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PROCEEDINGS

OF THE

ACADEMY OF NATURAL SCIENCES

OF

PHILADELPHIA.

1904.

January 5.

Mr. Arthur Erwin Brown, Vice-President, in the Chair.

Eleven persons present.

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

Library.—Dr. C. N. Peirce, Thomas A. Robinson, Henry C. Chapman, M.D., George Vaux, Jr., and Benjamin Sharp, M.D.

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

Instruction and Lectures.—Benjamin Smith Lyman, Henry A. Pilsbry, D.Sc., Charles Morris, Philip P. Calvert, Ph.D., and Dr. C. N. Peirce.

Finance.—Isaac J. Wistar, William Sellers, John Cadwalader, Edwin S. Dixon and the Treasurer.

Committee of Council on By-Laws.—Isaac J. Wistar, Arthur E. Brown, Thomas H. Fenton, M.D., and John Cadwalader.

Henry C. Chapman, M.D., presented a communication entitled "Observations on Tupaia ferruginea, with reflections on the Origin of Primates."

The Publication Committee reported that the following communications had been received:

"Studies in the Orthopterous Family Phasmidæ," by James A. G. Rehn. (December 12, 1903.)

"A Collection of Fishes from Sumatra," by Henry W. Fowler. (December 23, 1903.)

"The Roses of Pecos, New Mexico," by T. D. A. Cockerell. (December 24, 1903.)

The following were accepted for publication:

NEW JAPANESE MARINE MOLLUSCA: GASTROPODA.

BY HENRY A. PILSBRY.

The new species of Gastropoda contained in recent sendings from Mr. Y. Hirase are herein described. The material studied contains a large number of species previously not known from Japanese waters, which I hope to enumerate in a future paper.

Some shells from a collection made in Sagami Bay for the Academy, by Miss A. C. Hartshorne, are also included in this account.

TEREBRIDÆ.

Terebra hedleyi n. sp. Pl. I, figs. 1, 1*a*.

Shell slender, the length about $5\frac{2}{3}$ times the diameter, solid, whitish, marked sparsely with brown dots on the cinguli and with streaks below them, the last whorl with some dots or spots in a circular row on the base.

Sculpture consisting of a wide above a narrower tuberculate cord, occupying somewhat more than half the total width of the whorl, below these cinguli there are four small equal spiral cords, the lowest one partly covered at the suture. On the last whorl these cords gradually diminish downward, those on the periphery and base being small and very low or subobsolete. The growth-striæ are oblique on the cinguli, arcuate on the cords below them. Whorls $15\frac{1}{2}$, the first large and globose, first $1\frac{1}{2}$ smooth and gray-white. The last whorl abruptly contracts below, and is produced in a short anterior canal. Aperture small, irregularly rhombic, the outer lip thin and sinuous, columella vertical, abruptly bent to the left below, covered with a glossy white callous, which extends over the parietal wall.

Length 33.6, diam. 6 mm.; length of aperture 6 mm.; diam. of the first whorl 1 mm.

Hirado, Hizen. Types No. 85,946, A. N. S. P., from No. 1,412 of Mr. Hirase's collection.

This species is related to *T. serotina* A. and R., and the closely allied or identical *T. mariesi* Sm., but it is not costate below the tuberculate bands, and the protoconch is very much larger. Named in honor of Charles Hedley, of the Australian Museum.

Terebra hizenensis n. sp. Pl. I, figs. 2, 2*a*.

Shell slender with straight lateral outlines, white, lusterless. Whorls $15\frac{1}{2}$, nearly flat, the first two smooth, the first whorl rather globose and convex. Sculpture of rather strong, even, slightly arcuate rounded ribs, about 21 in number on the last whorl, and nearly as wide as their intervals. These ribs are cut but not interrupted by a spiral groove defining a subsutural fasciole, the groove being deeper in the interstices. Below the groove or furrow there are 6 to 8 spiral cords, low on the summits of the ribs, stronger in the intervals; and above the furrow there are 4 or 5 finer spiral threads. The suture is rather deeply impressed. The small aperture is irregularly trapezoidal; columella vertical; canal recurved. Length 26, diam. 6, longest axis of aperture 6 mm.

Hirado, Hizen. Types No. 85,993, A. N. S. P., from No. 1,529 of Mr. Hirase's collection.

Similar to *T. subtextilis* Smith in color and sculpture, but in specimens of the same length this species is broader with a larger aperture.

Terebra awajiensis n. sp. Pl. I, figs. 3, 3*a*.

Shell straightly acuminate, rather slender, the diameter contained about $4\frac{3}{4}$ times in the length. The upper half of each whorl is brownish cream-tinted, the lower half purplish or reddish-brown, usually paler or fading toward the suture below. The last whorl has a supraperipheral purple-brown band, sharply defined on its upper edge, paler and fading below, where it is interrupted by light streaks. It extends as far as the basal contraction, but just below the periphery is divided by a narrow whitish spiral band. Sculpture of rather acute, nearly vertical riblets, which bend forward a little below, and on the last whorl are distinctly bent forward, and gradually diminish downward, disappearing at the subperipheral light band. The ribs are pale and interrupt the dark band. The intervals are concave and wider than the ribs, without spiral striation, but the whole surface shows faint growth-lines. Slightly below the upper third each whorl is cut by a spiral furrow interrupted by the ribs, leaving an oblong pit in each interval (but in some specimens the furrow is continuous though weak over the ribs). The pits are first developed on the 8th or 9th whorl, those above having no trace of the sulcus. Whorls about 18, the first 3 smooth, the apical whorl purple-black and having a diameter of about .3 mm.; subsequent whorls nearly flat, parted by a narrow, impressed suture, the last whorl rounded peripherally, strongly contracted below. Siphonal fasciole short and convex, bounded above by a low and inconspicuous ridge. Aperture a little less than one-fourth the length of the shell, acuminate above, with a deep and wide basal channel. Columella brown, with a low, wide and very indistinct basal fold, below which it is bent somewhat to the left. Parietal wall covered with a thin transparent varnish.

Length 37, diam. 8 mm.; length of aperture 8.8 mm.; 21 ribs on last whorl.

Length 35, diam. 7.3 mm.; length of aperture 8.7 mm.; 25 ribs on last whorl.

Fukura, Awaji. Types No. 86,004, A. N. S. P., from No. 1,352 of Mr. Hirase's collection.

This species is close to *T. nitida* Hinds in sculpture, but it is less slender, and the last whorl is more swollen peripherally and more contracted beneath. It differs from *T. lischkeana* in the smooth intercostal spaces.

Parviterebra paucivolvis n. sp. Pl. I, fig. 4.

Shell lanceolate, moderately solid, white with four spiral series of squarish red-brown spots, the upper series bordering the suture below, two others at the periphery, and the fourth on the base. The suture is widely gray-margined by transparence. Sculpture of close, fine, rounded longitudinal riblets, as wide as their intervals, and on the last whorl much smaller, almost obsolete. These are crossed by spiral subpunctate impressed lines, which are rather widely spaced. Whorls 7, but slightly convex, the last, as seen from the front, longer than the spire, gradually tapering downward. Aperture lanceolate, the columellar margin but slightly concave.

Length 12, diam. 3.4 mm.

Length 11.5, diam. 3 mm.

Yakujima, Ōsumi. Types No. 86,133, A. N. S. P., from No. 1,419 of Mr. Hirase's collection.

This species seems most closely related to the Australian *Euryta brazieri* Angas, which, however, has a larger aperture. Also to *E. pulchella* Angas (*Terebra angasi* Tryon) and *E. trilineata* Angas, both of which differ in details of form and coloration. The small Japanese *T. tantilla* Smith is diversely sculptured and belongs to a different section. The Australian species mentioned are placed in the subgenus *Euryta* by Angas and Tryon, but they are not related to the type of *Euryta* (now *Mazatlania*). I propose for them the genus *Parviterebra*, characterized by the small number of whorls, absence of any groove defining a subsutural band, and by the long, gradually tapering body-whorl without a differentiated siphonal fasciole at the base, the columella straight to its abrupt truncation below. This genus is not closely related to *Terebra* or the subgenus *Mazatlania*, but seems to belong to the *Terebridæ*. The Japanese species defined above is the type of this group.

CONIDÆ.

Conus dormitor n. sp. Pl. I, figs. 9, 9*a*.

Shell rather narrow and long, the diameter somewhat more than $\frac{1}{3}$ the length, the spire elevated, concave-sided, $\frac{1}{4}$ the length of the shell. The apex is broken off, 11 whorls remaining, the peripheral angle of each projecting above the suture. The last $2\frac{1}{2}$ are even at the periphery, but those preceding are nodulose. The concave, steeply sloping upper surface of each whorl is closely and regularly, finely costulate, the riblets arcuate, and decussated by several unequal spiral shallow grooves. The last whorl has almost straight lateral outlines, and is sculptured with closely punctate spiral grooves, very faint near the angle of the whorls, but becoming stronger and closer toward the base. The siphonal fasciole is closely spirally striate, not punctate. The aperture is long, narrow, and of equal width throughout.

Length 44, diam. 16 mm.; aperture 34 mm. long.

Kikai, Osumi, in a deposit probably Pliocene. Types No. 85,950, A. N. S. P., from No. 1,552 of Mr. Hirase's collection.

This cone is related to *C. acutangulus* Lam., but is longer than that species. *C. aculeiformis* Rve. is similar in shape, but differs in sculpture. The specimens show no color.

Conus kikaiensis n. sp. Pl. I, figs. 8, 8*a*.

Shell long and narrow, the diameter about one-third the length, the elevated and slightly concave-sided spire one-fourth the length. Whorls remaining 10, nearly flat and steeply sloping, the smooth peripheral angle projecting a little above the suture, the surface above it sculptured with 3 to 5 low, unequal spiral cords, and fine, arcuate growth-lines. Lateral outlines of the last whorl nearly straight. Sculpture of regular, rather strong, narrow spiral grooves, which are somewhat striate across, weaker above. There are 23–25 of these grooves above the convex siphonal fasciole, which is indistinctly finely striate spirally. In some specimens the flat intervals between the grooves are divided in the middle by a smaller groove.

Length 40–41, diam. 13 mm.

Kikai, Osumi; fossil in a Pliocene (?) deposit. Types No. 85,948, A. N. S. P., from No. 1,553 of Mr. Hirase's collection.

This species is not unlike *C. dormitor* and *C. aculeiformis* in general shape, but it differs essentially from both in the sculpture of the spire.

The outer lip is a good deal damaged in both of the specimens received.

Conus gratacapii n. sp. Pl. I, figs. 10, 10*a*.

Shell slender and lengthened, the diameter somewhat exceeding one-third of the length, the high straight-sided spire occupying two-fifths the length of the shell. Apex broken. 12 whorls remaining are flat, with the smooth peripheral angle immediately above the suture, but scarcely projecting, a little more prominent on the upper than on the lower whorls. The surface of each whorl is a trifle concave, and sculptured with about 6 low, unequal spiral cords. Below the peripheral angle the last whorl is sculptured with about 25 spiral grooves, weaker above, stronger and closer below; and the growth-striæ curve strongly backward near the angle. The aperture is very narrow, and of equal width throughout, and two-thirds as long as the shell.

Length 30, diam. 11 mm.; length of aperture 20 mm.

Length 31, diam. 11.5 mm.; length of aperture 20.3 mm.

Kikai, Osumi, in a Pliocene (?) deposit. Types No. 85,947, A. N. S. P., from No. 1,554 of Mr. Hirase's collection.

This peculiar species resembles *C. kikaiensis* in sculpture, but is unlike that in form. It is named for Mr. L. P. Gratacap, of the American Museum of Natural History.

PLEUROTOMIDÆ.

Drillia streptonotus n. sp. Pl. III, figs. 18, 18*a*, 18*b*.

Shell slender and turrite, solid, light brown with an obscure band below the suture and another on the base. Sculpture of regular, subvertical rounded folds as wide as their intervals, about 18 in number on the last whorl, where they disappear a short distance below the periphery. These are crossed by numerous spiral threads, alternately larger and smaller, but on the lower, contracted half of the last whorl the spirals are regular and equal. Under a strong lens the whole surface is seen to be covered with densely crowded rows of minute papillæ. Whorls 9½, strongly convex. The first whorl is smooth and rounded; then an acute peripheral keel begins, and a whorl and a half later low radial sculpture and fine papillæ appear. The first two or three sculptured whorls are angular, the keel persisting to the end in the peripheral thread. Aperture flask-shaped, wider above, the outer lip with about 6 small teeth within, arranged in pairs; deeply excised above, and produced in a short recurved spout at the anal sinus; contracted below to form a short siphonal canal.

Length 8.8, diam. 2.8 mm.; length of aperture 3 mm.

Length 6.9, diam. 2.3 mm.

Hirado, Hizen. Types No. 86,128, A. N. S. P., from No. 1,416*b* of Mr. Hirase's collection.

Distinct by its turrite shape, convex whorls and spout-like anal sinus, and the beautiful minute sculpture, hardly visible without a compound microscope.

Drillia albiguttata n. sp. Pl. III, fig. 19.

This species, of which only more or less beach-worn specimens have been received, is extremely similar to *D. zebra* Lam. of the West Indies. It is somewhat more slender. The ground color is chocolate. The sculpture consists of thick longitudinal ribs, 12 on the last whorl, each with a white spot at the shoulder, another below the middle of the last whorl, and there is a white band around the siphonal fasciole. There is a seam-like welt below the suture, and the unworn intervals between the ribs are sculptured with alternately large and small spiral cords. Whether these pass over the ribs or not cannot be ascertained from the examples examined. The lip and anal sinus are like those parts in *D. zebra.*

Length 11, diam. 4.5 mm.

Seto, Kii. Types No. 86,122, A. N. S. P., from No. 1,349 of Mr. Hirase's collection.

Daphnella radula n. sp. Pl. II, figs. 17, 17*a*.

Shell fusiform, rather solid, pale brown, indistinctly mottled with white and marked with short brown lines on the larger spiral cords, a series of alternately white and brown squarish spots below the suture. Surface sharply sculptured with alternate spiral cords and threads, about 52 in all on the last whorl, intersected by fine raised longitudinal threads, prominent where they cross the spirals. The lower edge of the anal fasciole is defined by a sulcus slightly unlike the other intervals, where the growth-lines bend abruptly backward. Whorls 8, the first two brown, with the usual diagonally intersecting grooves of *Daphnella,* the next whorl with three spirals. Last whorl long, tapering above and below. Aperture more than half the shell's length. Outer lip thick but beveled to an edge, obliquely and deeply excised above, a little sinuated near the base. The anterior channel is short and rather shallow.

Length 13.5, diam. 5 mm.; length of aperture 7.7 mm.

Hirado, Hizen. Types No. 85,965, A. N. S. P., from No. 903*a* of Mr. Hirase's collection.

The shell of this species is thick, like that of *Daphnella maculosa*

Pse.; but it is noticeably wider than that, with a more ample aperture and entirely different coloration.

Mangilia pura n. sp. Pl. II, figs. 15, 15*a*.

Shell fusiform, rather thin, cream-white, indistinctly stained with brown in some places below the suture. Sculpture of curved, slightly sinuous, rounded longitudinal ribs, slightly narrower than their concave intervals, and about 21 in number on the last whorl; the last rib much larger, forming a stout lip-varix. These are crossed by many spaced spiral threads passing over ribs and intervals, and about 30 in number on the last whorl. The intervals between these threads are sometimes divided by a secondary threadlet; and there is throughout a very minute, even and regular granulation produced by the intersection of spiral and longitudinal striæ. Whorls about 8, the first two rounded, and with delicate spaced costulæ, forming a trochoidal nucleus; the last whorl slightly ascending in front. Aperture long and narrow, obtuse at the ends, smooth within, slightly retracted above.

Length 13, diam. 4.7 mm.; length of aperture 7.7 mm.

Length 9.8, diam. 3.8 mm.

Hirado, Hizen. Types No. 85,974, A. N. S. P., from No. 1,527 of Mr. Hirase's collection.

This species seems to be similar to *M. cylindrica* Reeve, but that shell is more slender.

Mangilia semicarinata n. sp. Pl. II, figs. 16, 16*a*.

Shell fusiform-turrite, white with some brown stains below the suture and a brown spot at the middle of the lip-varix; rather thin. Sculpture of many slightly oblique and arcuate longitudinal riblets about as wide as their intervals, and sixteen in number on the last whorl. These are crossed by spaced spiral threads, about 18 from the shoulder down on the last whorl, a little widened where they pass over the riblets. The spaces between the threads and above the shoulder are very finely striate spirally. Whorls 7, the first 1½ rounded, radially weakly costulate, several whorls following convex, rounded, the last 2 or 3 whorls angular at the shoulder. The last whorl bears a narrow, elevated, arcuate lip-varix. Aperture narrow, both lips slightly arcuate; blunt at the ends, smooth within. Anal sinus rather deep and rounded, the varix curving back of it.

Length 7, diam. 2.7 mm.; length of aperture 2.7 mm.

Hirado, Hizen. Types No. 86,124, A. N. S. P., from No. 1,520 of Mr. Hirase's collection.

Mangilia kamakurana n. sp. Pl. II, figs. 11, 11*a*.

Shell very small, white with a brown spot in the middle of the lip-varix, the spire terraced, lower half conic. Sculpture of slightly curved obliquely longitudinal ribs, 11 on the last whorl, the last one, behind the lip, much larger. These are crossed by spaced spiral threads, with smaller threads between them, the intervals still more finely striate spirally. Whorls 5 (the embryonic ones broken off), strongly angular near the middle, flattened and sloping above the angle, contracting below it; the last whorl similarly angular, convex below the angle, contracted near the base. Aperture oblong, the columellar margin concave above the middle. Outer lip thick, with a moderately deep rounded sinus above; smooth within.

Length 4.7, diam. 2 mm.

Kamakura, Sagami. Type No. 70,940, A. N. S. P. No. 71,025, from Japan, without exact locality, is the same species.

Mangilia cinnamomea peraffinis n. subsp. Pl. II, figs. 12, 12*a*.

Shell stoutly fusiform, glossy, purple-brown, becoming flesh-colored at the anterior end, with a broad white band at the periphery, and three indistinct, equally spaced whitish bands on the sloping surface below it. Sculpture of longitudinal ribs about half as wide as the concave intervals and 9 in number on the last whorl. Whorls 7, those of the spire subangular in the middle, the first two whorls having delicate widely spaced riblets. The last whorl is widest above but not angular, and tapers regularly downward. The aperture is rather narrow, blunt at both ends. The outer lip is slightly retracted above and below, and has about 9 small teeth within, those in the middle rather indistinct. The columella has about 8 slightly larger short transverse wrinkles.

Length 7, diam. 3 mm.

Hirado, Hizen. Types No. 85,952, A. N. S. P., from No. 1,519 of Mr. Hirase's collection.

This pretty *Cythara* corresponds fairly well with *M. cinnamomea* Hinds[1] except in color. It differs from *M. planilabrum* Reeve[2] in having no angular projection of the lip above.

Mangilia (Cythara) hirasei n. sp. Pl. II, figs. 13, 13*a*.

