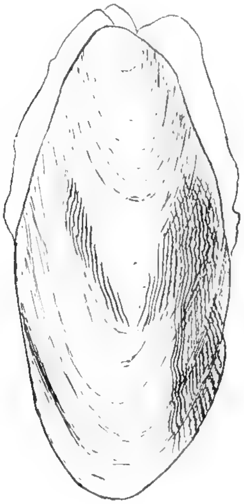

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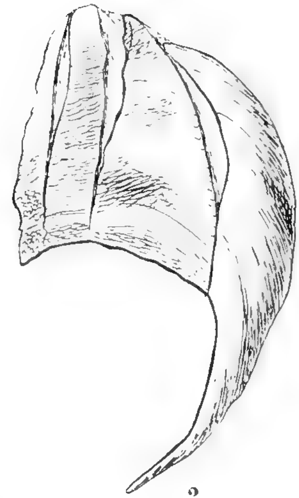

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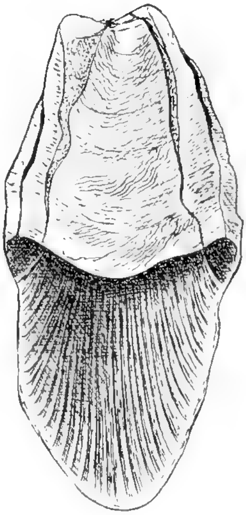

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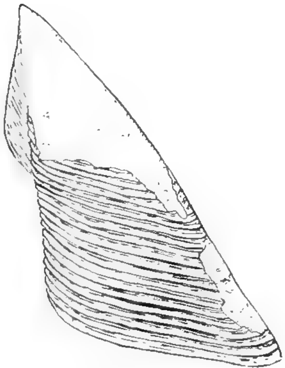

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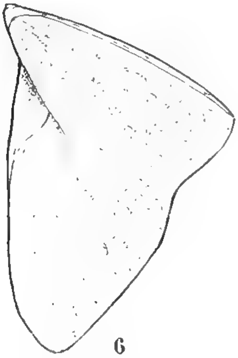

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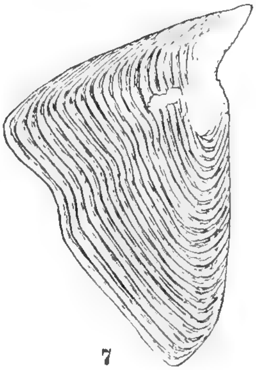

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Pilsbry del.

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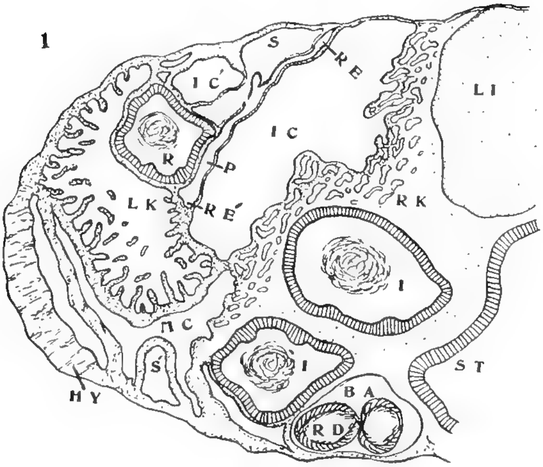

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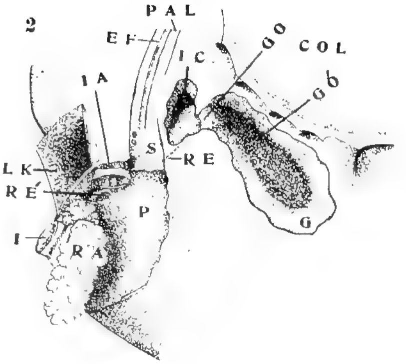

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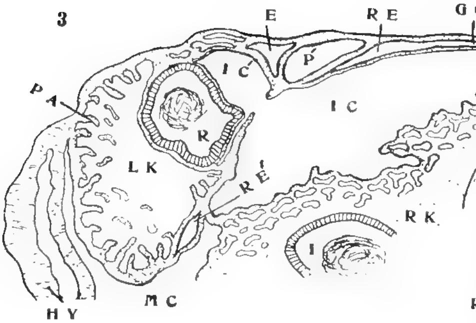

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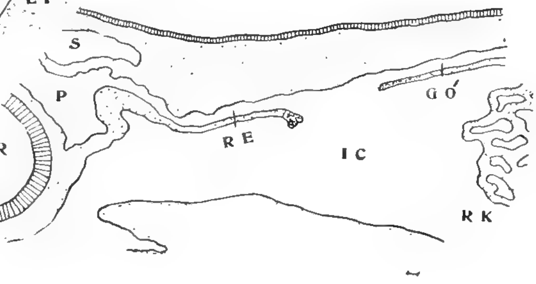

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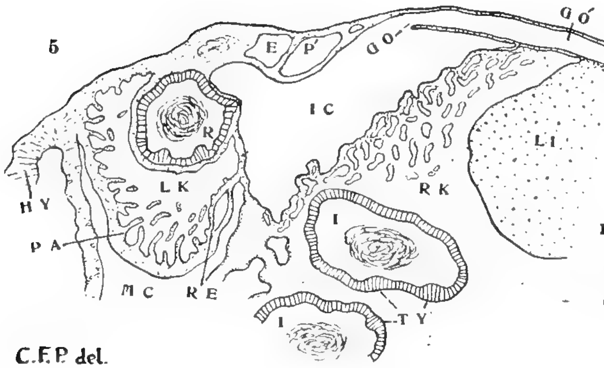

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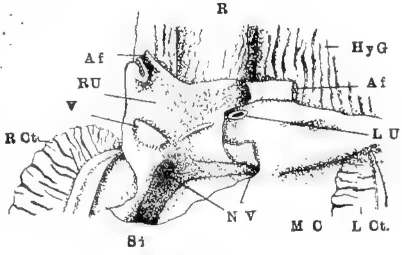
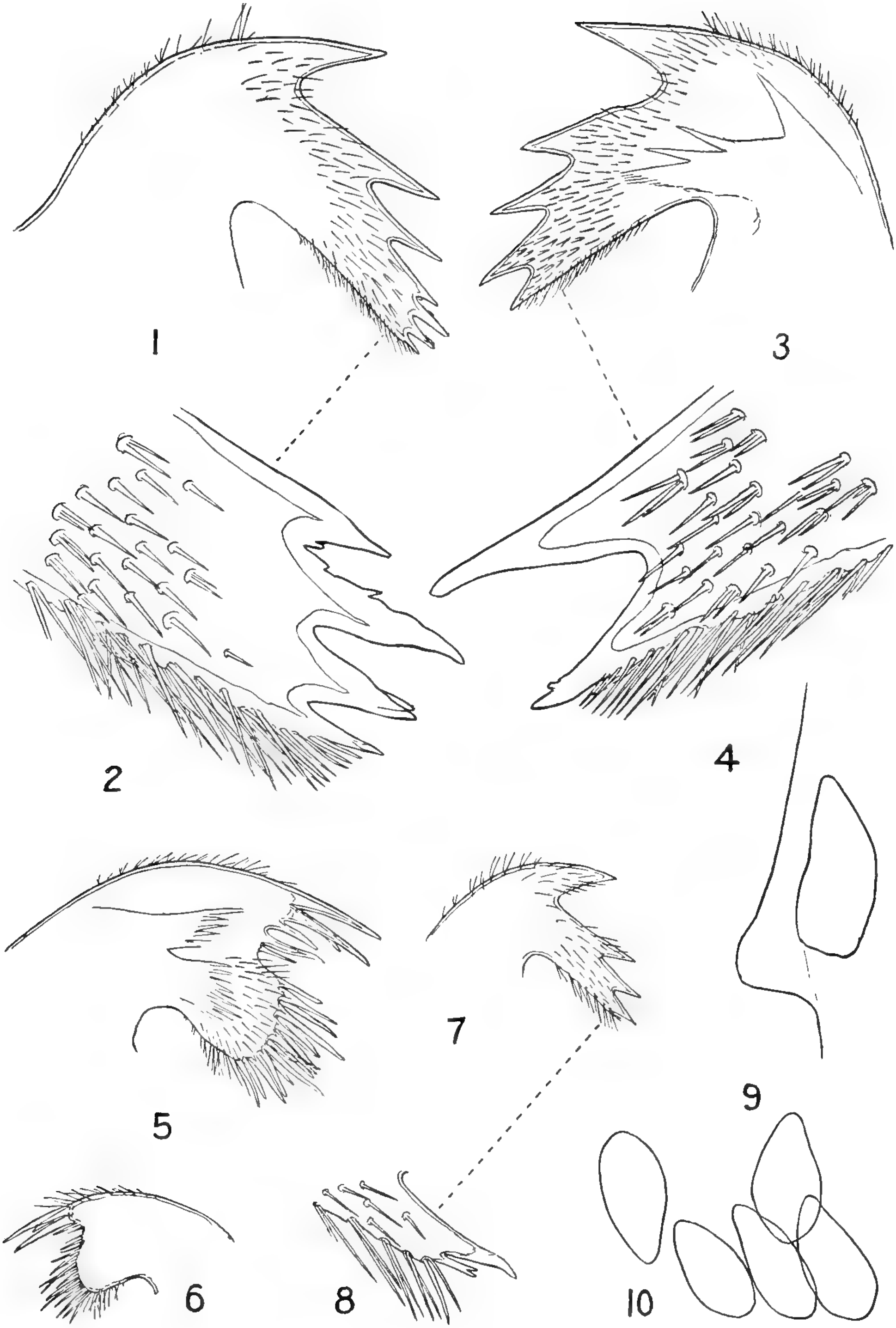