Shell irregularly biconic, resembling *M. decussata* Pse. and *delacouriana* Cr. in shape; thick and solid; whitish, indistinctly marked with about 4 yellowish spots on the front slope of each rib, and corresponding brown spots on the lip-varix, and with a band composed of 4 to 6

[1] *Zool. Voy. "Sulphur,"* Pl. 9, fig. 1.
[2] *Conch. Icon., Mangelia*, Pl. 6, fig. 43.

purple-brown lines below the suture. Sculpture of longitudinal rounded ribs parted by wider concave intervals, and 10 or 11 in number on the last whorl. The last rib is much larger and forms the lip-varix. About 30 spiral threads, on the last whorl, cross the ribs and intervals, sometimes with minor threads between them. The spaces between these threads are evenly granulose by the decussation of growth-lines and spiral striæ, there being about four spiral series of granules in each interval. Whorls $7\frac{1}{2}$, the first $2\frac{1}{4}$ smooth and rounded, the rest subangular in the middle, the last whorl shouldered above, the shoulder rounded. Aperture narrow. Outer lip nearly straight, with about 8 white teeth within; columella white, with four or five small entering folds, increased to 8 or 10 at the margin, and with several on the parietal wall.

Length 8, diam. 3.6 mm.

Length 7, diam. 3 mm.

Hirado, Hizen. Types No. 85,975, A. N. S. P., from No. 1,516 of Mr. Hirase's collection.

This species differs from *M. decussata* and *delacouriana* in its minute sculpture of regular, squarish granules.

Clathurella chichijimana n. sp. Pl. I, figs. 7, *7a*, *7b*.

Shell small, solid, fusiform, gray-white with five black-brown and the same number of white longitudinal stripes on the ribs, sometimes continuous, sometimes dislocated. Sculpture of 10 strong longitudinal ribs crossed by spiral threads which swell into tubercles on the ribs, and are 9 or 10 in number on the last whorl. Whorls 7, the first $2\frac{1}{2}$ yellow, rounded, forming a trochiform protoconch, sculptured with vertical riblets decussated by delicate, obliquely forward-descending striæ. The junction of the protoconch and the sculptured shell is very oblique and sharply defined.

Aperture narrow, with a deep sinus above. Outer lip with four small teeth within.

Length 4, diam. 1.7 mm.

Chichijima, Ogasawara. Types No. 86,127, A. N. S. P., from No. 1,439 of Mr. Hirase's collection.

This species of the group of *C. tincta* is closely related to *C. maculosa* Pse., but differs in having the spirals conspicuously swollen where they cross the ribs. *C. dichroma* Sturany is very similar, but whether it agrees in minor details cannot be known from the brief description.

Clathurella centrosa n. sp. Pl. I, figs. 6, *6a*.

Shell small, fusiform, solid, white with a series of brown spots below the suture on alternate ribs, and a brown band on the base. Sculpture of numerous longitudinal ribs slightly narrower than their intervals, and about 13 in number on the last whorl. These are crossed by spiral cords, narrower than their intervals, of which there are 6 on the last whorl, followed by a costate space, as though a cord had been omitted, and then 4 more beaded, oblique cords on the narrow, lower part of the whorl. Apex broken off, 4½ whorls remaining, the last with a thick varix behind the outer lip. Aperture narrow with two low teeth within the outer lip; anal sinus deep and rounded.

Length 4, diam. 1.9 mm.

Hahajima, Ogasawara. Types No. 86,125, A. N. S. P., from No. 1,384 of Mr. Hirase's collection.

Clathurella lischkeana n. sp. Pl. II, figs. 14, 14*a*.

Shell turrite with rather wide spire, solid and strong, orange-colored, with a black band below the suture terminating behind the lip-varix, and an ill-defined brown band below the periphery. There is also a black spot on each side of both the anal and the siphonal sinus. Sculpture of strong, rounded longitudinal ribs about as wide as their concave intervals, strongest on the periphery and above, diminishing rapidly on the contracting base, and 9 in number on the last whorl, the last one much higher, more prominent and longer below, forming the lip-varix. Rather coarse spiral cords pass over these ribs and their intervals, 4 or 5 of them visible on the penultimate whorl. Whorls about 6 besides the nucleus, which is broken from the specimens before me. They are convex and separated by a deep suture. Aperture small, widest in the middle, with a deep rounded sinus above, which is cut into the thick lip-varix a short distance below the suture. The outer lip has a large black-brown spot within below the sinus and another near the base, and there are several (usually 3) low teeth within.

Length 5.8, diam 2.5 mm.

Hahajima, Ogasawara. Types No. 85,957, A. N. S. P., from No. 1,388 of Mr. Hirase's collection.

This little orange-and-black species resembles Reeve's figure of his *Pleurotoma nassoides*, but it is only half the size of that, and is a conspicuously thick and solid shell, not "thin as though pellucid" or "semitransparent," as Reeve states of his *nassoides*.

MITRIDÆ.

Mitra hirasei n. sp. Pl. III, figs. 21, 21*a*.

Shell thick-fusiform, solid, lusterless, or with two broad spiral bands and some longitudinal streaks of rose, the paler ground-color showing only in an ill-defined median band and some pale streaks. Sculpture of narrow spiral ridges parted by wider intervals, and alternately smaller, the penultimate whorl with about 5 such primary spirals, last whorl with about 17 primary or larger and an equal number of smaller spirals (counted on the outer lip from suture to channel). There are also some much finer spiral threads. Longitudinal sculpture of rather wide-spaced grooves, cutting the spirals and intervals. The larger spiral ridges are marked with a stippled or articulated line of brown. Embryonic whorls wanting; subsequent whorls 7, convex, the last tapering to the base. Aperture narrow, smooth inside; columellar side nearly straight, with 5 plaits.

Length 27, diam. 11 mm.; length of aperture 17 mm.

Hirado, Hizen. Types No. 85,994, A. N. S. P., from No. 902 of Mr. Hirase's collection.

This species may be closely related to *Mitra helvacea* Phil. (*Zeitschr. f. Malak.*, 1851, p. 84), but that species has not been identified or figured in more than half a century since its publication, and the description is not conclusive. *M. pretiosa* is a somewhat similar species with a much larger spire. *M. rufilirata* A. and R., *Zool. "Samarang,"* Moll., p. 26, Pl. 10, fig. 26, is also very closely related, but it differs, apparently, in the more finely sculptured intervals between the spiral cords.

Thala ogasawarana n. sp. Pl. III, fig. 22.

Shell very small, slender and fusiform, brown with a series of ill-defined whitish spots at the periphery. Surface evenly cancellate, there being about 6 spirals on the penultimate, 14 on the last whorl, crossed by longitudinals of the same size and spacing; the lower 4 spirals nearly continuous. Whorls $5\frac{1}{2}$; suture rather superficial, rising a little near the aperture. Aperture about half the total length, narrow throughout but slightly wider above. Outer lip thick, finely denticulate within, with a slight sinus above. Columella with 4 strong, transverse plaits.

Length 6, diam. 2 mm., aperture 3 mm. long.

Chichijima, Ogasawara. Types No. 86,000, A. N. S. P., from No. 1,436 of Mr. Hirase's collection.

Few of the species of this genus have been adequately described or illustrated. *T. exilis* (Rve.) seems related to this species. It is more tapering anteriorly and "pale violet-purple."

COLUMBELLIDÆ.

Columbella turturina borealis n. subsp.

Smaller and less inflated than typical *turturina* Lam., and with the aperture narrower. Yellowish-chestnut-brown, with some bands of white dots, and with alternate snowy and dark-brown spots below the suture, the former raised into low nodules in places. Base spirally striate. Lips lilac-tinted, the outer lip with about 8 tubercles within. Columella with the usual two folds, and a row of small tubercles.

Length 7, diam. 4.5 mm.

Length 6.5, diam. 3.8 mm.

Hachijojima, Izu. Types No. 86,002, A. N. S. P., from No. 1,391 of Mr. Hirase's collection.

C. deshayesii Crosse, *C. palumbina* Gld. and *C. sandwichensis* Pse., probably all one species, are larger than the above race, and more striate on the back.

Columbella albinodulosa var. **ogasawarana** n. subsp. Pl. III, fig. 23.

Shell fusiform, solid, gray-white, closely lineolate vertically with brown, the lines irregular, and interrupted by two spiral belts of irregular brown and snowy dots and fretwork, and with two transverse chestnut spots or short bands upon the terminal varix; the brown lines sometimes partially coalescent, and the pattern interrupted in some specimens by a few broad snowy stripes. Some of the whorls of the spire are usually weakly nodulose below the suture, the nodules white. Whorls about 9, nearly flat, the last slightly convex, contracted below, and very weakly striated spirally on and near the short siphonal fasciole; expanded in a low rounded varix behind the outer lip. Aperture white, toothed within, there being about 7 teeth within the outer lip, 4 or 5 on the columellar margin, with a low, obtuse fold within.

Length 8.7, diam. 3.3 mm.; length of aperture 4 mm.

Hahajima, Ogasawara. Types No. 86,003, A. N. S. P., from No. 1,468 of Mr. Hirase's collection.

This form differs from *C. albinodulosa* as figured by Reeve[3] and by Fischer[4] in coloration, and in lacking spiral striation on the lower part of the body-whorl. It is also a smaller form, and very likely will prove to be specifically distinct.

C. albinodulosa seems, from the figures, to approach some forms of *C. varians* Sowb.

Columbella liocyma n. sp. Pl. III, fig. 24.

Shell obesely fusiform, rather thin, rose-red with snow-white dots at rather wide intervals below the suture on the spire, and a whitish band there on the last whorl, where there are also several white dots along the border of the siphonal fasciole, which is dark brown tesselated with white. Sculpture of numerous smooth, rounded longitudinal ribs a

[3] *Conch. Icon.*, Pl. 23, fig. 138.

[4] *Journ. de Conchyl.*, 1901, p. 101, figs. 3–6.

little wider than their intervals, the contracted base and fasciole spirally lirate. Whorls 6–7, convex, the last convex below the suture and peripherally, contracted below, the longitudinal ribs absent on its last half, which is smooth except for a small rounded varix behind the lip, marked with a large white spot above and another in the middle. Both lips are dentate within, the outer margin with about 8 teeth, the upper ones, in the middle of the lip, stronger; inner lip with five weak teeth. Columella with one deeply placed basal fold.

Length 5, diam. 2.6 mm.

Length 5.7, diam. 2.8 mm.

Types No. 85,961, A. N. S. P., from No. 1,392 of Mr. Hirase's collection.

A beautiful rose-colored, smooth-waved little species.

Columbella somnium n. sp. Pl. III, figs. 28, 29.

Shell stoutly fusiform, solid and strong, variously colored: (1) pink, sprinkled with white dots, with a white band maculate with brown below the suture, and a peripheral line of white dots, the swollen lip-varix white with several brown spots, or (2) white with longitudinal ragged brown markings, mingled with a clear gray reticulation on the back of the last whorl. Surface glossy and nearly smooth, there being a few very low and inconspicuous nodules below the suture on the back of the last whorl, and 2 or 3 spiral cords above the short, convex siphonal fasciole, which is spirally coarsely striate. Spire with slightly convex lateral outlines; apex obtuse. Whorls 7, but slightly convex, the last broadly gibbous, varixed behind the outer lip. Aperture half the shell's length, the outer lip straight, lilac-tinted, with 8 teeth within, columella with a single broad, low, deeply placed fold, and a series of 8 teeth at the edge, which is lilac-tinted and distinct but not elevated.

Length 11.7 to 12.7, diam. 5 mm.

Yakujima, Osumi. Types No. 86,129, A. N. S. P., from No. 1,424 of Mr. Hirase's collection.

This beautiful species resembles *C. dunkeri* Tryon, but differs in the straightened outer lip, heavier varix and narrower mouth with stronger teeth.

Columbella hahajimana n. sp. Pl. III, fig. 25.

Shell very minute, obesely fusiform, moderately solid, yellowish marked with some faint angular brown lines or with white belts at suture, periphery and base, and marked with angular brown lines, and a row of oblong spots above the middle. Sculpture of many close, small longitudinal folds which do not extend below the periphery, the narrow part of the base spirally striated. Aperture white, about half the length of the shell, narrow and sinuous, the outer lip toothed within, the columellar lip very minutely so.

Length 2.8, diam. 1.3 mm.

Hahajima, Ogasawara. Types No. 85,960, A. N. S. P., from No. 1,387 of Mr. Hirase's collection.

This small *Seminella* resembles *C. troglodytes* Souv. and *C. sinensis* Sowb., but the longitudinal plication is finer than in either. *C. sinensis* has been taken in Tokyo Bay.

Columbella divaricata n. sp. Pl. III, fig. 26.

Shell fusiform, rather thin, not glossy, light olive-brown, marked with *red-brown spiral lines which slowly converge forward from above and below, meeting in acute angles just below the periphery.* About 5 of these lines may be counted in any one place on the penultimate whorl. *Suture bordered below with a snow-white band* which ascends the spire Surface smooth except on the contracted base which is spirally lirate. Whorls about 6, nearly flat, the last without noticeable varix behind the acute lip. Aperture narrow and long, not dentate within, the columella only slightly concave.

Length 6, diam. 2 mm.

Hirado, Hizen. Types No. 85,972, A. N. S. P., from No. 1,411 of Mr. Hirase's collection.

This beautiful species is colored somewhat like *C. digglesi* Braz., which in other respects is totally unlike. I know of no related form.

MURICIDÆ.

Coralliophila jeffreysi var. hiradoensis nov. Pl. III, fig. 27.

The shell in this form is fusiform, with the aperture noticeably longer than the spire. There are 7 or 8 strong folds on the last whorl, most prominent at the periphery. The whole surface is closely lirate spirally, the cords densely roughened with suberect scales. There are 17 primary cords on the last whorl above the prominent siphonal fasciole, not counting 4 or 5 smaller ones interpolated in the subperipheral region. The aperture is white within, with a dark-brown marginal border which is deeply sulcate. There are a few acute cords making the throat sulcate.

Length 29, diam. 15.5 mm.; length of aperture 16.5 mm.

Hirado, Hizen. Types No. 85,981, A. N. S. P., from No. 1,407 of Mr. Hirase's collection.

In *C. jeffreysi* Smith the aperture is smaller.

Ocinebra monoptera n. sp. Pl. IV, figs. 32, 32a.

Shell small, solid lusterless, ashy-gray. Sculpture of numerous small longitudinal folds, about 12 on the penultimate whorl, becoming obsolete below the periphery on the last whorl, crossed by numerous unequal, scaly spiral cords, about 20 on the last whorl. Whorls 6, the first rounded, forming a smooth mammillar protoconch, the rest angular in the middle, the last angular peripherally, flat and sloping above, convex below the angle, contracted downwards; expanding behind the lip in a very broad wing-like varix, triangular in section. Aperture oval, the outer lip built forward in a thin rim, and with two low fold-like teeth within. Anterior canal closed, tubular.

Length 12.5, diam. 7.2 mm.

Hirado, Hizen. Types No. 86,121, A. N. S. P., from No. 1,522 of Mr. Hirase's collection.

This peculiar little species resembles the larger *O. nassoides* Reeve,[5] but the wing is wide below, not notched there, and the longitudinal ribs are weaker. *O. japonica* Dkr. is a much larger and multivaricose shell, but seems to be related to this. Reeve's *Triton nassoides* has been referred to *Nassaria*, but it has little resemblance to the type of that genus.

Purpura tosana n. sp. Pl. III, fig. 30.

Shell small, imperforate, fusiform, solid, gray-white with an interrupted black-brown band below the suture, another below the periphery and a less distinct one at the base. Sculpture of numerous longitudinal rounded folds or waves, many of them followed by a raised line marking a former peristome. These folds are more distinct on the spire than on the last whorl, where there are 10 to 15 of them. The folds are crossed by numerous strong, rounded spiral cords, which are often weakly striate in the same direction, are wider than their deep intervals, and pass equally over folds and valleys. There are about 10 of these spiral cords on the last whorl, besides some small ones below the suture and in the intervals of the large cords on the basal slope. The interstices in well-preserved shells are delicately, closely lamellose. The spire is rather slender and acute. There are about 7 whorls in perfect shells, the first two forming a smooth, bulbous, shortly cylindric nucleus. Subsequent whorls are somewhat concave below the suture, then convex. The last whorl is inflated peripherally, contracted below, with a plicate basal fasciole. The aperture is slightly more than half the length of the shell, dark purplish-brown with light bands

[5] *Conch. Icon.*, II, *Triton*, Pl. 20, fig. 96.

within. Outer lip whitish, beveled, and furnished with 3 to 6 small tubercles within. Basal canal short and open.

Length 14, diam. 7.3 to 7.7, length of aperture 8 mm.

Kashiwajima, Tosa. Types No. 85,991, A. N. S. P., from No. 1,375 of Mr. Hirase's collection.

This small species, unusually slender for a *Purpura*, seems to have no near relatives in the Orient.

Sistrum (Ricinula) morus var. **borealis** n. v. Pl. III, fig. 31.

Shell biconic-oblong, faintly pink-tinted white, the mouth lilac-tinted. The whole shell is longitudinally costate, the ribs rounded, as wide as the intervals, and continuous from whorl to whorl. These are crossed by two strong ridges on the whorls of the spire, one immediately below, one just above the suture, rising into short spines or points at the intersections. On the last whorl there are 4 or 5 prominent spiral ridges, the first close to the suture, the next and most prominent at the angular shoulder; all are spinose where they cross the longitudinal ribs. Between these principal spirals there are spiral cords throughout. The siphonal fasciole is prominent, leaving an umbilical crevice. There are 5 teeth within the outer lip, the upper two large, the others small.

Length 14, diam. 8.5 mm.

Length 12.5, diam. 8 mm.

Hachijojima, Izu. Types No. 85,982, from No. 1,401 of Mr. Hirase's collection.

The biconic form, pale color and rough sculpture differentiate this from all forms of the polymorphic *morus* group known to me; and it will probably prove to be constantly distinct enough for specific rank, though in view of the variability of *R. morus* I have considered this northern form to be a subspecies of the tropical *morus*.

FUSIDÆ.

Fusus suboblitus n. sp. Pl. I, fig. 5.

Shell fusiform, widest in the middle, whitish with a brown band below the suture and another below the periphery, the anterior canal in part brown; there are also some indistinct brown longitudinal streaks. Sculpture of numerous longitudinal folds, strongest on the convexity of each whorl, disappearing on the base and near the suture, 12 in number on the last whorl. Each rib bears about six compressed tubercles, as though crossed by coarse spiral cords, which are reduced to narrow threads in the intervals, but are prominent on the ribs. The whole surface has a finer sculpture of spaced spiral threads with numerous unequal spiral striæ between them, all slightly crenulated by the close, fine growth-striæ. The high and rather slender spire is composed of 6 very convex whorls, the apical ones being broken off in the type specimen. The suture is deeply constricting. The last whorl is convex, rapidly contracting below, and produced in a long, slender and nearly straight anterior canal. Aperture ovate, hardly longer than the narrow canal at the base. The outer lip is thin, and retracted in a broad shallow posterior sinus. Length 36.5, diam. 12.5 mm.; length of aperture with anterior canal 20 mm.

Japan, exact locality unknown. Type No. 70,941, A. N. S. P.