C.F.P. del.

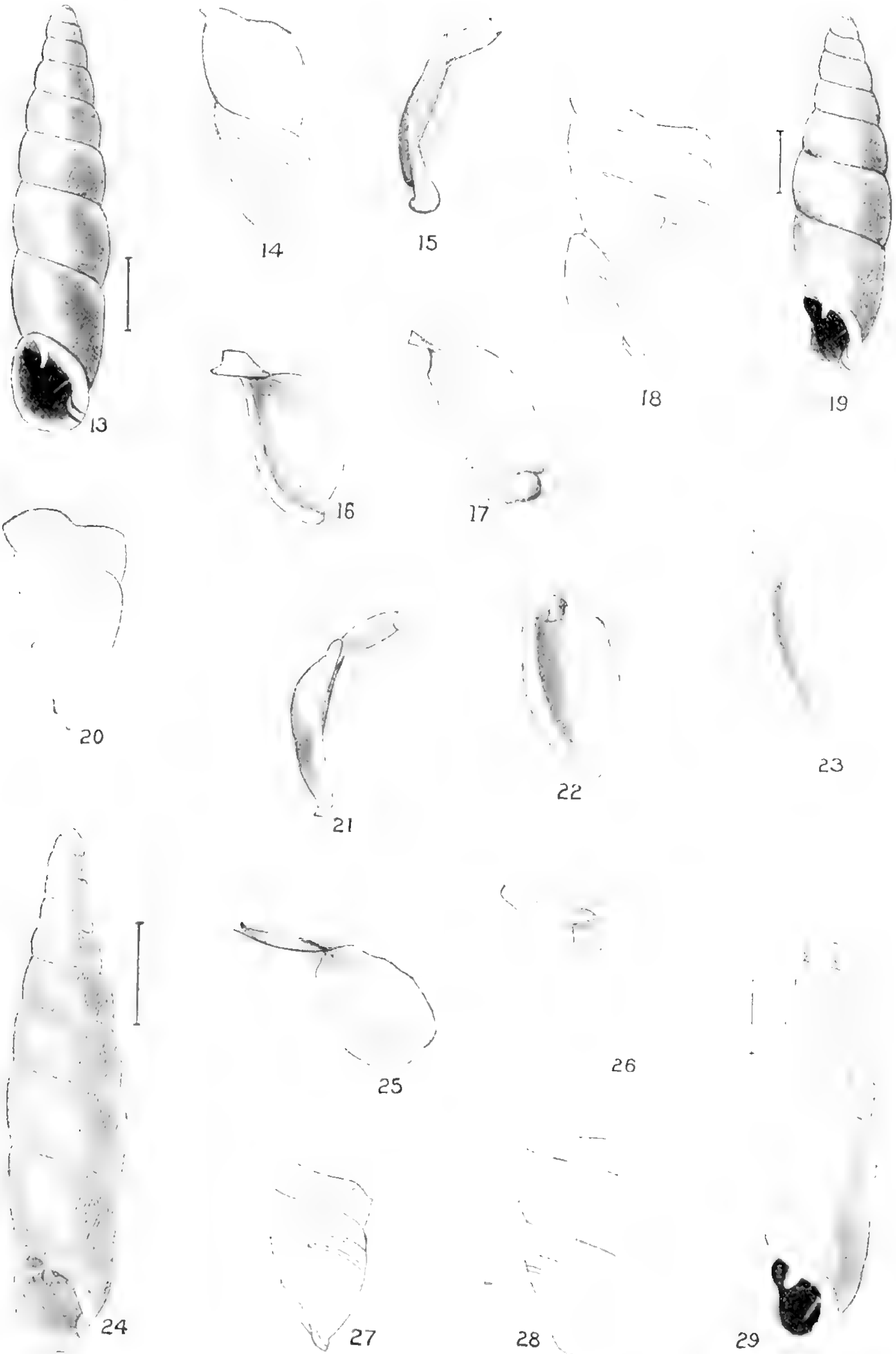
PALMER ON HALIOTIDÆ



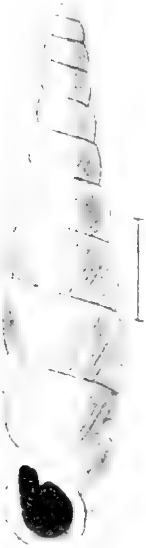
PILSBRY ON THE CIRRIPEDE GENUS MEGALASMA

PILSBRY. JAPANESE CLAUSILIIDÆ.

PLATE XXXIII.



PILSBRY. JAPANESE CLAUSILIIDÆ.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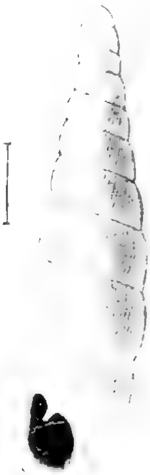
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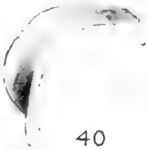
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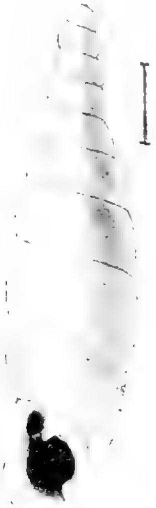