This peculiar Fusoid species has been in the collection of the Academy for a good many years, during which time I have not seen anything much like it. It may possibly belong to the *Pleurotomidæ*.

BUCCINIDÆ.

Tritonidea tosana n. sp. Pl. IV, fig. 33.

Shell wide-fusiform, solid; brown, closely marked with many narrow black bands. Sculpture of numerous small longitudinal folds, which are nearly obsolete on the last whorl, disappear on its last third, and elsewhere do not pass below the periphery. There are about 15 rather acute, black primary spiral cords on the last whorl, the intervals between them densely striated with similar but smaller spirals of two or three sizes. Whorls nearly 7, slightly convex, the last inflated in the middle, contracted below. The convex, moderately prominent siphonal fasciole is sculptured like the rest of the shell. Aperture blue-white and indistinctly sulcate within, the throat smooth; posteriorly it is acute and slightly channelled, there being a small callous pad on the inner lip. Outer lip sulcate within, bevelled to an acute edge, which is tessellated with black and yellowish. Columella concave above, oblique and straight below, the white columellar callous showing several inconspicuous transverse plicæ near the edge.

Length 22.5, diam. 12 mm.; aperture 14 mm. long.

Kashiwajima, Tosa. Types No. 85,990, A. N. S. P., from No. 1,462 of Mr. Hirase's collection.

This species is most nearly related to *T. undulata* Schepman, but differs from that in the much smaller and more numerous longitudinal folds.

Cyllene japonica n. sp. Pl. IV, fig. 34.

Shell fusiform; flesh-tinted, indistinctly marbled and mottled with white and irregularly speckled with brown; vertically rather weakly striate and spirally grooved, the grooves narrow, separated by flat intervals. There are four or five grooves on the penultimate and next earlier whorls, with a smooth space one-third or one-half the exposed width of the whorl between the lowest groove and the suture. This smooth area extends upon the front of the last whorl. The back of the last whorl is grooved throughout, the grooves more widely spaced in the peripheral region. The outer lip is swollen outside as usual, and lirate within. The rounded, callous columella is closely obliquely sulcate as usual. There are 5 whorls, the apical one smooth, obtuse and rounded, the rest flat, parted by a channelled suture; the last whorl is a little concave below the suture.

Length 11.8, diam. 5.5 mm.

Hirado, Hizen. Type No. 82,144, A. N. S. P.

This species may be near the insufficiently described, unfigured *C. gibba* A. Ad., but in the absence of measurements or adequate description no comparison with that form is possible. It differs from the other species in the absence of longitudinal ribs. In the young stages the whorl is smooth on the median convexity, but spiral grooves set in there on the last whorl.

NASSIDÆ.

Nassa semiplicata hiradoensis n. subsp. Pl. IV, figs. 35, 35*a*.

Shell ovate-turreted, solid and thick, lusterless, variously colored: (1) Yellow with the intervals between the ribs black, the mouth and outer lip banded with black; (2) dull blackish-brown, uniform or with a yellow or white peripheral band, mouth banded; (3) uniform cream-tinted, the mouth white. Sculpture of strong, rounded longitudinal folds as wide as their intervals, 11 or 12 in number on the last whorl, the last one much larger, forming a prominent, rounded, swollen varix behind the lip, usually preceded by a much smaller fold. Over the folds and intervals run coarse spiral cords, rounded or flattened, as wide as their intervals or wider, and either of even strength or weaker in the valleys. On the last whorl there are 9 to 11 of these cords. Some shells show a very minute and superficial spiral striation throughout. Whorls about 7 (the apex broken), strongly convex, the last rounded at the periphery, sloping below, with a moderately deep basal sulcus. Aperture ovate; outer lip with 7 or 8 teeth within, the lower 4 usually larger, the others small. Columella calloused, white, with 3 small transverse wrinkles. A callous cord near the posterior angle defines a small posterior sinus.

Length 16, diam. 8.5 mm.; length of aperture 7 mm.

Length 15.5, diam. 8 mm.; length of aperture 7 mm.

Hirado, Hizen. Types No. 85,999, A. N. S. P., from No. 843*b* of Mr. Hirase's collection.

This form is smaller than *N. semiplicata* and has stronger spiral cords throughout. It is related to *N. incrassata* and *N. festiva.*

Another form of the same species, from the same locality, is smaller, with more numerous, weaker folds, about 15 on the last whorl, and 9 spiral cords.

Length 13, diam. 6.8 mm.

Length 12, diam. 6 mm.

At Fukura, Awaji, there is another form referable to *hiradoensis*, but more elongate, with smaller folds, 15–17 on the last whorl, or obsolete on its later half, the teeth within the lip smaller. The shell is of a dull dirty yellow tint externally, the mouth yellowish-brown or chestnut-tinted within.

Length 19, diam. 9 mm.; aperture 8 mm. long.

This race looks a good deal like some forms of *N. mendica* Gld. The operculum is smooth-edged.

Nassa semiplicata hizenensis n. subsp. Pl. IV, figs. 36, 36*a*.

Much smaller than *hiradoensis*, with the folds small and close, but not strong on the spire, weak or obsolete on the last whorl. There are weak spirals above and below on the last whorl, obsolete in the peripheral region. Whorls about 7, of which the first $1\frac{1}{2}$ are smooth, forming bulbous, elevated protoconch. Teeth within the outer lip weak. Color purple-black, reddish-brown or olive, sometimes with a light band.

Length 10 to 11, diam. 5 mm.

Hirado, Hizen. Types No. 85,996, A. N. S. P., from No. 843*c* of Mr. Hirase's collection.

This form differs from *N. teretiuscula* A. Ad. by its spiral sculpture.

AQUILLIDÆ.

Tritonidæ and *Tritoniidæ* of authors.
Lampusidæ R. B. Newton, Cat. Brit. Eoc. and Oligoc. Moll. Edw. Coll., p. 145 (1891).
Lotoriidæ Harris, Catal. Tert. Moll., I, Australasian, p. 185 (1897). Kesteven, Proc. Linn. Soc. N. S. Wales for 1902, p. 443.
Septidæ Dall and Simpson, Moll. Porto Rico, p. 416 (1902); Nautilus, XVII, p. 55 (September, 1903).

The preoccupation of the name *Triton* resulting in a search for other names available for the molluscan group has led to some diversity in modern usage. The earliest available name for the group, so far as I have been able to learn, is *Aquillus* of Montfort. This name, as Johnson has pointed out,[6] precedes *Lotorium* in the *Conchyliologie Systématique.* Its resemblance to *Aquila* is no bar to acceptance because the Latin word *aquillus* or *aquilus,*[7] signifying dark or water-colored, is different from *aquila,* an eagle. In this connection it may be noted that Montfort used "watery" names for his other genera of *Tritons.*[8]

The genera of *Aquillidæ* may therefore stand thus:

I.—*Aquillus* Montf., *Conch. Syst.*, II, 578. Type *cutaceus* L.
(Includes the sections *Lampusia* Schum, 1817, type *pilearis* L.; *Lotorium* Montf., 1810, type *L. lotor*=*femoralis* L.; *Monoplex* Perry, 1811, type *cynocephalus* Lam.)
Subgenus *Septa* Perry, 1811. Type *S. rubicunda* Perry (=*australis* Lam.).
(Includes *Triton* Montf. and *Tritonium* Cuv.)
II.—*Distortrix* Link, 1807. (*Distorsio* auct.)
III.—*Priene* H. and A. Ad.
IV.—*Colubraria* Schum., 1817. Type *maculosa* Gmel. (*Epidromus* Klein of authors).
Subg. *Cumia* Bivona, 1838, type *lanceolata* Mke.
V.—*Apollon* Montf., 1810 (+*Gyrina* Schum., 1817).
VI.—*Gyrineum* Link, 1807.
(Including *Biplex* Perry, *Buffo* Montf., *Bufonaria* and *Lampas* Schum., etc., some of which are available for subgeneric and sectional divisions.)

Some authors recognize more than one genus among the forms referred above to *Aquillus,* but when a wide range of species is examined, the subgenera seem to merge pretty thoroughly together. Indeed *Septa* is not very distinct, except in the typical species. This subject has been ably discussed by Kesteven, with whose conclusions I fully agree. It seems to me that he has shown conclusively the untenability of *Ranularia, Lampusia, Lotorium,* etc., as generic divisions. *Colubraria* stands apart from all the other genera, and the examination of its dentition is a desideratum. It may possibly be Rhachiglossate. The subgenus *Cumia* includes small Mediterranean and Antillean species. A series of Antillean and Pacific species referred to this

[6] *Nautilus,* XVII, p. 24 (June, 1903).

[7] Both spellings are given in dictionaries consulted. The etymology suggested by Herrmannsen is obscure and more than doubtful.

[8] Harris (*t. c.*, p. 186) rejects *Aquillus* because (1) its etymology is uncertain, and (2) if emended sufficiently it can be made identical with *Aquila* Brisson. It seems scarcely necessary to reply that uncertain etymology is not usually considered ground for rejection of a name, and no authorization of such a course can be found in the British Association or any later code. And to the second objection it may be urged that by a similar process of emendation about half the names in use might be changed. Harris is wide of the mark in citing *Murex lotorium* as the type of *Lotorium* Montf. It is rather hard to see how such a mistake could be made. Montfort's engraving is a characteristic representation of the common *Murex femoralis* L.

division by Tryon and others, of which *decapitatus* Reeve and *bracteatus* Hinds are typical, belongs to the Rhachiglossa, as Mr. Vanatta and the writer will elsewhere show. Mr. Kesteven has shown that *Triton speciosum* Angas is a *Trophon*.

Aquillus labiosus (Wood).

Murex labiosus Wood, Index Testac. Suppl., p. 15, Pl. 5, fig. 18*a* (1828).
Triton labiosus of authors.
Triton exaratum Reeve, Lischke, Jap. Meeres-Conch., II, p. 35; III, p. 30, Pl. 2, figs. 15–17. Not of Reeve!
Tritonium excavatum Reeve, Pilsbry, Catal. Mar. Moll. Jap., p. 47.

Hirado, Hizen (Hirase, No. 911).

This species has been erroneously described and figured as *T. exaratum* Reeve, an Australian form, which I have determined by comparison of numerous Australian specimens to be distinct from the Japanese species. *Aquillus exaratus* (Rve.) has a much more highly conic nucleus with more whorls; the postnepionic whorls have a flatter shoulder, and coarser secondary spiral striation. It should be deleted from the Japanese list.

There is no trustworthy or authentic West Indian record for *Aquillus labiosus*. The specimens so marked which I have seen are from shell dealers, who, like many others, have not always been careful about localities.

NATICIDÆ.

Polinices sagamiensis n. sp. Pl. IV, figs. 37, 37*a*.

Shell obliquely hemispherical, solid and heavy, smooth; chestnut-brown, with the spire, a band below the suture, and an area at the base, the umbilicus and aperture white. The spire is very small, short and low, though slightly conic. Whorls 5, the last one very rapidly enlarging, globose, narrowly rounded at the base, where it curves into the umbilicus. The suture is superficial. The very oblique aperture is half round and pure white, the columellar side straight. The posterior angle is filled with a very heavy convex callous. At the middle of the columellar margin a large, rounded, flat-topped lobe projects into the umbilicus, terminating a very large spiral cord which nearly fills the axial cavity, leaving a crescentic umbilical furrow, overhung on the convex arc by a heavy rounded rib which forms the outer margin of the umbilicus.

Length 32.5, diam. 35 mm.

Hayama, a place on Sagami Bay, about 4 miles from Kamakura. Type No. 85,956, A. N. S. P., collected by Miss A. C. Hartshorne.

This is the species I listed as a form of *P. powisianus* var. *draparnaudii*

Recluz, in the *Catal. Mar. Moll. Jap.*, p. 72, having before me then a single specimen obtained by Mr. Frederick Stearns, now in his collection in Detroit. I at that time noted the differences between the specimen and *N. draparnaudii* Recl., but thought the former might be abnormal. The large size of the umbilical lobe and the strong cord around the umbilical crescent readily distinguish *P. sagamiensis* from *draparnaudii, effusa* Swains., *powisianus* Recl., *cumingianus* Recl. and other species of that group.

CALYPTRÆIDÆ.

Ergæa walshi ('Herm.' Rve.).

This name *Ergæa* was originally proposed for a subgenus of *Crepidula* (*Crypta*), comprising the species *C. plana* Ads. and Rve. (not Say) and *C. walshi* 'Herm.' Rve. It was J. E. Gray in 1867 who raised the group to generic rank, explained its morphology, and showed that it is related to *Calyptræa*. Gray's half-contemptuous estimate of the inability of his conchological contemporaries to appreciate morphological problems, expressed in his paper of '67,[9] has been amply justified by the history of this genus; for in the latest works it still remains included in *Crepidula*.[10] Having reached the same conclusion independently before reading Gray's paper, it was with some surprise that I found that he had exposed the facts in the case.

Ergæa is the end of a line of differentiation from *Calyptræa*, parallel in its evolution to that phylum of *Crepidula* represented by the flat white slipper-limpets of the group of *Crepidula crepidula* Linné (*C. unguiformis* Lam.) and *C. plana* Say. The two groups, arising from diverse ancestors, have reached a superficially similar appearance, by adaptation to growing inside other shells.

Ergæa walshi ('Herm.' Rve.) has been taken by Mr. Hirase at Fukura, Awaji Island (No. 1,443 of Hirase's register), and by Miss Hartshorne at Hayama, on Sagami Bay.

Amalthea conica Schum. Essai, p. 181, Pl. 21, f. 4 (1817).

Patella cassida Dillwyn, Catal. II, p. 1,037 (1817).
Hipponyx australis Lam., Quoy and Gaim., Voy. Astrolabe, III, p. 434, Pl. 72, figs. 25–34 (1834). Not *Patella australis* Lamarck.

This abundant and widespread species has been called *Hipponyx australis* by writers on the Japanese fauna. Hedley has recently shown that the Lamarckian species is a South Australian *Capulus*, a

[9] *Proc. Zool. Soc. London*, 1867, p. 740.
[10] Tryon, *Manual of Conchology*, VIII, p. 130 (1886); Fischer, *Manuel de Conchyliologie*, p. 758 (1885).

conclusion borne out by the specimens before me. Mr. Hirase has sent *Amalthea conica* from Riukiu, Hirado, Hizen, and Fukura, Awaji.

I am unable to see any differences between the shells of this species from South Australia, Japan, Mauritius, etc. Though individually variable, there seems to have been no racial differentiation. Tryon adds the following names to the synonymy of this species: *Hipponyx acutus* and *suturalis* Q. and G., *cornucopiæa* Hutton, *orientalis* Dufo.

CERITHIIDÆ.

Cerithium trailli kikaiensis n. subsp. Pl. IV, fig. 38.

Shell with the lateral outlines nearly straight above, convex in the lower half; cream-white, sparsely dotted with brownish-yellow on the spiral threads, and with beads of dull violet sparsely and irregularly scattered along the spiral cords.

Sculpture of three rather weakly tuberculate spiral cords on each of the intermediate whorls of the spire, the upper one close to the suture, the intervals between them spirally striate, there being about 4 threads in each interval, the median one largest. The upper whorls have alternate cords and threads, crossed by close longitudinal waves. On the last whorl there are about 8 principal tuberculate cords, the intervals finely, unevenly striate. The later whorls have swollen varices at intervals of about half a whorl, but they become closer above, about one-third of a volution apart. Whorls about 10. The aperture is ovate, with a sinus above defined by a cord on the inner lip. The outer lip is strengthened by a small varix, and is sulcate within, there being usually a pair of liræ between the terminations of two spiral cords of the exterior. The throat is smooth and white, showing some blackish dots through. The basal channel is very short and oblique. The inner lip is coated with a rather thick deposit of a *deep purple color.*

Length 15, diam. 7 mm.

Kikaiga-shima, Osumi. Types No. 86,001, A. N. S. P., from No. 1,503 of Mr. Hirase's collection.

Compared with *C. trailli* Sowb. from Singapore, this is a very much smaller form, paler, with more numerous varices and a purple columella.

Cerithium subscalatum n. sp. Pl. IV, fig. 39.

Shell small, turrite; brown, the spiral cords paler, the intervals darker. Sculpture of longitudinal waves or folds, about 12 on the penultimate whorl, and with one rounded varix on the last whorl opposite the aperture. The folds do not extend below the periphery on the last whorl, where they are also much weaker. Spiral sculpture of many crowded, smooth cords, three of which are larger, two near the periphery and one at the middle of the base. There are three smaller cords between the upper and middle enlarged ones, and five between the middle and the basal cord, which is largest of all. Sometimes only the median and lower cords are enlarged. Whorls about 9, those of the spire angular at the lower third. Aperture ovate with a short, deep anterior canal, the outer lip strengthened by a moderately strong, rather narrow varix.

Length 7.5, diam. 3.2 mm.

Length 8.3, diam. 3.7 mm.

Hahajima, Ogasawara. Types No. 86,130, A. N. S. P., from No. 1,466 of Mr. Hirase's collection.

This peculiar little Cerite is very closely related to *Bittium oosimense* Watson, but differs by the number of whorls and the details of the spiral sculpture, as may be seen on comparison with Watson's excellent description and figure. It may perhaps be identical with *Bittium scalatum* Dunker. That species has been described too briefly to decide with any certainty, and it has not been figured. The species before me, however, is a true *Cerithium*, not a *Bittium*.

RISSOIDÆ.

Rissoa tokyoensis n. sp. Pl. IV, fig. 40.

Shell very small, regularly tapering from the last whorl, bright chestnut colored, the very thick peristome white. Sculpture of 8 spiral cords on the last whorl, the upper four rather coarsely regularly tuberculate, those below less so, the lower two smooth. The spire and upper portion of the last whorl are indistinctly plicate longitudinally, the tubercles on the spirals being at the points of intersection. Whorls 5, convex, the first one smooth, the last whorl with a heavy white varix behind the lip. Aperture oval, the outer lip sinuous, advanced below.

Length 2.3, diam. 1.2 mm.

Tokyo Harbor. Types No. 70,910, A. N. S. P.

Rissoa ogasawarana n. sp. Pl. IV, fig. 41.

Shell ovate, with a rather short, straightly conic spire. Cream-white, with some indistinct brown spots below the suture. Sculpture of rather small close longitudinal riblets, which on the last whorl do not pass below the periphery. These are crossed by about 11 spiral cords on the last whorl. There are about 5 or 5½ slightly convex whorls, the last one with a broad rounded but rather low varix a short distance behind the thin outer lip. Aperture ovate, entire below.

Length 2.2, diam. 1.2 mm.

Hahajima, Ogasawara. Types No. 85,951, A. N. S. P., from No. 1,385 of Mr. Hirase's collection.

Rissoina rex n. sp. Pl. IV, figs. 42, 42*a*.

Shell solid, the lower two-thirds slowly tapering, somewhat cylindric, the upper third more rapidly tapering to an acute apex; not glossy; white. Sculpture of regular longitudinal rounded ribs, as wide as their intervals and about 19 in number on the penultimate whorl, and not extending upon the base of the last one. These ribs are crossed by numerous unequal fine spiral threads. Whorls 10, moderately convex, parted by a deeply impressed suture, the last whorl swollen behind the outer lip. Aperture small, ovate, vertical, hardly channelled below.

Length 14, diam. 4.8 mm.

Hirado, Hizen. Types No. 85,949, A. N. S. P., from No. 753 of Mr. Hirase's collection.

This large *Rissoina* seems to be rather abundant. With the type lot there was a specimen of a reddish-brown color with a small white basal tract and a light band above. The ribs are more numerous, 25 on the penultimate whorl, and there are 4 broad varices on the last 3 whorls, while the type has only 1 at the end of the last volution. The shape is also less cylindric than in the type. More material is needed to determine the status of this form.

Rissoina materinsulæ n. sp. Pl. V, figs. 43, 43*a*.

Shell oblong-acuminate, the outlines of the spire convex; solid, white. Sculpture of many small straight, crowded, rounded, low longitudinal riblets, the intervals transversely striate. The apex is wanting, about 6 whorls remaining. These are slightly convex and separated by a shallow, linear suture. The last whorl is swollen into a wide rounded varix behind the outer lip, the fine riblets of the rest of the surface being developed also upon it. The aperture is semioval, the thick outer lip a little advanced below; columellar margin moderately concave, truncate below by the shallow, rounded basal channel.

Length 5, diam. 2 mm.

Hahajima, Ogasawara. Types No. 85,976, A. N. S. P., from No. 1,390*a* of Mr. Hirase's collection.

Rissoina (Rissolina) lævicostulata n. sp. Pl. V, figs. 44, 44*a*.

Shell narrowly ovate-acuminate, regularly tapering from the last whorl, white, with a red-brown blush on the back of the last whorl, moderately solid. Sculpture of about 20 rounded, obliquely longitudinal, slightly sinuous ribs about as wide as the intervals, both ribs and intervals smooth. Whorls about 8, moderately convex, the last with a very strong, heavy varix behind the outer lip, and with a convex siphonal fasciole at the base, bounded above by a groove and regularly plicate, the ribs passing over it. Aperture semioval, the outer lip thick and sinuous, columellar margin but slightly concave, a shallow but distinct channel at its base in the basal margin.

Length 4.8, diam. 2 mm.

Kamakura, Sagami. Types No. 70,906, A. N. S. P. It also occurs at Hahajima, Ogasawara, No. 1,390*b* of Mr. Hirase's collection.

This form is related to *R. costulata* Dkr., but differs by its more numerous ribs. *R. plicatula* Gld., an unfigured species, also seems to be related.

Rissoina (Zebina) tridentata (Michaud).

Rissoa tridentata Michaud, Descript. nouv. esp. Rissoa (p. 6) in Ann. Soc. Linn. de Lyon, I, 1836.
Rissoina curta Sowb., Schwartz, Monogr. Rissoina, p. 107 (1860).
R. bidentata Phil., Archiv. f. Naturg., 1845, p. 64 (Friendly Is.).
R. eulimoides A. Ad., P. Z. S., 1851, p. 279 (Capul, Philippines).
Eulima dentiens Dkr., Malak. Bl., XVIII, 1871, p. 152 (Viti Is.).
Rissoa crassilabrum Garr., Proc. Cal. Acad., I, 1857, p. 102 (Hilo).
Rissoina coronata Recl., Schwartz, Monogr. Rissoina (1860), p. 109 (Mauritius).

Kikai-ga-shima, Osumi, typical specimens of this species, which has not before been reported from the east coast of Asia. The synonymy as given by Tryon[11] requires some emendation in the light of the large series of specimens now available for study. The following forms, united with *R. tridentata* by him, are, in my opinion, perfectly distinct species:

Rissoa semiglabrata A. Ad., *P. Z. S.*, 1851, p. 279.

Rissoa semiplicata Pse., *P. Z. S.*, 1862, p. 242; *Amer. Jour. of Conch.*, III, p. 295, Pl. 24, fig. 29.

The former of these differs from all forms of *tridentata* in the more acuminate spire and the sculpture. The latter, of which specimens from Pease are before me, is a very much smaller species, with more of the spire plicate. I add to the synonymy of *R. tridentata* the *Eulima dentiens* of Dunker, of which authentic specimens are before me. It is absolutely identical with *tridentata* Mich. *R. crassilabrum* Garrett is also a typical *tridentata*, with teeth, and 8 mm. long.

Whether the toothless form *coronata* 'Recl.' Schwartz is varietally separable is doubtful, but the series before me shows that toothless individuals occur with normal *tridentata*. The size varies a good deal:

Length 5.3, diam. 2.3 mm. (Schwartz, type of *R. coronata*).

[11] *Man. Conch.*, IX, p. 389.

Length 6, diam. 2.6 mm. (Schwartz, type of *R. eulimoides*).
Length 6.5, diam. 2.8 mm. (Schwartz, type of *bidentata*).
Length 7, diam. 3.7 mm. (Hawaiian Islands specimen).
Length 8, diam. 4 mm. (Michaud, *R. tridentata*).
Length 8, diam. 4 mm. (Viti Islands specimen).
Length 9, diam. 5 mm. (Viti Islands specimen).
Length 10, diam. 5.3–5.7 mm. (Kikai-ga-shima specimens).
Length 10.5, diam. 4.8 mm. (Viti Islands specimen).

The sizes from 5.5 to 10.5 mm. long are represented by specimens before me. Rarely there is a varix on the penultimate whorl. The larger shells are generally somewhat distorted, and are then extremely like *Eulima*. Indeed, the whole genus or subgenus *Zebina* is excessively Eulimoid in structure of the shell, so much so as to suggest that the *Eulimidæ* may have had a Rissoinoid progenitor. Probably the *Gymnoglossa*, even as restricted by Fischer, is not a natural group.

To the distribution of *R. tridentata* indicated above should be added the Red Sea localities given by Sturany[12] in his valuable report on the "Pola" gastropods. With the Japanese locality here recorded, this gives the species an enormous range in the Indo-Pacific life-area.

TURBONILLIDÆ.

Turbonilla hiradoensis n. sp. Pl. V, fig. 45.

Shell very slender, the length 5 times the greatest diameter; glossy; white, encircled by two brown lines, of which one is at the periphery of the last whorl and ascends the spire a little below the middle of the whorls, and the other revolves below the periphery of the last whorl, its upper edge being barely visible above the suture of the preceding whorls. Sculpture of nearly vertical, slightly arcuate rounded riblets, as wide as their intervals, extending from suture to suture on the spire, and on the last whorl they gradually decrease below the periphery, becoming obsolete around the axis, where the base is nearly smooth; over all there is an excessively fine, minute, dense spiral striation. On the last whorl there are 29 riblets. There are 12 convex whorls in addition to the smooth, planorboid, upturned nuclear whorl; sutures deeply impressed.

Length 8.3, diam. 1.7 mm.

Hirado, Hizen. Types No. 85,986, A. N. S. P., from No. 1,517 of Mr. Hirase's collection.

[12] "Gastropoden des Rothen Meeres" (p. 56), in *Denkschr. K. Akad. Wissensch.*, LXXIV, p. 264.

This species differs from *T. bicincta* A. Ad. by the absence of spiral liræ on the base.

A variety may be called *T. hiradoensis* var. *badia*. It is of a dark reddish-brown or purplish-brown color throughout. The specimens occurred with *T. hiradoensis*.

Turbonilla (Cingulina) terebra Dkr. Pl. V, fig. 46.

Shell slender, its length four times the diameter; lateral outlines straight; white; faintly marked with growth-lines. Sculpture of 3 spiral grooves on each whorl, the spaces between them equal, the lowest groove smaller than the others, a narrow space between it and the suture. Last whorl with the third groove nearly peripheral, several narrower grooves below it on the convex base. Whorls 11, besides the upturned planorboid nucleus. They are moderately convex and separated by deep sutures.

Length 8, diam. 2 mm.; aperture 2 mm. long.

Hirado, Hizen. No. 922*b* of Mr. Hirase's collection.

This species tapers more rapidly than *T. triarata*, and the 3 spiral grooves are parted by 2 equal spaces. The space above the upper groove is more convex than the others. In immature shells the base has numerous spiral engraved striæ, closer near the axis, but in the largest shells they become fainter.

This species must be closely related to *Cingulina subulata* Clessin,[13] described from Macao; but the whorls are more convex, and there are spiral grooves on the base of the last whorl, which in *subulata* is said to be "nach unten gerundet, glatt." The spiral grooves are more emphatic in *T. spina* C. and F., of New South Wales and South Australia, and which has also been reported from Karachi by Melvill, *Proc. Zool. Soc.*, 1901, p. 395.

The following species of the subgenus *Cingulina* have been reported from Japan:

C. cingulata Dkr., *Moll. Jap.*, p. 16.

C. terebra Dkr., *Moll. Jap.*, p. 16.

C. circinata A. Ad., *Ann. Mag.*, 1860, VI, p. 414.

C. japonica Clessin, *Conchylien Cabinet, Eulimidæ*, p. 223.

None of them have been adequately described or figured.

Turbonilla (Cingulina) cingulata (Dkr.). Pl. V, fig. 47.

In this species there are three deep equidistant spiral furrows, somewhat narrower than the intervening cords, on each whorl. Of the four cords, the upper three are equal, the lower one narrower. On the base

[13] *Conchylien Cabinet, Eulimidæ*, p. 223.

there are several spiral grooves, and some finer striæ near the axis. A well-grown specimen measures, length 10.5, diam. 2.5 mm. There are about 13 postnepionic whorls. The shell figured is from Hirado, Hizen. Dunker's type was from Deshima (near Nagasaki), also in southwestern Kyūshū.

This species is apparently close to *C. circinata* A. Ad., the type of *Cingulina*, found at Awa-shima, which is known to me by Adams' brief description only.

Turbonilla (Cingulina) triarata n. sp. Pl. V, fig. 48.

Shell very slender and long, the length about four times the greatest diameter; lateral outlines straight. White, glossy, slightly marked with growth-lines. Sculpture of three spiral grooves on each whorl, the lowest one at the suture below, the other grooves defining three nearly flat spaces, the upper one narrowest, lower widest. Last whorl with the third groove at the periphery, the base convex, very minutely and closely striate spirally. Whorls 13, besides the elevated planorboid nucleus which stands on edge at the summit. Suture channelled.

Length 9.5, diam. 2.3 mm.; length of aperture 2.1 mm.

Hirado, Hizen. Types No. 85,977, A. N. S. P., from No. 1,005 of Mr. Hirase's collection.

This form must stand near *Cingulina japonica* Clessin,[14] but agrees with neither the description nor figure. Clessin states that his species has a single line running below the suture, the rest of the whorl being smooth, but he figures two more spiral lines; and the last whorl, which he says is subangular below, the base smooth, is figured with 5 spiral lines. The proportions, 11 x 1.9 mm., are more slender than *T. triarata*. One becomes accustomed to such discrepancies in Clessin's work. His ideals of descriptive zoology are not lofty.

TURBINIDÆ.

Collonia rosa n. sp. Pl. VI, fig. 53.

Shell obliquely globose-turbinate, narrowly umbilicate, rose-red, with two apical whorls yellow. Sculpture of somewhat unequal spiral cords, about as wide as their intervals, and 25 to 27 in number on the last whorl. Several of the cords, at unequal intervals, are slightly larger than the others, and all are nearly smooth except near the suture and umbilicus, where there are short radial folds. Spire short, conic. Whorls about 4, convex. Aperture but slightly oblique, circular, white, smooth and pearly within. Inner margin of the peristome thick and white. A slightly sinuous cord ascends almost vertically into the

[14] *Conchylien Cabinet, Eulimidæ*, p. 223, Pl. 36, fig. 3.

umbilicus, on the side opposite the aperture. The margin of the umbilicus is more or less distinctly crenulate.

Alt. 5.5, diam. 6 mm.

Tanabe, Kii. Types No. 85,992, A. N. S. P., from No. 1,457 of Mr. Hirase's collection. Also from Tokyo Bay.

In some of the specimens, especially those not quite mature, there is some white mottling in the peripheral region, and a white area around the umbilicus. The specimens from Tokyo Bay which I provisionally refer to this species want the subsutural and umbilical plication.

PHASIANELLIDÆ.

Phasianella tristis Pils. Pl. VI, fig. 64.

Nautilus, XVII, 69 (October, 1903).

Rishiri, Kitami.

TROCHIDÆ.

Trochus hirasei n. sp. Pl. V, figs. 52, 52*a*.

Shell imperforate, pyramidal, with the outlines slightly convex below and noticeably concave along the upper half of the spire; base flat. White, with bold radial stripes of blood-red or purplish-red on the later whorls, the spire very minutely and copiously speckled with olive-green and red, the latter color predominating on the spiral cords. Base whitish, tessellated with blood-red oblong spots on the spiral cords. The upper half of the spire is sculptured with short obliquely vertical waves on the lower third of each whorl, terminating in nodes above the suture; above these waves there are several low, weakly granose spiral cords. The waves gradually diminish on the penultimate whorl and are nearly obsolete on the last, and the spiral cords increase in number and strength. The periphery is acutely angular in front but in fully adult shells becomes blunt behind the lip. The flat base is sculptured with about 12 very low and smoothish circular cords. The aperture is smooth and silvery within. The columella bears an acute lobe above, separated from the base by a deep incision, and it terminates below in an oblong, whitish tubercle. The umbilical region is pearly as usual.

Alt. 50, diam. 45 mm.

Tanabe, Kii. Types No. 82,104, A. N. S. P., from No. 1,295 of Mr. Hirase's collection.

Trochus hirasei differs from *T. conus* Gm.[15] in its wider base, acutely

[15] The synonymy of this species, which is commonly known by the non-binomial name given by Chemnitz, is as follows:

Trochus conus Gmel., *Syst. Nat.* (13), p. 3,569 (1790), based upon

Trochus acutangulus, etc., Chemnitz, *Conchyl. Cab.*, V, p. 81, Pl. 167, fig. 1,610 (1781).

angular periphery and flat lower surface. It holds a relation toward *T. conus* somewhat similar to that existing between *T. maximus* Koch and *T. niloticus* L.

This form seems to be identical with *T. turris* Philippi, *Zeitschr. f. Malak.*, 1846, p. 102 (preoc.) = *T. altus* Phil., *Conchyl. Cab.*, p. 217, Pl. 32, fig. 7 (not of Perry, 1811). The habitat of Philippi's species was unknown, but Dunker has reported it from the Inland Sea of Japan.

Four recent species of the typical section of *Trochus* are now known: *T. niloticus*, *T. maximus*, *T. conus* and *T. hirasei.*

Chlorostoma rugatum Gld.

Gld., Otia Conch., p. 158.
C. turbinatum A. Ad., Pilsbry, Catal. Mar. Moll. Jap., p. 94, Pl. 6, figs. 9, 10. Not of A. Adams.

I formerly figured this under the erroneous name *C. turbinatum*, but Adams described that species as umbilicate, while this is imperforate. The figures cited above are from specimens from Hakodate, the type locality. The species extends down the ocean coast of Nippon to Sagami Bay, where it has been found at Hayama, near Kamakura, by Miss A. C. Hartshorne.

Chlorostoma rugatum sublævis n. subsp. Pl. V, fig. 50.

Shell imperforate but with a rather deep pit in the place of the filled umbilicus, shaped like *C. rugatum* or more depressed, slate-black or purplish-black. *Upper surface free from oblique corrugation, or with it only weakly indicated in places.* Base weakly sculptured with low spiral cords. Axial callous white, or sometimes green-tinted and with an orange outer border.

Alt. 21, diam. 26 mm. (Kamoito, Teshio).

Alt. 26, diam. 32 mm. (Afun, Teshio).

Kamoito and Afun, Teshio, in Yesso, the types No. 80,388, A. N. S. P., from the former place.

Clanculus hizenensis var. **fraterculus** n. v. Pl. VI, fig. 54.

The shell is trochiform with flattened base, straightly conic spire and rounded periphery. On a nearly white ground it is radially maculate with brown on the upper surface, with smaller spots interposed between the others at the peripheral region. The base has paler small spots on the ribs, sometimes partially arranged in radial stripes. The apical $1\frac{1}{2}$ whorls are uniform, the next whorl irregularly dotted with pink on a pale buff-brown ground. The $5\frac{1}{2}$ or 6 whorls are convex and parted by a narrow, deep suture.

Trochus altus Perry, *Conchology*, Pl. 47, fig. 3 (1811).
Trochus elatus Lamarck, *An. sans Vert.*, VII, p. 21 (1822).
Trochus senatarius Philippi, *Conchyl. Cab.*, *Trochus*, p. 324, Pl. 46, fig. 7.

The sculpture is of closely beaded spiral cords, of which there are five on the penultimate and next earlier whorls, the upper three small, the lower two much larger and wider spaced. On the last whorl there is a group of three large cords in the peripheral region, three smaller ones above them; the intervals being densely obliquely striate, with no trace of spiral striæ or secondary threads. The base, which is slightly convex, has eight subequal spirals, which are smaller and less deeply cut into beads than those above them. The intervals throughout are about equal in width to the adjacent spiral cords.

The aperture is very oblique, sulcate within, with 8 to 10 liræ, the bevelled edge fluted. The oblique columella has a low nodule above and a strong tooth at the base. Its edge is flanged outwardly. The rather narrow umbilicus is guarded by about four teeth.

Alt. 5.3, diam. 5.8 mm.

Alt. 4.5, diam. 4.5 mm.

Riukiu. Types No. 85,980, A. N. S. P., from No. 1,451 of Mr. Hirase's collection.

This form is closely related to *C. hizenensis* Pils. from Hirado, Hizen, from which it differs chiefly in the smaller size, different coloration and the splitting of the subsutural bead-cord into two.

Clanculus gemmulifer pallidus Pils. Pl. VI, fig. 63.

Nautilus, XVII, 71 (October, 1903).

Kashiwajima, Tosa.

Gibbula vittata Pils. Pl. VI, fig. 59.

Nautilus, XVII, 69 (October, 1903).

Riukiu Island.

Gibbula incarnata Pils. Pl. VI, fig. 62.

Nautilus, XVII, 70.

Kumihama, Tango.

Monilea (Rossiteria) nucleolus Pils. Pl. VI, figs. 58, 58*a*.

Nautilus, XVII, 70.

Euchelus lischkei n. sp. Pl. VI, fig. 55.

The shell is globose with conic spire and narrow umbilicus, moderately solid, and of a uniform purple-brown color. There are about 5 convex whorls parted by a narrow channelled suture.

The sculpture is of closely beaded spiral cords parted by intervals of about their own width. On the last whorl there are 11 of these primary cords, with, in full-grown shells, a small secondary cord in each interval. The earliest sculptured whorl has three large cords, this number being soon doubled by intercalation of new ones. The intervals are more or less strongly latticed across by threads continuous with the beads on the spirals. The round, oblique aperture is closely lirate within. The columella is noticeably concave, and bears a weak tooth below. The narrow umbilicus is bounded by a white cord.

Alt. 7.5, diam. 6.5 mm.

Hachijo-jima, Izu. Types No. 85,979, A. N. S. P., from No. 1,395 of Mr. Hirase's collection.