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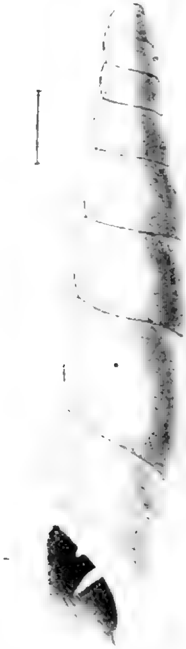
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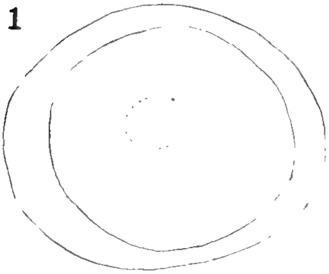

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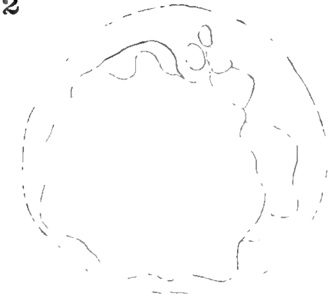

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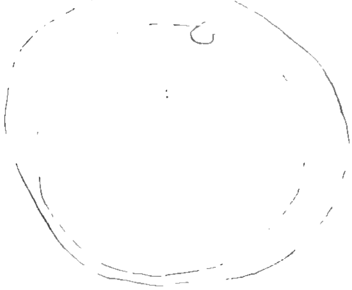

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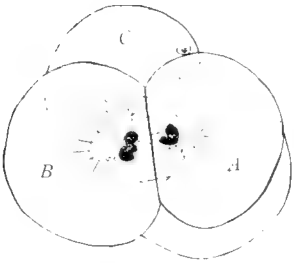

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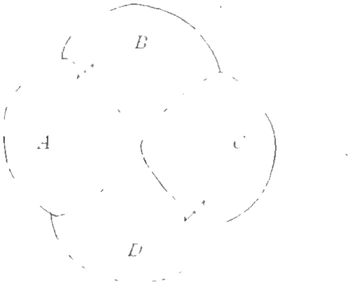