This species, in form and sculpture, is much like *E. atratus* (Gm.) on a diminutive scale, but the columellar tooth is far weaker. *E. ruber* A. Ad., *E. gemmatus* (Gld). and other small granose species also have a much stronger columellar tooth.

Euchelus hachijoensis n. sp. Pl. VI, fig. 56.

Shell globose, with short spire and narrow umbilicus; spirally granose-lirate; coral-red, sparsely dotted with darker red, usually on alternate spirals above and on all the basal spirals. Whorls 4, convex, the first 1 smooth.

Sculpture of crowded, closely granose or beaded spirals, 12 or 13 in number and subequal on the last whorl, the granules weakly connected across the intervals. On the penultimate whorl the spirals usually alternate in size, as is ordinarily the case in shells where they increase in number by intercalation. The subcircular, oblique aperture is smooth or at least not distinctly sulcate inside. The columella is slightly concave and terminates in a very weak tubercle. The umbilicus is bounded by a white rib.

Alt. 4, diam. 4.5 mm.

Hachijojima, Izu. Types No. 85,978, A. N. S. P., from No. 1,395*b* of Mr. Hirase's collection.

This small red species has an unusually weak columellar tubercle. I do not know of any closely related form.

Euchelus (Hybochelus) cancellatus orientalis n. subsp. Pl. VI, figs. 57, 57*a*.

Shell similar to *E. cancellatus* of South Africa in form, but differing in having more large spiral cords, 10 at the beginning of the last whorl, each interval bisected by a small thread. Near the end of the whorl some of these threads become nearly as large as the primary cords, and minute threads of a third order appear in some of the intervals. In *E. cancellatus* there are only 8 primary cords at the beginning of the last whorl, the intervening threads are much larger, and additional threads are intercalated sooner and more numerously. The pits produced by oblique riblets are much narrower in *orientalis*, the upper series in each pair of intervals are usually subdivided, while in *E. cancellatus* the pits are regular and uniform.

Alt. 13, diam. 15 mm.

Kashiwajima, Tosa. Type No. 85,954, A. N. S. P., from No. 1,475 of Mr. Hirase's collection.

SIPHONARIIDÆ.

Siphonaria subatra n. sp. Pl. VI, figs. 61, 61*a*, 61*b*.

Shell oval, thin, with subcentral apex, nearly straight slopes and strongly projecting "siphon." Dark ashy-brown where eroded in the middle, blackish around the border, and gray or banded with black in the intervening zone; the interior intense black-brown with short white marks at the terminations of the ribs. Sculpture of numerous rather coarse, unequally spaced radial ribs, projecting at the edge, with much finer radial threads between them, several in each interval. The siphonal groove usually continues weakly past the apex of the cavity, its end curving forward.

Length 16–17, width 13–14.5, alt. 4 mm.

Chichijima, Ogasawara. Types No. 86,132, A. N. S. P., from No. 1,482 of Mr. Hirase's collection.

S. atra, of the South Pacific, is a much heavier and larger shell, more strongly serrate at the edge. *S. amara* Nutt. is a higher species, with the siphonal projection less conspicuous.

Siphonaria rucuana n. sp. Pl. VI, figs. 60, 60*a*, 60*b*.

Shell small, thin, steeply conic, with subcentral summit. The apex is brown, smooth and glossy, *Crepidula*-shaped, the tip curving backward and to the left. The sculpture is of 20 to 25 unequal rounded radial ribs, of which about half do not extend to the apex. The ribs are whitish-gray, the intervals generally dusky. The ribs irregularly denticulate the margin. The siphonal rib projects moderately, and shows a rather faintly impressed line along its ridge. The interior is deep-brown or even black-brown within the muscle-impression, and usually striped with brown to or nearly to the edge, between the white rib rays.

Length 8, width 6.5 to 7, alt. 3.3 mm.

Length 8.5, width 7, alt. 4 mm.

Riukiu Island. Types No. 86,131, A. N. S. P., from No. 1,364 of Mr. Hirase's collection.

This small form is unlike any of the region, and seems fairly constant in a number of specimens.

TORNATINIDÆ.

Tornatina insignis n. sp. Pl. V, figs. 49, 49*a*.

Shell cylindric, white, marked with slight growth-lines only. Spire rather long and slender; whorls 4 after the up-tilted nucleus, *very* *convex*, the suture deep but *not in the least channelled*, the shoulder of the last whorl rounded. Aperture of the usual shape, the thin outer lip arched forward in the middle, moderately retracted above. Columella concave, with a very inconspicuous fold above.

Length 4.7, diam. 2 mm.

Hirado, Hizen. Types No. 85,984, A. N. S. P., from No. 1,271*a* of Mr. Hirase's collection.

Remarkable for the total absence of a channel at the suture.

Tornatina decorata n. sp. Pl. V, fig. 51.

Shell straightly cylindric, white under a pale yellow cuticle, which is closely decorated with red-brown spiral lines; sculptured with slight growth-lines only. Spire short. Postnuclear whorls about 3½, parted by a deeply channelled suture, which does not descend much except at the last whorl. Aperture of the usual shape, the outer lip moderately arched forward in the middle and retracted above, deeply slit at the suture. Columella callous, flattened, slightly concave, with a low fold above.

Length 6.8, diam. 3.9 mm.

Hirado, Hizen. Types No. 85,985, A. N. S. P., from No. 1,235 of Mr. Hirase's collection.

Readily known by the brown lineolation and short spire when in good condition; but the color is solely cuticular. No similar species has been reported from the northwest Pacific.

STUDIES IN THE ORTHOPTEROUS FAMILY PHASMIDÆ.

BY JAMES A. G. REHN.

The material treated in the following pages is almost wholly from the collections of the Academy, the U. S. National Museum, and the collection of Mr. Morgan Hebard, of Chestnut Hill, Philadelphia.

The localities represented by large series are as follows:

Costa Rica (various localities). Schild and Burgdorf collection. [U. S. N. M.]

Mombasa, East Africa. [Collection of Morgan Hebard.]

South Africa. [A. N. S. Phila.]

Trong, Lower Siam. Dr. W. L. Abbott. [U. S. N. M.]

Goenong Soegi, Sumatra. A. C. Harrison, Jr., and Dr. H. M. Hiller. [A. N. S. Phila.]

Obi, Moluccas. [Collection of Morgan Hebard.]

The author wishes to thank Dr. William H. Ashmead, of the National Museum, and Mr. Hebard for many kindnesses rendered during the preparation of this and other papers.

Subfamily LONCHODINÆ.

Genus **MYRONIDES** Stål.

1875. *Myronides* Stål, Recensio Orthopterorum, III, pp. 8 and 63.

Included *M. pfeifferæ* (Westwood) and *M. kaupii* Stål, of which the former may be considered the type.

Myronides ashmeadi n. sp.

Type.—♂; Trong, Lower Siam. (W. L. Abbott.) [Cat. No. 6,974, U. S. N. M.]

Apparently related to *M. filum* Sharp[1] from New Britain, but readily separated by the absence of pronounced cephalic and metathoracic tubercles, the comparatively greater length of the limbs, and the single tooth on the apical portion of the femora.

I take pleasure in dedicating this very distinct species to my friend, Dr. William H. Ashmead, of the United States National Museum, as a token of personal esteem and regard for his pronounced scientific ability.

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[1] Willey's *Zoological Results*, Part I, p. 81, Pl. VII, fig. 1.

Form very slender. Head moderately elongate, subequal; eyes subovate, projecting considerably beyond the head; antennæ with the basal joint longer than broad, depressed, subequal in width. Pronotum about twice as long as broad. Mesonotum very elongate, subequal, surface with but few small tubercles. Metanotum (with median segment) not quite three-fifths the length of the mesonotum; median segment about two-fifths the metathoracic length. Abdomen slender, elongate, exceeding the thoracic segments in length; ninth dorsal segment tectate, compressed, apex very deeply and narrowly emarginate; supra-anal plate not visible; cerci of moderate length, subequal, incurved; subgenital plate short, not extending beyond the base of the supra-anal, apex very broadly and evenly rounded. Limbs very slender, the anterior and posterior pair subequal in length, median pair shorter. Anterior femora equal to the pronotum, mesonotum and metanotum (without median segment) in length, depressed, rectangular in section, supplied with a median subbasal dentiform process on the inferior surface; tibiæ very slightly exceeding the femora in length, subtrigonal in section; metatarsi about equal to the remaining tarsal joints in length. Median femora slightly exceeding the mesonotum in length, subtrigonal in section, inferior surface with a median subbasal process as on the anterior femora, genicular lobes acute; tibiæ very slightly exceeding the femora in length, subtrigonal in section. Posterior femora slightly exceeding the middle of the fourth abdominal segment,[2] sectionally subquadrate, the usual subbasal process present; tibiæ exceeding the femora by about the length of the median segment, sectionally subtrigonal; metatarsi equal to the remaining tarsal joints in length.

General color dull brownish-green, becoming rather pale green on the limbs; head, antennæ, pronotum, under surface of the abdominal segments, and the genicular regions very dull obscure claret. Pubescence on the tarsal joints golden yellow.

Measurements.

Total length,	71	mm.
Length of pronotum,	3.5	"
Length of mesonotum,	16.5	"
Length of metanotum (with median segment),	9	"
Length of abdomen,	38.5	"
Length of anterior femora,	23.5	"
Length of anterior tibiæ,	25.5	"
Length of median femora,	16.5	"
Length of posterior femora,	23	"

[2] Not including the median segment.

Two additional male specimens have been examined, one a topotype, the other from Khow Sai Dow, Trong, 1,000 feet elevation, taken in 1899.

Myronides porus (Westwood)?

1859. *Lonchodes Porus* Westwood, Cat. Orth. Ins. Brit. Mus., I, p. 42, Pl. VII, fig. 9. [East Indies.]

One female; Khow Sai Dow, Trong, Lower Siam, 1,000 feet. January–February, 1899. (Dr. W. L. Abbott.) [U. S. N. M.]

While the female of this species has never been described, the present specimen is in such condition that the more important characters cannot be critically examined. For this reason some uncertainty exists as to the correctness of the determination.

Genus **PHRAORTES** Stål.

1875. *Phraortes* Stål, Recensio Orthopterorum, III, pp. 8 and 64.

Type.—*Phasma elongata* Thunberg.

Phraortes mikado n. sp.

Type.—♀; Yokohama, Japan. (Loomis.) [A. N. Caudell.]

Allied to *P. elongatus* (Thunberg) (=*Phasma niponense* De Haan), but differing in the character of the lamellar expansions on the median and posterior femora, the carination of the anterior femora, and the non-gibbous sixth abdominal segment.

Form slender, elongate. Head moderately long, considerably wider anteriorly than posteriorly; eyes circular, moderately prominent; occiput bearing a pair of acute conical spines, equal in height to the depth of the eye. Pronotum rectangular, longer than broad, surface with slightly marked longitudinal and transverse depressions. Mesonotum over four times the length of the pronotum, subequal except posteriorly, median longitudinal depression well marked. Metanotum (with median segment) about four-fifths the length of the mesonotum, subequal except for the gradually expanded posterior portion, median segment about one-fourth the length of the metanotum alone. Abdomen considerably exceeding the head and thoracic segments in length, the greatest width being at the third and fourth segments; ninth dorsal segment tectate, carinate, lateral margins sinuate, the apex with a median triangular emargination which exposes the truncate extremity of the tectate and carinate supra-anal plate; subgenital plate scoop-shaped, compressed, carinate. Limbs very slender, the anterior pair exceeding the others in length. Anterior femora exceeding, by more than the length of the median segment, the combined length of the head, pronotum and mesonotum, subtrigonal in section, superior external and inferior margin sparsely serrulate, lower surface with a carina which is internal proximally but median distally; tibiæ exceeding the length of the femora by over the length of the head, pentagonal in section. Median femora comparatively short, not quite equal to the length of the mesonotum, subtrigonal in section, the superior surface narrowly flattened, lower margins slightly expanded basally and provided with several dentiform serrations, lower surface with the weak median carina elevated apically and bearing several rather slight dentiform processes, genicular lobes acute. Posterior femora considerably exceeding the pronotum and mesonotum in length, general structure identical with that of the median femora except that the external inferior margin alone is expanded and developed into but one dentiform serration; tibiæ slightly exceeding the femora in length, pentagonal in section, median inferior carina evenly elevated in the proximal portion.

General color greenish-brown, paler anteriorly and posteriorly.

Measurements.

Total length	104.5	mm.
Length of pronotum,	3.5	"
Length of mesonotum,	21	"
Length of metanotum (with median segment),	17	"
Length of abdomen,	57	"
Length of anterior femora,	32	"
Length of anterior tibiæ,	38	"
Length of median femora,	20	"
Length of posterior femora,	25.5	"

Genus **DIXIPPUS** Stål.

1875. *Dixippus* Stål, Recensio Orthopterorum, III, pp. 9 and 66.

Included *crawangensis* (Haan), *nodosus* (Haan), and *uniformis* (Westwood), of which the first may be selected as the type.

Dixippus sumatranus (Haan).

1842. *P[hasma] sumatranum* Haan, Natuur. Gesch. Neder. Overzeesche Bezitt., Plaaten, tab. 13, fig. 6. [Batang Singalang, Sumatra.]

One male; Goenong Soegi, Lampong, Sumatra. (A. C. Harrison, Jr., and Dr. H. M. Hiller.) [A. N. S. Phila.]

As Kirby has shown,[3] this form is no doubt distinct from *nodosus*, with which Haan confused it in his text, after having separated and applied a name to it on his plate. Kirby's male specimen and the one before me carry out the characters of the female figured by Haan, and

[3] *Trans. Linn. Soc. London*, zool. ser., VI, 2d ser., pp. 458, 459.

accordingly prove that the very different looking *nodosus* is something quite distinct.

The male specimens from Baram, North Borneo examined by Kirby, may prove to be a closely allied but distinct species, as the measurements given are very much larger than those of the Sumatran individual examined. The dimensions of the Goenong Soegi specimen are as follows:

Total length,	66	mm.
Length of pronotum,	2.7	"
Length of mesonotum,	16	"
Length of metanotum (with median segment),	13	"
Length of abdomen,	33	"
Length of anterior femora (approximately),	13	"
Length of anterior tibiæ,	12	"
Length of median femora,	9	"
Length of posterior femora,	11	"

Dixippus uniformis (Westwood).

1848. *Phasma* (*Lonchodes*) *uniforme* Westwood, Cabinet Orient. Entom., Pl. XXXIX, fig. 3. [Prince of Wales' Island, Malacca.]

One male; Khow Sai Dow, Trong, Lower Siam, 1,000 feet elevation. January–February, 1899. (Dr. W. L. Abbott.) [U. S. N. M.]

This specimen has the mesothorax and the metathorax each with a broad median transverse band of rich grass green.

The distribution of the species is supposed to cover Malacca, Sarawak and Amboina or Ceram.

Genus **CARAUSIUS** Stål.

1875. *Carausius* Stål, Recensio Orthopterorum, III, pp. 8 and 64.

Included *C. strumosus* and *C. macer* Stål, of which the former may be considered the type.

Carausius bracatus n. sp.

Type.—♀; Trong, Lower Siam. (Dr. W. L. Abbott.) [Cat. No. 6,979, U. S. N. M.]

Apparently not closely allied to any of the previously known species of the genus.

Size rather large; form elongate, subequal; surface of the head and body nodulose. Head subequal in width; interspace between the eyes bearing a transverse fold, which is crossed by a slight median longitudinal sulcus, and developed into slight elevations laterally; posterior part of the head with four slight transversely disposed tubercles; eyes circular, moderately prominent; antennæ with the first joint depressed, elongate-ovate in outline, second joint moniliform and about one-third the length of the first. Pronotum about a third again as long as broad; posterior margin arcuate; median transverse sulcus arcuate, longitudinal sulcus much less distinct. Mesonotum about four and one-half times the length of the pronotum, subequal in width (except at the posterior articular portion). Metanotum (with median segment) about twice the length of the head and pronotum; median segment equal to one-half of the metanotum alone. Abdomen exceeding the head and thoracic segments in length, subequal in width, apical segments with a median longitudinal carina, which become more distinct as the apex is approached; ninth dorsal segment apparently tectate in life,[4] apex slightly sinuate; supra-anal plate produced, acuminate, tectate, the apex triangularly emarginate; subgenital plate rugulose, carinate, apex with a distinct finger-like median process. Limbs of moderate length, all compressed, the anterior pair exceeding the others in size. Anterior femora slightly over twice the length of the head and pronotum, compressed trigonal in section, each margin with a foliaceous carinate ridge, lower surface with the median carina prominent proximally, and bearing several dentiform serrations distally; tibiæ equal to the femora in length, strongly compressed, the dorsal portion bearing a marked foliaceous ridge, inferior surface widely and deeply sulcate; metatarsi equal to the remaining tarsal joints in length, superior portion strongly cristate; remaining tarsal joints small, the apical one equal to the second and third in length. Median femora equal to about two-thirds the length of the mesonotum, compressed, dorsal portion strongly carinate; tibiæ equal to the femora in length, pentagonal in section, external inferior carina with a basal arcuate expansion; metatarsi equal to the second, third and fourth tarsal joints together, dorsal surface not expanded. Posterior femora two-thirds the length of the mesonotum, compressed, dorsal aspect carinate, genicular lobes subacuminate, internal inferior carina apically expanded and bearing three distinct teeth; tibiæ equal to the metanotum and median segment in length, pentagonal in section, dorsal surface sulcate, basal portion of the inferior median and the apical portion of the dorsal carina roundly expanded; metatarsi but slightly longer than the terminal tarsal joint, dorsal surface not crested.

General color red-brown, becoming dull umber on the limbs and ashy-brown on the head.

[4] Distorted in the dried specimen.

Measurements.

Total length.	125.5 mm.
Length of pronotum,	6 "
Length of mesonotum,	28 "
Length of metanotum (with median segment),	22 "
Length of abdomen,	65 "
Length of anterior femora,	24 "
Length of anterior tibiæ,	24.2 "
Length of median femora,	18 "
Length of posterior femora,	20 "

Carausius mammatus n. sp.

Type.—♀; Island of Obi, Moluccas. [A. N. S. Phila., presented by Mr. Morgan Hebard.]

This new and interesting form exhibits some relationship with *C. mercurius* Stål,[5] from an unknown locality, but differs in the form of the apical segments of the abdomen and the character of the expansion of the anterior tibiæ. Kirby's *Dixippus* (?) *insularis*[6] from Thursday Island appears to be related to the new form, but can be separated by a number of characters.

Size rather large; form moderately slender; surface evenly rugulose. Head slightly contracted posteriorly; interocular region with a transverse ridge, incised centrally and laterally developed into acute erect dentiform processes; eyes rather small, subovate; tubercles on the posterior half of the head arranged in distinct longitudinal series; antennæ not quite equal to half the length of the body, the basal joint depressed, subovate, expanded, second joint half the length of the first. Pronotum subequal in width, the anterior and posterior margins subtruncate, transverse median sulcus short. Mesonotum slightly expanded posteriorly, a fine median carina present and extending a considerable distance on the abdomen. Metanotum (with median segment) equal to two-thirds the length of the mesonotum, subequal in width; median segment slightly more than two-thirds the length of the metanotum alone. Abdomen with the three basal segments longitudinal, subequal in width; fourth segment with slight lateral expansions on the apical half, slightly exceeding the basal segments in width; fifth segment strongly expanded and moderately inflated, the expansion greatest on the apical portion, dorsal surface with a pair of median transversely disposed mammillate tubercles; sixth segment equal to the first in width, in length equal to the fifth, both segments being somewhat shorter than the basal ones; seventh, eighth and ninth segments

[5] *Annales Soc. Entom. Belg.*, Comp.-rend., XX, p. lxxii.
[6] *Trans. Linn. Soc.*, 2d ser, zool., VI, p. 460.

subequal in width, tectate, the seventh almost equal to the other two in length, apical margin with the median portion truncate; supra-anal plate moderately produced, truncate, rounded; cerci very short, hardly visible; subgenital opercule equal to the apex of the supra-anal plate in length, compressed, keeled, the posterior portion of the carina irregularly dentate. Anterior femora slightly shorter than the mesonotum in length, compressed, the superior margin considerably expanded basally and undulate, inferior external margin apically with two distinct teeth, external genicular lobes acute; anterior tibiæ about equal in length to the femora, compressed, the superior margin with a continuous foliaceous expansion which develops a slight premedian lobe; metatarsi equal in length to the remaining tarsal joint, superiorly with a foliaceous expansion equal in height to that on the tibiæ; fifth tarsal joint almost equal in length to the second to fourth inclusive. Median femora equal to the metanotum (with median segment) in length, slightly compressed, the internal inferior margin armed apically with two dentiform processes, external genicular lobes acute; median tibiæ shorter than the femora and equal to the fifth and sixth abdominal segments in length, inferior median carina with a low basal expansion, the superior carina with an apical bullate expansion of about equal height; metatarsi not equal to the length of the remaining joints, without any foliaceous expansion; fifth tarsal joint shorter than the second to fourth inclusive. Posterior femora not quite reaching the middle of the third abdominal segment, moderately compressed, sulcate above, internal genicular lobes acute, lateral inferior margins armed apically with two spines, those on the internal margin prominent; posterior tibiæ exceeding the femora and almost equal to the mesonotum in length, median inferior carina with a low elongate foliaceous expansion at the extreme base, apex with a bullate expansion similar to the median tibiæ; metatarsi about equal to the remaining tarsal joints in length, fifth tarsal joint equal to the second and third in length.

General color wood-brown, finely flecked with blackish, becoming semi-ochraceous on the anterior limbs and antennæ, the latter with regularly disposed, usually incomplete annuli of blackish.

Measurements.

Length of body, ...	110	mm.
Length of pronotum, ...	4.5	"
Length of mesonotum, ...	24.5	"
Length of metanotum (with median segment), ...	17	"
Length of median segment, ...	7.5	"

Measurements.

Length of abdomen	59	mm.
Length of anterior femora	22	"
Length of anterior tibiæ	23	"
Length of median femora	17	"
Length of posterior femora	19.5	"

Carausius obiensis n. sp.

Type.—♀; Island of Obi, Moluccas. [A. N. S. Phila., presented by Mr. Morgan Hebard.]

Allied to *C. mammatus*, but differing in the non-nodose fifth abdominal segment, the absence of large spines in the head and foliaceous expansions on the anterior metatarsi.

Size medium; form elongate; surface irregularly granulose. Head rather short, subequal in width; interspace between the eyes with a few rather large granules, but no distinct spines; eyes moderately large, circular; antennæ not equal to half the length of the body, basal joint rather elongate, twice as long as broad, depressed, second joint not quite half the length of the first. Pronotum longitudinal, somewhat compressed posteriorly; anterior margin truncate, posterior broadly arcuate; median transverse sulcus short. Mesonotum slightly less than half the length of the abdomen, a median longitudinal carina present and continued to the apex of the abdomen. Metanotum (including median segment) two-thirds the length of the mesonotum; median segment two-thirds the length of the metanotum alone, anterior margin obtuse-angulate. Abdomen with supplementary lateral carinæ in the apical portion; five basal segments longitudinal, subequal in length; sixth segment slightly shorter than the fifth; seventh, eighth and ninth segments together about equal to the sixth in length, subequal in width, tectate; eighth and ninth segments transverse, each shorter than the somewhat longitudinal seventh; supra-anal plate tectate, carinate, the apical margin rounded; cerci depressed, broad, subacuminate, not equalling the apex of the supra-anal plate in length; subgenital opercule cymbiform, keeled, of moderate size, apex subacuminate but not exceeding the apex of the supra-anal plate, the median carina apically undulate. Anterior femora equal to five-sixths the length of the mesonotum, moderately compressed, superior carina slightly expanded and undulate basally, external inferior carina bearing two preapical dentiform processes; anterior tibiæ equal in length to the femora, compressed, superior carina developed into a rather low even lamellate ridge which divides apically and encloses a comparatively broad shallow sulcus, inferior median carina developed similar to the superior carina; metatarsi equal to the remaining tarsal joints in length, but slightly dilated superiorly; fifth tarsal joint equal to the second to fourth inclusive in length. Median femora almost equal to the metanotum (with median segment) in length, external inferior margin armed apically with two dentiform processes; median tibiæ slightly shorter than the femora, apically with a slight tumidity, the inferior median carina with a low triangular basal expansion; metatarsi not quite equal to the remaining tarsal joints in length, not dilated; fifth tarsal joint about equal to the second to fourth joints inclusive. Posterior femora reaching to the base of the third abdominal segment, slightly compressed, internal inferior margin apically with two dentiform processes, internal genicular lobes spiniform; posterior tibiæ equal to five-sixths the length of the mesonotum, slightly tumid at the apex, inferior median carina with a low triangular basal lobe; metatarsi equal to the remaining tarsal joints in length, not dilated; fifth tarsal joint equal to the second and third in length.

General color ochraceous-brown streaked with wood-brown, a line of the latter tint following the central line of the body, and reinforced on the metanotum and abdomen by lateral lines of the same tint. Antennæ ochraceous with usually imperfect annuli of blackish. Limbs mottled with blackish-brown on the anterior pair, and rather solid purplish-brown on the posterior pair.

Measurements.

Length of body,	83	mm.
Length of pronotum,	3.5	"
Length of mesonotum,	19.2	"
Length of metanotum (including median segment),	13.5	"
Length of median segment,	6	"
Length of abdomen,	44.5	"
Length of anterior femora,	17	"
Length of anterior tibiæ,	17	"
Length of median femora,	12.5	"
Length of posterior femora,	14.5	"

Subfamily HETERONEMINÆ (*Bacunculinæ*).

Genus **HESPEROPHASMA** Rehn.

1872. *Phantasis* Saussure, Miss. Scient. Mexiq. l'Amer. Cent., Orth., p. 188. (Not of Thomson, 1860.)
1901. *Hesperophasma* Rehn, Canad. Entom., XXXIII, p. 271.

Type.—By selection, *Phasma planulum* Westwood.

Hesperophasma planulum (Westwood).

1859. *Phasma planulum* Westwood, Catal. Orth. Ins. Brit. Mus., I, p. 34, Pl. 1, fig. 7. [San Domingo.]

One female; no data. [A. N. S. Phila.]

Genus **CEROYS** Serville.[7]

1839. *Ceroys* Serville, Orthoptères, p. 262.

Included *perfoliatus* Gray and *multispinosus* Serville, of which the former may be considered the type.

Ceroys bigibbus n. sp.

Type.—♀; Nicaragua. [Cat. No. 6,973, U. S. N. M.]

Apparently closer related to *C. rabdota* Westwood than to any other species of the genus. From this it may be separated by the spinose mesonotum, the comparatively shorter limbs, the absence of any very marked appendages to the basal abdominal segments, and the very different character of the apical segments of the abdomen.

Size medium; form rather elongate; surface rugulose, lobate and spinulose. Head longitudinal; occiput with a pair of prominent ear-like processes, the extreme posterior margin with a pair of blunt spiniform processes; eyes subspherical, moderately prominent; antennæ about equal in length to the pronotum and mesonotum, basal joint strongly depressed. Pronotum slightly longitudinal, saddle-shaped; surface strongly tuberculate, a distinct paired series extending on either side of the faint median longitudinal sulcus; anterior margin with a pair of medium size, rounded tubercles; posterior margin with a pair of very prominent spinous processes. Mesonotum about four times the length of the pronotum, somewhat constricted anteriorly, slightly expanded centrally; median portion with a pair of low transverse cariniform lobes; posterior margin with two small pairs of median rounded lobes; lateral borders with a row of low rounded fold-like tubercles. Metanotum (with median segment) two-fifths the length of the mesonotum, immediately anterior to the median segment two low rounded lobes are developed; median segment very small, not one-fifth the length of the whole segment; supra-coxal region of the metathoracic segment margined by a saw-like series of rounded lobules. Abdomen slightly exceeding the thorax in length, the six basal segments all transverse or subtransverse, each segment with the posterior margin with two median pairs of lobules; sixth dorsal segment depressed, laterally supplied with rounded foliaceous expansions; seventh and eighth segments somewhat compressed, subcarinate, the posterior margins irregularly sinuate and serrate; ninth segment strongly depressed posteriorly, tuberculate, apex with the median portion sinuate; supra-anal plate produced, convex, apex narrowly rounded; subgenital opercule reaching slightly beyond the apex of the supra-anal plate, longitudinally striate,

[7] Stål's *Caulonia* (*Recensio Orthopterorum*, III, p. 74, 1875) is apparently nothing more than a synonym of Serville's genus.

lateral borders emarginate, apex rectangulate. Limbs rather short, all lobate to a greater or lesser extent. Anterior femora three times the length of the pronotum, basal flexure occupying almost half the entire femur, superior margin with an apical dentate foliaceous lobe; tibiæ about equal to the femora in length, superior margin with four rounded lobes, decreasing in size toward the apex; metatarsi short, exceeded in length by the terminal tarsal joint and about equal to the second and third together. Median femora about equal to the anterior femora in length, posterior superior margin with a large bidentate apical lobe and several smaller ones distributed between the large one and the proximal extremity, anterior superior margin with several low rounded lobules, inferior margins with several low lobules and a median bidentate apical lobe; tibiæ about equal to the femora in length, the superior margin with three lobules decreasing in size toward the apex; metatarsi as in the anterior limbs. Posterior femora equal to the four basal joints of the abdomen in length, the superior margin with three large subpyramidal lobes, the largest being bilobate and placed at the distal extremity, several small lobules are located between the larger lobes, inferior margins with several small low lobules, the apical larger than any of the others and strongly bilobate; posterior tibiæ exceeding the femora by half the length of the fifth abdominal segment, superior surface with three rounded lobules, decreasing in size toward the distal extremity; metatarsi as in the anterior limbs.

General color brownish-black, becoming reddish-brown toward the apex of the abdomen; antennæ with the three terminal segments pale ochraceous.

Measurements.

Total length,	78	mm.
Length of pronotum,	5.5	"
Length of mesonotum,	22	"
Length of metanotum (including median segment),	9.5	"
Length of median segment,	1.9	"
Length of abdomen,	39	"
Length of anterior femora,	14.8	"
Length of anterior tibiæ,	15.5	"
Length of median femora,	12.5	"
Length of posterior femora,	16	"

There is a small female specimen from Tucurrique, Costa Rica, in the U. S. National Museum collection, which resembles very much the type of *bigibbus*. A number of points of difference, however, exist, but as these conditions in the specimen may be due to immaturity, I have provisionally determined it as this species. The following is a brief diagnosis:

Size small; form somewhat slenderer than in the type, but otherwise similar. Head with the auricular appendages very prominent, the margins sinuate, about reaching the posterior margin of the head; eyes ovate. Mesonotum with the median processes as in the type, but more pronounced; a distinct longitudinal median carina developed. Metanotum with a distinct median carina; lateral margins with distinct sinuous carinæ. Abdomen as in the type, but all of the longitudinal plicæ exaggerated; lateral lobes of the sixth dorsal segment not differing materially from that of the other specimen; seventh dorsal segment about equal to the sixth in length, tectate, strongly carinate; eighth and ninth segments subequal in length, supplied with a number of sinuous longitudinal rugæ, the eighth apically supplied with a median pair of low rounded lobes, the ninth with the apical margin truncate; supra-anal plate moderately produced, rounded, hirsute; cerci very short, simple, not extending beyond the apical margin of the ninth dorsal abdominal segment; subgenital opercule extending slightly beyond the apex of the eighth dorsal segment, carinate, apex rectangulate; terminal ventral segment rectangulate; apex narrowly incised. Limbs as in the type but stouter.

Measurements.

Total length.	46	mm.
Length of pronotum.	3.5	"
Length of mesonotum,	12	"
Length of metanotum (with median segment),	6	"
Length of median segment,	2.1	"
Length of abdomen,	2.3	"
Length of anterior femora,	9	"
Length of anterior tibiæ,	8	"
Length of median femora,	6.5	"
Length of posterior femora,	9.5	"

Genus **DIAPHEROMERA** Gray.

1835. *Diapheromera* Gray, Synops. Phasm., pp. 13 and 18.

Type.—*Diapheromera sayi* Gray=*Spectrum femoratum* Say.

Diapheromera calcarata (Burmeister).

1838. *B[acteria]* (*Bacunculus*) *calcarata* Burmeister, Handb. d. Entom. II, p. 566. [Mexico.]

Four specimens, two males and two females: Alta Mira, Tamaulipas. Mexico, June 28, 1903. (M. E. Hoag.) [A. N. S. Phila.] Guaymas. Sonora, Mexico. [U. S. N. M.]

The male of this species is, as noted by Saussure,[8] almost identical with that of *D. femorata,* but the female can readily be distinguished by the comparatively robust limbs and short conoid cerci. The female from Alta Mira is interesting, as it possesses two short spinous interocular processes, but is in every other detail perfectly typical of the species. The male from Guaymas has the right anterior limb aborted. Saussure has recorded this species from near Tampico.

Genus SERMYLE Stål.[9]

1875. *Sermyle* Stål, Recensio Orthopterorum, III, pp. 23 and 76.

Type.—As restricted,[10] *Acanthoderus mexicanus* Saussure.

Sermyle physconia n. sp.

Types.—♂ and ♀; Piedras Negras, Costa Rica. (Schild and Burgdorf.) [Cat. No. 6,975, U. S. N. M.]

Allied to *S. mexicana* (Saussure), but differing in the female in the reduced expansion of the fifth abdominal segment, the much longer sixth, and the less compressed seventh, eighth and ninth segments. As the male of *mexicana* has been imperfectly described, comparison is hardly possible. From *S. ætolus* (Westwood) it can readily be distinguished by the smaller size and shorter genital opercule.

♂.—Size medium; form elongate; surface subglabrous. Head rather elongate, but slightly expanded anteriorly; interspace between the eyes with a pair of erect dentiform tubercles; eyes subcircular, decidedly prominent; antennæ over twice the length of the anterior femora, basal joint depressed. Pronotum longitudinal, over half again as long as broad, median transverse sulcus deeply impressed. Mesonotum slender, two and a half times the length of the head and pronotum together, subequal (except posteriorly), rounded. Metanotum (with median segment) equal to three-fourths the length of the mesonotum, similar in shape to the mesonotum but more robust; median segment subquadrate, equal to one-fifth the length of the metanotum alone. Abdomen slender, elongate, all segments longitudinal; seventh segment compressed, but apically dilated; eighth segment slightly longitudinal, apically compressed, practically fused with the seventh; ninth segment slightly over half the length of the seventh, bullate, moderately expanded, apical margin with a comparatively deep median

[8] *Miss. Scientifiq. Mexiq.*, Orth., p. 165.

[9] The genus *Pseudosermyle*, created by Caudell (*Proc. U. S. Nat. Mus.*, XXVI, p. 867), includes the forms having trifid cerci in the male. The Mexican *Bacteria tridens* Burmeister is accordingly a member of the genus *Pseudosermyle*. No such foliaceous lobes are developed in this genus as are found in true *Sermyle*.

[10] *Vide* Caudell, *Proc. U. S. Nat. Mus.*, XXVI, p. 867.

emargination; cerci very slightly incurved, apically decurved, internal inferior margin with a blunt basal tubercle, surface strongly hirsute; first segment of the genital opercule bearing a recurved claw-like process immediately before the apex; second segment of the opercule hastate. Limbs slender, without distinct foliaceous expansions. Anterior femora half again as long as the mesonotum, trigonal in section; tibiæ slightly exceeding the femora in length, quadrate in section; metatarsi considerably exceeding the remaining tarsal joints in length. Median femora equal in length to the mesonotum, slightly curved, subquadrate in section, genicular lobes triangular; tibiæ equal to the femora in length, compressed; metatarsi slightly shorter than the remaining tarsal joints. Posterior femora reaching to the middle of the fifth abdominal segment, equal to the head, pronotum and mesonotum in length, slightly curved, subquadrate in section; tibiæ slightly longer than the femora; metatarsi slightly longer than the remaining tarsal joints.

General color greenish-brown; limbs annulate with pale ochraceous.

♀.—Form elongate, moderately robust; size medium; surface granulose. Head somewhat elongate, strongly tuberculate; interspace between the eyes with a pair of erect foliaceous lobes, the margins of which are irregularly crenulate; eyes subcircular, moderately prominent; antennæ over twice the length of the anterior femora, basal joint depressed. Pronotum longitudinal, slightly expanded posteriorly; median transverse sulcus distinctly marked. Mesonotum about twice as long as head and pronotum together, subequal; median longitudinal carina distinctly marked, subobsolete posteriorly. Metanotum (with median segment) about three-fourths the length of the mesonotum, subequal; median segment about one-third as long as the metanotum itself, transverse. Abdomen exceeding the head and thoracic segments in length, subequal in width, surface longitudinally striate as well as tuberculate; fifth segment with the median portion of the apical margin bearing a pair of small converging foliaceous lobes; sixth segment equal to the fifth in length, subequal to the latter in width; seventh and ninth segments subequal in length, eighth transverse, apical margin of the ninth segment obtusely produced and with a broad V-shaped median emargination; styles broad, depressed, somewhat produced apically; subgenital plate produced, reaching to the posterior margin of the eighth dorsal segment, carinate, apex subacuminate with a narrow triangular median emargination. Limbs of rather slender build and but moderate length. Anterior femora exceeding the length of the mesonotum by the length of the median segment, compressed in the apical two-thirds, subquadrate in section; tibiæ exceeding the femora by almost the length of the pronotum, quadrate in section; metatarsi very considerably exceeding the remaining tarsal joints in length. Median femora slightly exceeding the metanotum (with median segment) in length, subquadrate in section, inferior margins with an irregularly rounded prebasal lobe, genicular lobes acuminate; tibiæ subequal to the femora in length, quadrate in section; metatarsi considerably shorter than the remaining tarsal joints. Posterior femora slightly exceeding the second to fourth abdominal segments in length, subquadrate in section; tibiæ slightly longer than the femora in length, quadrate in section; metatarsi but slightly shorter than the remaining tarsal joints.

General color yellowish-brown (green in life?), becoming yellowish-green on the limbs.

Measurements.