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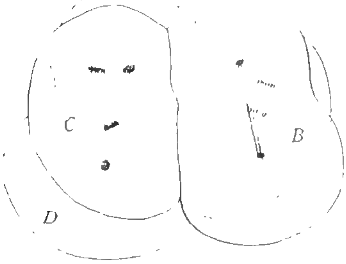

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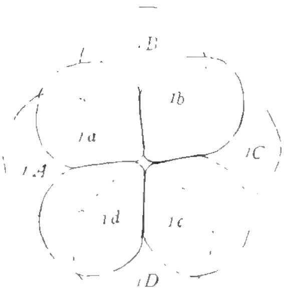
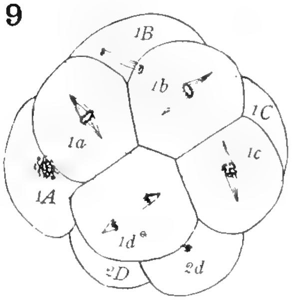


SURFACE. DEVELOPMENT OF PLANOCERA INQUILINA

9



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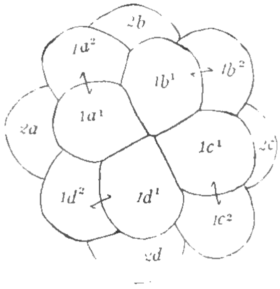

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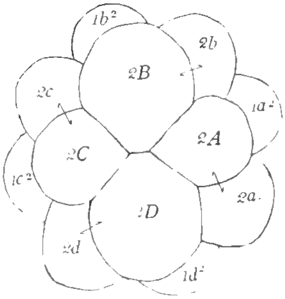

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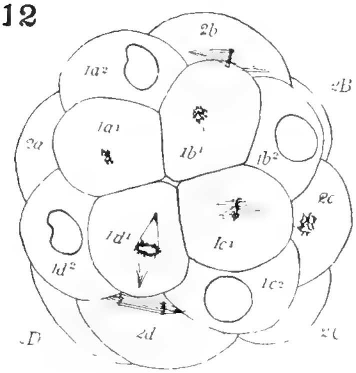

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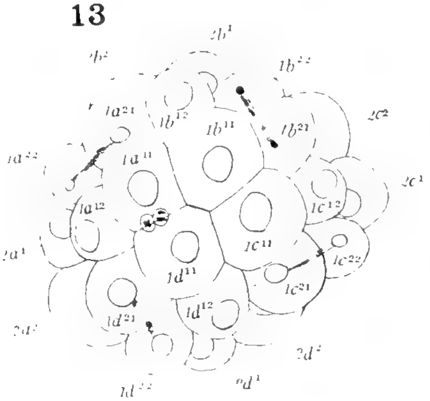

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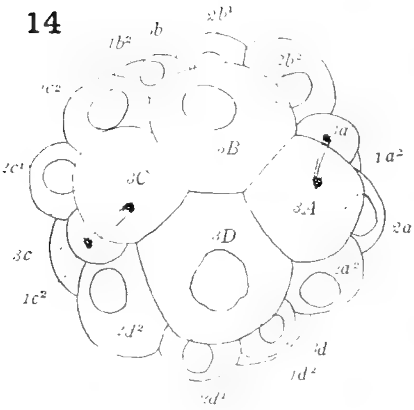

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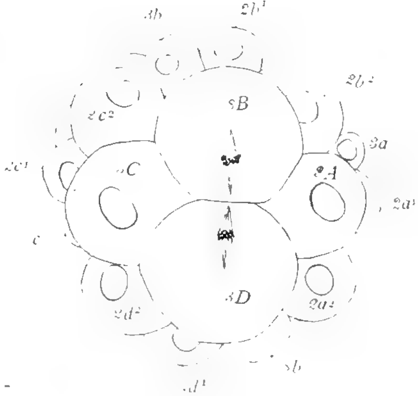

SURFACE. DEVELOPMENT OF PLANOCERA INQUILINA.

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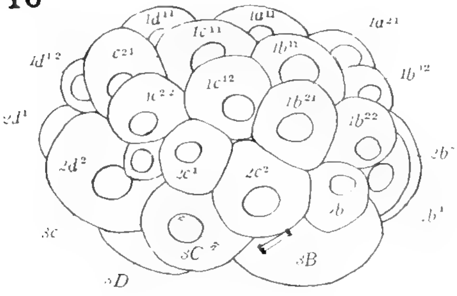

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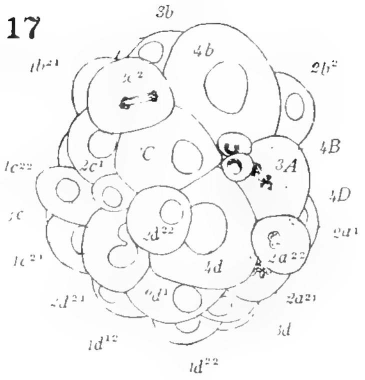

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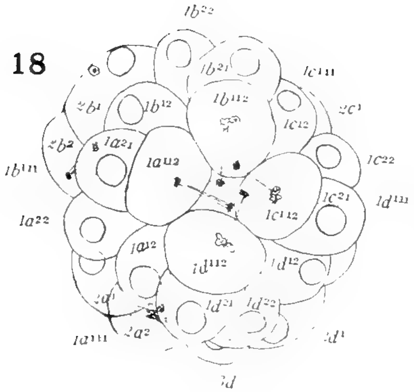

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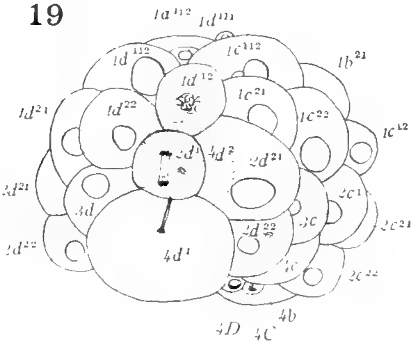

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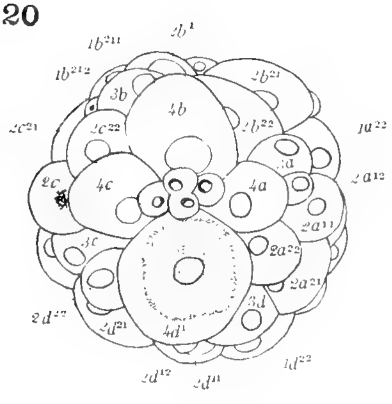

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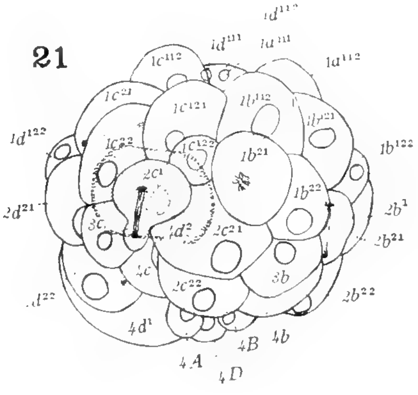

SURFACE. DEVELOPMENT OF PLANOCERA INQUILINA

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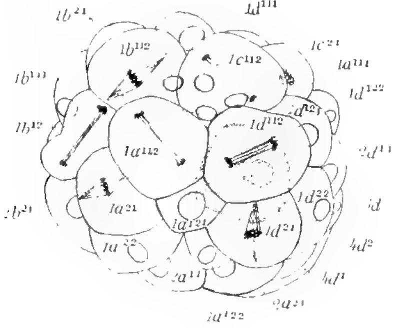

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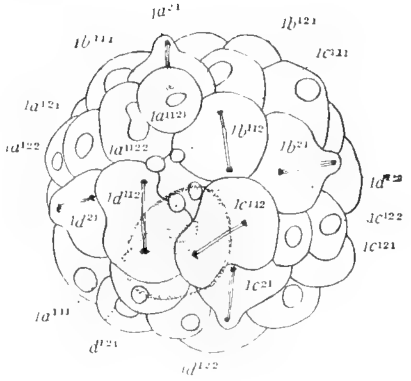

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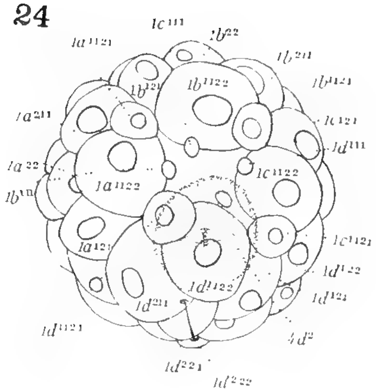