	♂	♀
Total length,	63 mm.	76.3 mm.
Length of pronotum,	2.6 "	4 "
Length of mesonotum,	14.5 "	16.5 "
Length of metanotum (with median segment),	12 "	12.5 "
Length of abdomen,	33 "	approx. 48 "
Length of anterior femora,	20.5 "	18.1 "
Length of anterior tibiæ,	22.5 "	21.5 "
Length of median femora,	15 "	14.2 "
Length of posterior femora,	19.5 "	20 "

One additional female specimen from the type locality has also been examined. It is considerably smaller than the type, but otherwise perfectly identical.

Genus **HETERONEMIA** Gray.[11]

1835. *Heteronemia* Gray, Synopsis Spec. Ins. Fam. Phasm., pp. 13 and 19.

Type.—*H. mexicana* Gray.

Heteronemia yersiniana (Saussure).

1868. *Bacteria Yersiniana* Saussure, Revue et Magasin de Zoologie, 2e ser., XX, p. 65. [Porto Rico.]

One male; Utuado, Porto Rico, April 6, 1900. (Dr. C. W. Richmond.) [U. S. N. M.]

[11] There seems no escape from the substitution of this name for the species to which the time-honored name *Bacunculus* has been applied. Gray's name has three years' priority, and though based on partially abnormal characters, its true position has been definitely shown by Westwood (*Cat. Orth. Ins. Brit. Mus.*, I, pp. 25–26).

Heteronemia ignava n. sp.

Types.—♂ and ♀; Piedras Negras, Costa Rica. (Schild and Burgdorf.) [Cat. No. 6,976, U. S. N. M.]

Apparently closely related to *H. mexicana* Gray and *H. striata* (Burmeister), but differing from the former in the stouter body, longer limbs and different abdominal appendages in the male; and from *striata* in the shorter seventh abdominal segment in the male, and the different proportions of the three terminal segments in the female. From *H. festuca* (Giglio-Tos), another ally, it can readily be separated by the character of the female subgenital opercule, which is tridentate in *festuca*.

♂.—Size rather small; form moderately slender, subequal; surface chiefly glabrous. Head subequal, dorsal aspect bearing about four longitudinal rows of minute blunt tubercles; eyes very prominent; antennæ rather robust, about equal to half the entire length, basal joint somewhat depressed, the greatest width basal. Pronotum subequal in width, over half again as long as broad. Mesonotum very slightly expanded posteriorly, equal to the median femora in length. Metanotum (with median segment) about three-fourths the length of the mesonotum; median segment slightly transverse, about one-fifth the total length of the metanotum. Abdomen with the segments longitudinal, but about equal in width to the mesonotum; seventh dorsal segment slightly bullate apically and fused with the short eighth segment, the line of demarcation being hardly visible; ninth dorsal segment operculate, somewhat bullate, the apical margin with a deep V-shaped median emargination; cerci but slightly shorter than the ninth segment, compressed, slightly decurved and provided with a dentiform point at the lower angle of the apical margin; subgenital opercule with the apical margin rounded, and provided with an acute ungual preapical hook. Limbs rather short, femora and tibiæ subquadrate in section, all unarmed. Anterior femora and tibiæ each equal to the pronotum, mesonotum and half of the head in length; metatarsi equal to the remaining joints in length. Median femora and tibiæ equal to the mesonotum in length; metatarsi considerably shorter than the remaining tarsal joints. Posterior femora reaching to the apex of the fourth abdominal segment; tibiæ slightly exceeding the femora in length; metatarsi about equal to the remaining tarsal joints in length.

General color pale greenish-yellow, becoming brownish on the limbs and apex of the abdomen; head with faint longitudinal bars of dull brown.

♀.—Size rather small; form slender, thoracic width greater than the abdominal width; surface very sparsely and minutely tuberculate. Head subequal in width, slightly larger than the pronotum, surface bearing longitudinal rows of minute tubercles; eyes prominent; antennæ exceeding half the length of head and body, basal joint slightly depressed, subequal in width. Pronotum subequal in width, twice as long as broad. Mesonotum equal in length to the posterior femora, subequal in width, bearing a faint longitudinal carina which extends to the apex of the abdomen. Metanotum (with median segment) about three-fourths the length of the mesonotum; median segment subquadrate, equal to one-fifth the length of the metanotum alone. Abdomen with the segments strongly longitudinal, not equalling the thoracic segments in width, seventh dorsal segment tectate, about equal in length to the eighth and ninth together; ninth segment strongly tectate, carinate, the apical margin with a small triangular emargination; styles projecting beyond the ninth dorsal segment by slightly over half the length of the latter, compressed, apex rounded; subgenital opercule slightly exceeding the apical margin of the eighth dorsal segment in length, apex subacuminate, the preapical portion with a short ungual process. Limbs rather short, the femora and tibiæ subequal in length. Anterior femora equal to the pronotum and mesonotum in length; metatarsi exceeding the remaining tarsal joints in length. Median femora slightly longer than the metanotum (with median segment); tibiæ slightly shorter than the femora; metatarsi not quite equal to the remaining tarsal joints in length. Posterior femora reaching to the middle of the fourth abdominal segment; metatarsi about equal to the remaining tarsal joints.

General color dull olive-brown, the limbs obscurely annulate with very dull ochraceous; tubercles on head and thoracic segments milky white.

Measurements.

	♂	♀
Total length,	50.5 mm.	54 mm.
Length of pronotum,	2.2 "	2.5 "
Length of mesonotum,	11.5 "	12.2 "
Length of metanotum (including median segment),	9 "	10 "
Length of abdomen,	26 "	28.5 "
Length of anterior femora.	15.5 "	14.5 "
Length of anterior tibiæ.	15 "	14 "
Length of median femora,	11.2 "	10.5 "
Length of posterior femora,	13.5 "	12.5 "

Three female topotypes of this form agree perfectly with the type.

except that two of them are slightly lighter in color, much as in the male. This is, of course, of little consequence, being due entirely to the condition of the specimen. A smaller female from Ateñas, Costa Rica, is greenish-white in color, but otherwise is perfectly typical.

Genus **OREOPHOETES** n. gen.[12]

Allied to *Heteronemia*, but distinguished by the peculiar structure of the apical abdominal segments and the shape of the pronotum.

Pronotum slightly longitudinal, the anterior angles considerably produced, rounded; median transverse suture very distinct; postero-lateral angles depressed. Abdomen comparatively short, the basal segments but slightly longitudinal; sixth dorsal segment compressed, carinate; seventh dorsal segment very slightly shorter than the sixth, carinate, rather bullate apically; eighth segment slightly longer than the sixth segment, slightly depressed, carinate; ninth segment transverse, apex with broad triangular emargination; cerci subequal in width, slightly longer than the ninth dorsal segment. Sixth ventral abdominal segment compressed, carinate; seventh compressed, carinate, about half the length of the sixth; eighth segment about half the length of the seventh, compressed but not carinate; subgenital opercule bullate, equal in length to the eighth dorsal segment, apex rotundato-truncate, apical margin strongly reflexed, forming a very distinct rim. Limbs elongate, unarmed.

Type.—*Bacteria peruana* Saussure.

Oreophoetes peruana (Saussure).

1868. *Bacteria Peruana* Saussure, Revue et Magasin de Zoologie, 2e ser., XX, p. 65. [Peru.]

One male; Piches and Perene Valleys, Peru, 2,000–3,000 feet. (Soc. Geog. de Lima.) [U. S. N. M.]

This species has been recorded by Saussure from the plateau of Peru, beside the very broad type locality.

Genus **DYME** Stål.

1875. *Dyme* Stål, Recensio Orthopterorum, III, pp. 24 and 77.

Type.—*Dyme bifrons* Stål.

Dyme bifrons Stål?

1875. *D[yme] bifrons* Stål, Recensio Orthopterorum, III, p. 77. [Peru.]

One male; Piches and Perene Valleys, Peru, 2,000–3,000 feet. (Soc. Geog. de Lima.) [U. S. N. M.]

While this specimen is but two-thirds the size of the type male of *bifrons*, the proportions are about the same. The eighth dorsal

[12] *ουρεοφοιτας, mountain nymph*, in allusion to the locality of the type species.

abdominal segment exhibits no such character as "angulis posticis in dentem sat longum productis instructo," and for that reason I have queried the determination, although the specimen fully agrees otherwise.

Genus CALYNDA Stål.

1875. *Calynda* Stål, Recensio Orthopterorum, III, pp. 24 and 78.

Type.—*C. bicuspis* Stål.

Calynda bicuspis Stål.

1875. *C[alynda] bicuspis* Stål, Recensio Orthopterorum, III, p. 78. [Chiriqui.]

One female; Tucurrique, Costa Rica. (Schild and Burgdorf.) [U. S. N. M.]

This specimen is considerably larger than Stål's type, but agrees absolutely with the diagnostic characters given by him. A character apparently overlooked by Stål is the presence of a rounded foliaceous lobe on the basal portion of the inferior lateral carinæ of the median femora.

Genus BOSTRA Stål.

1875. *Bostra* Stål, Bihang till K. Svenska Vet. Akad. Handlingar, bd. 2, No. 17, p. 6.

Type.—*Bacteria turgida* Westwood.

Bostra incompta n. sp.

Type.—♂; San Carlos, Costa Rica. (Schild and Burgdorf.) [Cat. No. 6,977, U. S. N. M.]

Apparently closer related to *B. turgida* (Westwood) than to *B. dorsuaria* Stål. From *turgida* it differs in the very much greater size and the shape of the terminal abdominal segments. From *dorsuaria* it can readily be distinguished by the unarmed head and smaller size.

Size large; form very slender and elongate; surface glabrous. Head rather short, very slightly longer than the pronotum, subequal in width; eyes circular, not prominent; antennæ about equal to the body in length, basal joint oblong, scarcely depressed. Pronotum subequal in width, half again as long as broad. Mesonotum slightly shorter than the median femora, slender and subequal except for a slight posterior expansion. Metanotum (with median segment) not quite three-fourths the length of the mesonotum, scarcely wider than the mesonotum; median segment equal to over two-thirds the length of the metanotum itself. Abdomen with the six basal segments elongate, all at least three times as long as broad, the length of segments decreasing toward the apex; seventh dorsal segment somewhat bullate, slightly longer than broad; eighth segment equal to the seventh in length, compressed, lateral portions produced inferiorly, the margins rounded except the posterior angle which is slightly acuminate; ninth dorsal segment very slightly longer than broad, somewhat bullate, apical margin truncate with a very broad shallow median emargination; cerci rather small, slightly clavate, curved; subgenital opercule not quite equalling the apex of the eighth dorsal segment, large, compressed, tectate, apical portion with a longitudinal keel which develops a blunt point below and slightly posterior to the superior margin. Limbs very slender and elongate, carinate, unarmed. Anterior femora equal to the head, pronotum and mesonotum in length; tibiæ exceeding the femora by the length of the head and pronotum; metatarsi slightly exceeding the remaining tarsal joints in length. Median femora equal to the mesonotum in length; tibia exceeding the femora by the length of the pronotum; metatarsi equal to the remaining tarsal joints in length. Posterior femora reaching to the apex of the fourth abdominal segment; tibiæ exceeding the femora by about half the length of the first abdominal segment; metatarsi slightly exceeding the remaining tarsal joints in length.

General color brownish-olive, dark in the genicular regions and pale on the head, pronotum, apex of the abdomen and proximal portions of the femora.

Measurements.

Total length,	107	mm.
Length of pronotum,	3.7	"
Length of mesonotum,	27	"
Length of metanotum (with median segment),	20	"
Length of abdomen,	56	"
Length of anterior femora,	34.5	"
Length of anterior tibiæ,	42	"
Length of median femora,	28	"
Length of posterior femora,	33.5	"

Two additional specimens of this species have been examined, one a topotype, the other from Piedras Negras, Costa Rica. They agree perfectly with the type in structure and coloration.

Bostra remiformis n. sp.

Type.—♀; Piedras Negras, Costa Rica. (Schild and Burgdorf.) [Cat. No. 6,978, U. S. N. M.]

Apparently not allied to the only species of the genus, *B. turgida* Westwood, known from the female. It does not appear to be the female of any of the species based on the opposite sex. From the female of *B. turgida* it differs in the non-spinous body, the triangularly emarginate apex of the ninth dorsal abdominal segment, the very different cerci, and the unarmed limbs.

Size medium; form very slender and elongate; surface subglabrous. Head rather elongate, narrowed posteriorly; eyes subcircular, not prominent; antennæ slightly exceeding half the length of the body, filiform, basal joint moderately depressed. Pronotum about twice as long as broad. Mesonotum about equal in length to the posterior femora. Metanotum (with median segment) not quite three-fourths the length of the mesonotum; median segment two-thirds the length of the metanotum itself. Abdomen with six basal segments subequal in length; seventh, eighth and ninth segments sharply tectate, the seventh slightly exceeding either of the others in length, ninth with the apical margin with a broad rounded median emargination, exposing the rounded apex of the supra-anal plate; cerci elongate, depressed, paddle-shaped, slightly exceeding the ninth segment in length, apex rounded; subgenital opercule short, not reaching to the apical margin of the eighth dorsal segment, apex triangular produced, the preapical portion developing a recurved ungual process. Limbs of moderate length, strongly carinate and compressed. Anterior femora slightly exceeding the mesonotum in length; tibiæ slightly exceeding the femora in length; metatarsi slightly exceeding the remaining tarsal joints in length. Median femora about five-sixths the length of the mesonotum; tibiæ about equal to the femora in length; metatarsi equalled in length by the remaining tarsal joints. Posterior femora equal to three and a half of the fourth basal abdominal segments; tibiæ equal to the four basal segments; metatarsi exceeding the remaining tarsal joints in length.

General color yellowish-brown (probably green in life), very pale on the anterior limbs.

Measurements.

Total length,	78	mm.
Length of pronotum,	3	"
Length of mesonotum,	18.1	"
Length of metanotum (including median segment),	13.5	"
Length of abdomen (including cerci),	41.2	"
Length of anterior femora,	20	"
Length of anterior tibiæ,	21.5	"
Length of median femora,	15.5	"
Length of posterior femora,	19	"

Genus **ONCOTOPHASMA** n. gen.

Type.—*Bostra martini* Griffini.

Body of medium build; pronotum for the greater part slenderer than the abdomen. Metathorax strongly inflated and rugose; the tumid section involving the pleura as well as the dorsal portion, but not the metasternum, which is, however, strongly rugose; anterior portion of the metathorax not inflated. Median segment half again as long as broad, about equal to half the length of the metanotum itself. Anterior and median limbs without prominent spines, except the genicular lobes of the median femora which are spiniform, and two median apical spines on the inferior surface of the same limbs. Posterior femora inflated, armed along the median inferior carina with seven or eight distinct spines, the apical ones of large size, genicular lobes spiniform; tibiæ with the carinæ serrulate, the inferior pair also provided with dentiform spines.

This genus is near *Bostra*, but can be separated by the swollen metathorax and enlarged and strongly armed posterior femora. It will include *Bostra podagrica* Stål,[13] which has all the characters of *Oncotophasma* except the swollen metathorax, the character of which Stål does not mention. The two genera may be separated as follows:

Males.

A.—Posterior femora unarmed; intermediate femora not spined apically, ... *Bostra* Stål.

AA.—Posterior femora strongly spinose; intermediate femora apically bispinose, ... *Oncotophasma* Rehn.

Oncotophasma martini (Griffini).

1896. *B[ostra] Martini* Griffini, Bollettino dei Musei di Zoologia ed Anatomia comparata, XI, No. 236, p. 10, fig. [Forests by the lagoon of Pita, Darien, Colombia.]

One male; San Carlos, Costa Rica. (Schild and Burgdorf.) [U. S. N. M.]

Genus **CLONISTRIA** Stål.

1875. *Clonistria* Stål, Bihang till K. Svenska Vet. Akad. Handlingar, Band 2, No. 17, p. 6.

Type.—*Clonistria bartholomæa* Stål.

Clonistria linearis (Drury)?

1770. [*Mantis*] *linearis* Drury, Ill. Nat. Hist. Exot. Ins., I, p. 130, and Append., Pl. L, fig. 3. [Antigua.]

One male; Jamaica. [U. S. N. M.]

As considerable uncertainty has prevailed regarding the identity of Drury's *linearis*, a question which cannot satisfactorily be settled without a study of Antiguan material, I have queried the determination.

The specimen in hand has the under surface of the head marked with

[13] *Recensio Orthopterorum*, III, p. 79

blackish, while the whole upper surface is dull greenish more or less distinctly overcast with brownish.

Subfamily BACTERINÆ (*Palophinæ* Kirby[14]).

Genus **CLADOMORPHUS** Gray.

1835. *Cladomorphus* Gray, Synop. Ins. Fam. Phasmid., p. 15.

Type.—As restricted by Serville, *C. phyllinus* Gray.[15]

Cladomorphus phyllinus Gray.

1835. *C[ladomorphus] phyllinus* Gray, Synop. Ins. Fam. Phasmid., p. 15 [Brazil.]

One female; San Antonio de Jesu, Brazil. [A. N. S. Phila.]

This specimen is equal to the measurements given by Saussure.[16] I have adopted the above generic and specific names in preference to *Phibalosoma lepeletierii*, agreeing with Kirby[17] that page priority should be applied to this case, regardless of usage as to one sex having a systematic value superior to the other.

Genus **PTERINOXYLUS** Serville.

1839. *Pterinoxylus* Serville, Orthoptères, p. 226.

Type.—*P. difformipes* Serville (=*Haplopus eucnemis* Burmeister).

Pterinoxylus eucnemis (Burmeister)?

1838. *H[aplopus] eucnemis* Burmeister, Handb. d. Entom., II, p. 577. [Interior Brazil.]

Three specimens, all immature; two males, one female; Tucurrique and Turrialba, Costa Rica. (Schild and Burgdorf.) [U. S. N. M.]

This series, while all immature, range in size from 46 to 93 millimeters in total length, and agree perfectly with each other in the character of the lobes and nodes. The figure of Burmeister's type given by Westwood[18] appears to represent a form having the lobes more rounded and not so distinctly acuminate as in the Costa Rican individuals.

Genus **BACTERIA** Lepeletier and Serville.

1827. *Bacteria* Lepeletier and Serville, Encyclop. Method., Ins., X, p. 445.

Type.—*Mantis ferula* Fabricius (=*arumatia* Stoll).[19]

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[14] As I have not had the opportunity to examine more than a single specimen of the genera which Kirby (*Trans. Linn. Soc. London*, 2d ser., VI, p. 464) transferred to the *Heteronemine* (*Bacunculinæ* Auct.). I have not accepted his action. It is very evident that *Bacteria* at least is closely related to the *Heteronemine*, but Kirby's remarks are so brief that we glean little regarding the characters on which he proposes the removal.

[15] Of the four original species of the genus but one (*perfoliatus*) has been removed, and that to *Ceroys* by Serville in 1839.

[16] *Recerch. Zool. l'Amer. Cent., Mexique*, Orth., p. 180.

[17] *Proc. Royal Dublin Soc.*, n. s., VI, p. 571.

[18] *Cat. Orth. Ins. Brit. Mus.*, I, Pl. XXXVI, fig. 1.

[19] The name *Bacteria* was first used in the Latin form by Lepeletier and Ser-

Bacteria cubensis (Saussure).