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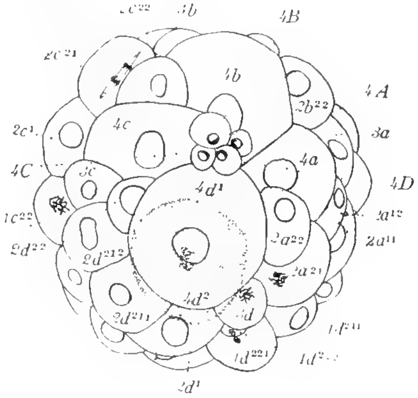

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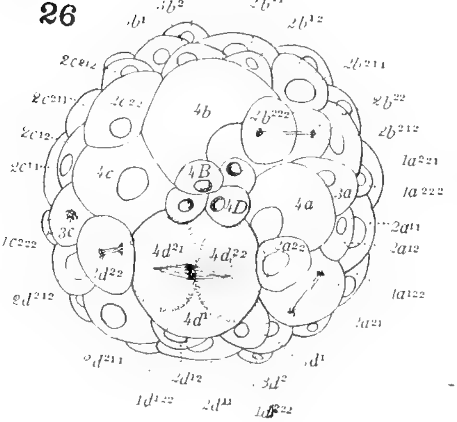

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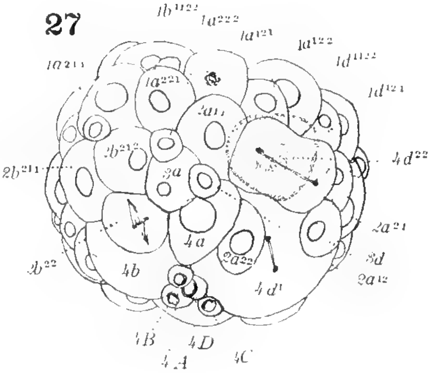

SURFACE. DEVELOPMENT OF PLANOCERA INQUILINA.

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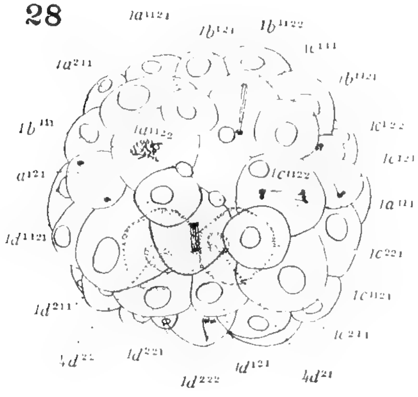

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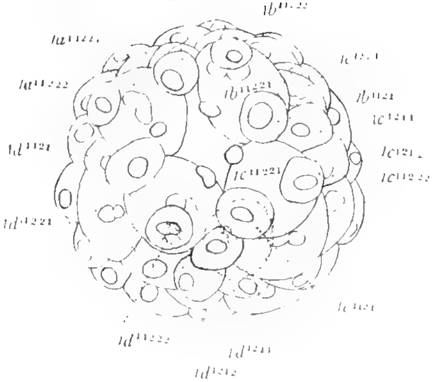

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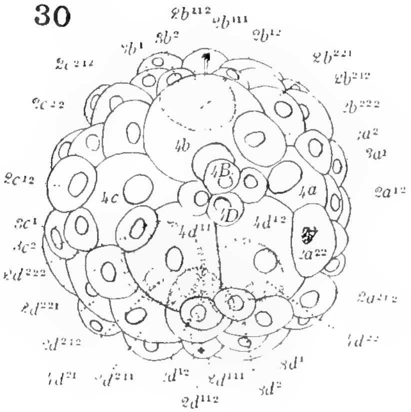

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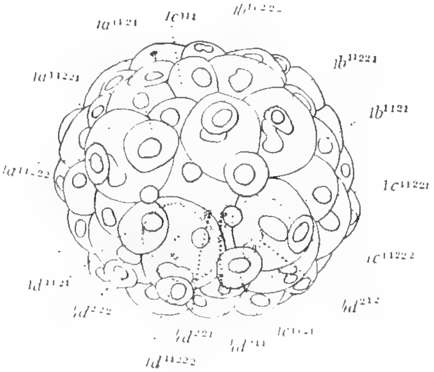

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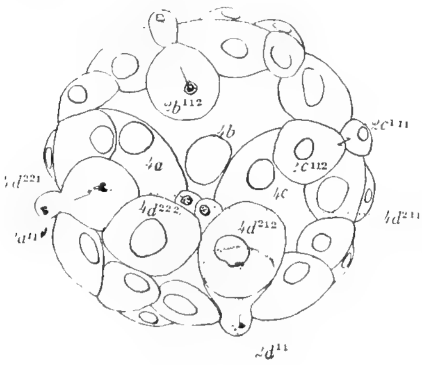

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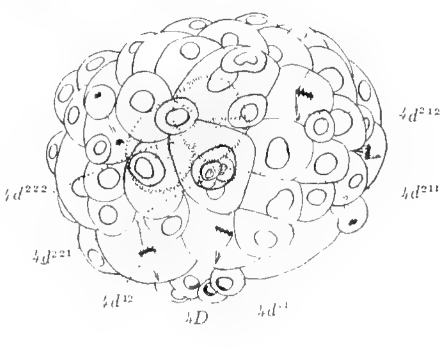

SURFACE. DEVELOPMENT OF PLANOCERA INQUILINA.

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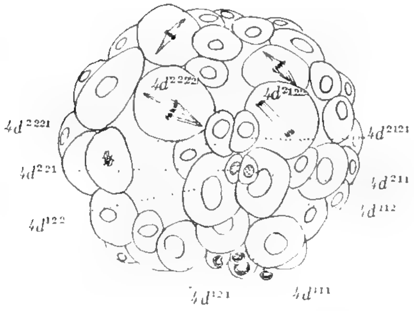

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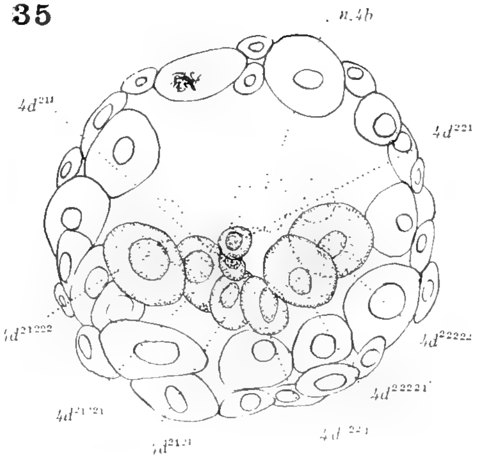

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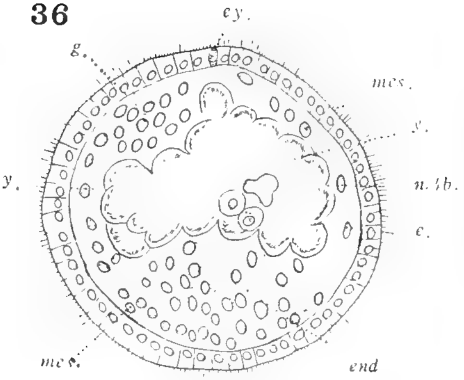

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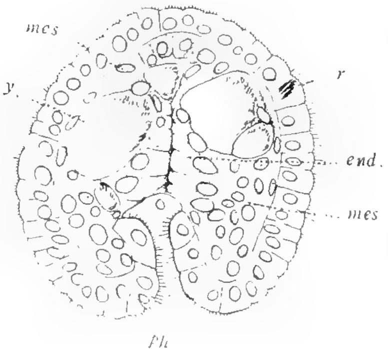

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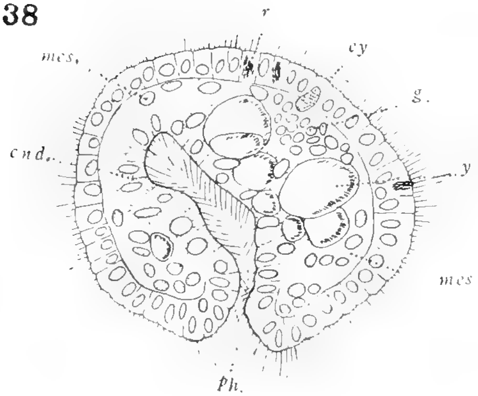

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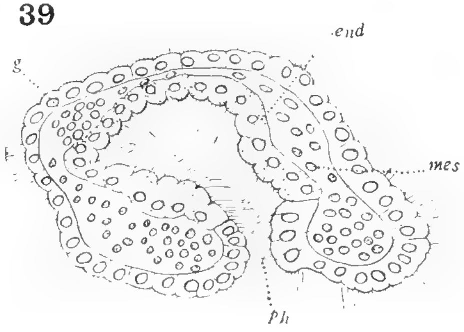

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