1868. *Phybalosoma Cubensis* Saussure, Revue et Magasin de Zoologie, 2e ser., XX, p. 67. [Cuba.]

One female; Baracoa, Cuba, February 4, 1902. (William Palmer.) [U. S. N. M.]

As the female of this species has never before been recorded, a description may prove of interest.

Size medium; form elongate; surface smooth. Head somewhat longitudinal, depressed, posterior portion constricted; interocular region with several transverse depressions; occiput with a fine longitudinal sulcus; eyes globose, very prominent; antennæ not quite half as long as the body, basal joint elongate-depressed. Pronotum longitudinal, almost twice as long as broad; transverse median depression slightly in advance of the middle; anterior portion with a transverse depression immediately posterior to the anterior margin; longitudinal median carina slight. Mesonotum nearly six times as long as the pronotum, subequal in width except for a slight anterior constriction and a moderate expansion in the supra-coxal region. Metanotum (with median segment) three-fifths the length of mesonotum; median segment occupying about three-fifths the length of the whole segment. Abdomen about equal to the thorax in length; four basal segments longitudinal, equal in size; fifth dorsal segment somewhat inflated apically; sixth segment compressed, tectate, carinate, slightly shorter than the preceding segments in length; seventh and eighth segments subequal in size, tectate, carinate, the posterior portion of the carina produced into a small rounded process; ninth segment about equal to the eighth in length, tectate, carinate, the lateral aspects each bearing a low boss-like rounded swelling, apical margin with a very shallow emargination, exposing the extreme tip of the supra-anal plate; cerci not half the length of the ninth dorsal segment, acuminate; subgenital opercule elongate, attenuate, apex decidedly acuminate, reaching to the apex of the ninth dorsal segment. Anterior femora and tibiæ compressed, each almost equal to the mesonotum in length; metatarsi equal to the remaining joints in length, superior surface with a distinct foliaceous crest. Median femora and tibiæ somewhat

ville, but is usually credited to Latreille. Latreille (*Fam. Nat. Regn. Anim.*, p. 412, 1825) published simply the French form Bactérie, and included no species under it. In 1807, Latreille (*Gen. Crust. et Insect.*, III, pp. 87–88) divided the genus *Phasma* into two sections, the first of which he subdivided, and it was on the second division of the first section that Lepeletier and Serville based their genus. This division included three species, all of Fabricius, *filiformis*, *ferula* and *calamus*. As the identification of these names is rather uncertain, I have selected *ferula* as the type, as it is usually considered a synonym of *arumatia* Stoll, which is based on a figure.

compressed, each slightly exceeding the metanotum in length; metatarsi about as long as the remaining tarsal joints, not cristate. Posterior femora somewhat compressed, equal to the three basal abdominal joints in length; tibiæ equal to the first three and half of the fourth basal abdominal segments; metatarsi slightly exceeding the remaining tarsal joints in length.

General color gray-brown, the pronotum grayish ochraceous, head with an indistinct blackish postocular bar.

Measurements.

Total length,	82.5	mm.
Length of pronotum,	3.5	"
Length of mesonotum,	23.7	"
Length of metanotum (with median segment),	14	"
Length of median segment,	8	"
Length of abdomen,	38	"
Length of anterior femora,	22.1	"
Length of anterior tibiæ,	22	"
Length of median femora,	14.5	"
Length of posterior femora,	17.9	"

Genus **APLOPUS** Gray.

1835. *Aplopus* Gray, Synop. Ins. Fam. Phasmid., p. 34.

Type.—*A. micropterus* (Lep. and Serv.) (=*Phasma angulata* Stoll).

Aplopus cytherea Westwood.

1859. *Haplopus Cytherea* Westwood, Cat. Orth. Ins. Brit. Mus., I, p. 86, Pl. XVIII, fig. 5. [San Domingo, Haiti.]

Two specimens, male and female; "West Indies." [U. S. N. M.]

As the female of this species was previously unknown, a description of the same is here appended.

Size large; form elongate; surface of the thoracic segments sparsely spinous. Head with the pair of occipital spines very prominent, the left considerably smaller than the right; eyes globose; antennæ equal to the head and thorax in length, basal joint of comparatively small size. Pronotum slightly longer than broad, in general shape similar to the male, the anterior pair of spines reduced in size and hardly larger than a posterior pair. Mesonotum about four times the length of the pronotum, rather narrow anteriorly, very gradually expanding posteriorly; spines disposed as in the male, but much less salient; mesosternum with an armature of obsolete spines disposed as in the male. Metanotum slightly more than half the length of the mesonotum. Tegmina slightly more than one-third the length of the mesonotum, ovate, coriaceous, with the venation very distinct and irregularly disposed; median protuberance longitudinal, rounded. Wings almost twice the length of the tegmina; costal and discoidal regions coriaceous and subreticulate as in the tegmina. Abdomen with the segments distinctly longitudinal; sixth dorsal segment somewhat expanded; seventh segment compressed, almost equal to the sixth in length; eighth and ninth segments subequal in length and width, together but slightly longer than the seventh segment, the ninth carinate and with the apex sinuate; supra-anal plate small, transverse, subtriangular, not half the length of the ninth dorsal segment; cerci short, conoid, not as long as the supra-anal plate; subgenital plate cymbiform, carinate, elongate, exceeding the apex of the supra-anal plate by the length of the fifth and sixth abdominal segments, apex narrowly rounded. Anterior femora three-fourths the length of the mesonotum, basal flexure sharp; tibiæ slightly longer than the femora; metatarsi somewhat shorter than the remaining tarsal joints. Median femora equal to the anterior femora in length, inferior surface with three spines on the apical portion of the median line, the anterior and posterior margins each apically with a single spine; tibiæ about equal to the femora in length; metatarsi hardly more than half the length of the remaining tarsal joints. Posterior femora exceeding the other femora and equal to the first, second and half of the third basal abdominal segments in length, anterior inferior margin with two apical spines, median line of the inferior surface with three spines, posterior inferior margin with a single apical spine; tibiæ slightly exceeding the femora in length; metatarsi but slightly shorter than the remaining tarsal joints.

General color (from spirits) vinaceous brown, metathorax with the pleura bearing a longitudinal whitish bar, a style of coloration also found on the lateral portions of the base of the subgenital opercule.

Measurements.

Total length,	128	mm.
Length of pronotum,	5.7	"
Length of mesonotum,	27.5	"
Length of metanotum (including median segment),	15.7	"
Length of tegmina,	10	"
Length of wings,	12.5	"
Length of abdomen (including subgenital opercule),	79	"
Length of subgenital opercule,	27.5	"
Length of anterior femora,	19.5	"
Length of anterior tibiæ,	20.5	"
Length of median femora,	19	"
Length of posterior femora,	23	"

Aplopus similis n. sp.

Types.—♂ (immature) and ♀; Swan Island, Caribbean Sea. [Cat. No. 7,343, U. S. N. M.]

Closely allied to *A. ligia* Westwood,[20] but differing in the much shorter antennæ, longer mesonotum and posterior limbs, the different character of the lateral expansions of the sixth abdominal segment, and the decidedly shorter subgenital opercule.

♂.—Size medium; form rather elongate. Head slightly longitudinal; occiput with two large acute spines of which the right is the larger, posterior margin of the head with a pair of small median spines; eyes subglobose; antennæ stout, somewhat depressed, slightly exceeding in length the head, pronotum and mesonotum, basal joint oblong, strongly depressed. Pronotum slightly longitudinal, anterior margin concave, posterior margin convex, lateral margins with a very prominent and deep semicircular emargination; transverse sulci two in number, one prominent and immediately posterior to the anterior margin, the other submedian and shallower in character; anterior half of the pronotum with two pairs of spines, the anterior of which is more distinct than the posterior, the remaining portion of the surface granulate. Mesonotum equal to the three basal abdominal segments; anterior portion constricted, gradually expanding to near the median portion, which is equal to the posterior width; surface with five pairs of irregularly placed spines, two pairs being very close to the anterior margin, while more than the posterior third of the whole surface is free from spines; lateral margins with an even row of low tubercles; mesothoracic pleura with a number of subobsolete protuberances; mesosternum with four pairs of low evenly placed tubercles. Metanotum about two-thirds the length of the mesonotum, median segment occupying very slightly more than half the length; metasternum with a few very obsolete tubercles. Tegmina and wings not developed, the rudiments very small. Abdomen considerably exceeding the head and thoracic segments in length; five basal segments longitudinal, simple, the fourth and fifth slightly shorter than the first to third; sixth segment longitudinal, slightly shorter than the fifth in length, the posterior lateral portions developed into smaller triangular lobes; seventh segment slightly shorter than the sixth; eighth and ninth segments smaller than the preceding segments, equal in length, both carinate, apical portion of the ninth truncate and with a distinct thickened elevated rim; cerci short, thick and rounded, but slightly exceeding the apex of the ninth segment; subgenital opercule large, slightly exceeding the eighth dorsal segment

[20] *Catal. Orth. Ins. Brit. Mus.*, I, p. 89, Pl. XI, figs. 1 and 2.

in length. Limbs distinctly carinate. Anterior femora equal to the metanotum and half of the first abdominal segment in length, basal flexure very marked, median line of the inferior surface with two apical spines; tibiæ very slightly shorter than the femora, the superior surface with a slight distal swelling; metatarsi but little shorter than the remaining tarsal joints. Median femora somewhat shorter than the anterior femora, superior margins each with a slight preapical lobe, anterior and posterior inferior margins serrulate, the former with two preapical spines, the latter with one, inferior median line with four evenly distributed spines; tibiæ not quite equalling the femora in length, distinct subbasal and preapical swellings developed; metatarsi about half the length of the remaining tarsal joints. Posterior femora but slightly shorter than the mesonotum in length, slight superior preapical lobes developed as in the anterior limbs, spine arrangement as in the median limbs except that the median line bears five spines; tibiæ equal to the femora in length, the swellings of the median limbs but slightly represented; metatarsi about two-thirds the length of the remaining tarsal joints.

♀.—Size large; form elongate. Head slightly ovate; occipital processes acute, much as in the male, but large and distinct; spines on the posterior margin of the head small but acute; eyes subglobose; antennæ about equal to the thoracic segments in length, filiform, basal joint depressed and with the lower surface concave. Pronotum about equal to the head in length; margins as in the male; spines numerous and rather regularly distributed, of moderate height, the anterior pair slightly exceeding the others in size. Mesonotum slightly exceeding the three basal joints of the abdomen in length, general shape very similar to that of the male; surface with numerous spines of not very regular distribution, a defined lateral row of evenly sized spines being present; mesothoracic pleura well spined; mesosternum with over twelve rather low spines. Metanotum not quite equal to the two basal abdominal segments in length; median segment equal to the first abdominal segment in length; metathoracic pleura with a longitudinal row of about nine rather even spines. Tegmina rather more than half the length of the metanotum (including median segment), ovate, coriaceous; median protuberance low, rounded; venation very apparent, subreticulate. Wings equal to the tegmina in length, costal and discoidal areas subreticulate as in the tegmina. Abdomen with the segments all more or less longitudinal; five basal segments subequal in length; the first, second and third with a median pair of small spiniform processes placed close to the apical margin; sixth segment slightly shorter than the fifth, slightly amplicate, the lateral margins gently rounded; seventh segment compressed, equal to the sixth in length; eighth and ninth segments together about equal in length to the preceding segment, the ninth with the apical margin rectangulate, the apex with a triangular emargination exposing the rectangulate and carinate apex of the supra-anal plate; cerci very stout and short, depressed, not exceeding the apex of the ninth dorsal segment, subgenital opercule very long, exceeding the tip of the supra-anal plate by the length of the seventh and eighth segments, hastate, carinate, apex rectangulate. Anterior femora three-fourths the length of the mesonotum, basal flexure decided; tibiæ equal to the femora in length; metatarsi not quite as long as the remaining tarsal joints. Median femora equal to the first two basal segments of the abdomen in length, anterior and posterior inferior margins as in the male, the inferior median line with five or six spines; tibiæ equal to the femora in length, the structure similar to that of the male but less apparent; metatarsi but little more than half the length of the remaining tarsal joints. Posterior femora equal to the first two and a half of the third abdominal segments, the margins as in the male, the inferior median line with five or six spines; tibiæ equal to the femora in length and with the structure very similar; metatarsi shorter than the remaining tarsal joints.

General color (from spirits) dull ochraceous, the nine prominent spines tipped with black; tegmina with the venation dull cream on a blackish ground; wings with the costal and discoidal areas similar to the tegmina, posterior field pearl-white with the nerves purplish-black.

Measurements.

	♂		♀	
Total length,	78	mm.	134	mm.
Length of pronotum,	4	"	6.5	"
Length of mesonotum,	17.5	"	29.5	"
Length of metanotum (including median segment),	11.5	"	17	"
Length of median segment,	6	"	9.5	"
Length of tegmina,			10	"
Length of wings,			10	"
Length of abdomen,	42	"	82	"
Length of anterior femora,	14	"	21.5	"
Length of anterior tibiæ,	13.7	"	22.5	"
Length of median femora,	12.7	"	18.7	"
Length of posterior femora,	15.5	"	24.5	"
Length of subgenital opercule (from extreme base),			28.5	"

Aplopus achalus[21] **n. sp.**

Type.—♂; Adjuntas, Porto Rico, April 12, 1900. (Dr. C. W. Richmond.) [Cat. No. 7,344, U. S. N. M.]

Compared with *jamaicensis* Drury, the closest allied species, this new form may be separated by the unarmed head and mesonotum, the longer tegmina, the slenderer and weaker limbs, and the coloration. It appears very unlikely that this is the male of *angulata* Stoll (=*micropterus* Lep. and Serv.), as the female of that species has very prominent cephalic spines, and in all respects resembles the females of other species of the genus, the known males of which are very different from this in structure. Stoll's species was recorded from Porto Rico by Haan,[22] but there appears no likelihood that this new form is at all closely allied to it.

Size rather small; form moderately elongate; surface subglabrous. Head ovate, depressed; occiput without spines; eyes subglobose. Antennæ equal to the head, thorax and tegmina in length, robust, filiform, basal joint depressed, the inferior surface concave. Pronotum subquadrate, somewhat constricted posteriorly, anterior margin concave, the posterior convex; transverse anterior sulcus obsolete centrally, transverse median sulcus distinct, strongly impressed, longitudinal median sulcus slight, not extending the whole length of the pronotum. Mesonotum slightly over three times the length of the pronotum, gradually expanding posteriorly, surface with several irregular obsolete tubercles. Metanotum equal to the mesonotum in length; metathoracic pleura and metasternum rugulose; the whole metathorax depressed. Tegmina equal to the mesonotum in length, acute-ovate; median protuberance somewhat longitudinal, acute. Wings long, reaching to the seventh abdominal segment. Abdomen with all the segments more or less longitudinal, gradually decreasing in size from the base to the sixth segment; sixth and following segments distinctly carinate and tectate; seventh and eighth segments of the same general form, the latter slightly the shorter; ninth segment slightly shorter than the eighth segment, somewhat constricted toward the apex, apical margin subtruncate with a very broad and shallow median emargination; cerci about two-thirds the length, subequal, apex blunt; subgenital opercule very slightly exceeding the apical margin of the eighth dorsal segment, cymbiform, carinate, apex rounded with a narrow median triangular emargination. Anterior femora equal to the pronotum and mesonotum in length, basal flexure

[21] ἄχαλος, *i.e.*, unarmed.

[22] *Verhandl. Natuurl. Geschied. Nederl. Overzeesche Bezitt.*, Orth., p. 103, 1842.

strongly marked; tibiæ slightly shorter than the femora; metatarsi but slightly more than half the length of the remaining tarsal joints. Median femora a trifle longer than the tegmina, anterior inferior margin with two and the posterior inferior margin with one apical spine, median line with one spine which is more or less obsolete; tibiæ considerably shorter than the femora and almost equalling the mesonotum in length; metatarsi equalled in length by the second and third tarsal joints. Posterior femora equal to the first, second and half of the third abdominal segment, anterior inferior margin with two and the posterior with one apical spine, median line with two subapical spines; tibiæ about three-fourths the length of the femora; metatarsi equal to the second, third and fourth tarsal joints in length.

General color pale yellowish-green, washed with brownish on the head, pronotum and mesonotum; tegmina and wings with the veins darker than the basic color, costal margin of the tegmina and the base of the same region of the wing opaque-white, discoidal area of the tegmina smoky-brown, posterior field of the tegmina milky-white; antennæ and an obscure postocular bar pale purplish; marginal femoral spines black.

Measurements.

	achalus ♂	*jamaicensis* ♂
Total length,	61.5 mm.	65 mm.
Length of pronotum,	3 "	3 "
Length of mesonotum,	9 "	9.5 "
Length of tegmina,	10 "	8.2 "
Length of wings,	39 "	36.5 "
Length of anterior femora,	11.8 "	11.5 "
Length of anterior tibiæ,	10 "	10 "
Length of median femora,	11 "	10 "
Length of posterior femora,	14.8 "	13.5 "

Genus **ISCHNOPODA** Grandidier.

1869. *Ischnopoda* Grandidier, Revue et Magasin de Zoologie, 2e ser., XXI, p. 293.

Type.—*I. reyi* Grandidier.

Ischnopoda phillipsi Kirby.

1897. *Ischnopoda Phillipsi* Kirby, Trans. Linn. Soc. London, 2d ser., VI, p. 467. [Somaliland.]
1901. *Palophus reyi* Rehn (not of Auct.), Proc. Acad. Nat. Sci. Phila., 1901, p. 288. [Somaliland or Gallaland; no exact data.]

The individual recorded by the author in the above-mentioned paper is seen on second examination to be distinct from *reyi*, and appears to be identical with Kirby's *phillipsi*. A few discrepancies exist, however, in the measurements, the posterior femora of the type being eleven millimeters shorter than that of the specimen collected by Dr. A. Donaldson Smith, in the collection of the Academy.

Genus BACTRODODEMA Stål.

1859. *Bactrododema* Stål, Öfver. K. Vetensk.-Akad. Förhandl., 1858, p. 308.

Type.—*B. tiarata* Stål.[23]

Bactrododema miliaris Bolivar ?

1890. *B[actrododema] miliaris* Bolivar, Jornal Sci. Math. Phys. Nat. Acad. Real Sci., Lisboa, 2a ser., I, p. 87. [San Thomé, West Africa.]

One female; Gaboon river, West Africa. (Dr. Henry A. Ford.) [A. N. S. Phila.]

This specimen does not wholly agree with Bolivar's description of the species, differing in the bowed median and posterior femora, in which respect it approaches *B. welwitschi* Bolivar (*ibid.*, p. 88) from Golungo Alto, but from that is separated by the character of the cephalic spines and the longer wings. Westwood's *æstuans* appears to be a very distinct form.

Genus TIRACHOIDEA Brunner.

1893. *Tirachoidea* Brunner, Ann. Mus. Civ. Stor. Nat. Genova, 2a ser., XIII, p. 83.

Included *Phibalosoma cantori* Westwood, *Ph. hypharpax* Westw., *Ph. tiarchus* Westw. and *Cyphocrania tamyris* Westw., of which the first, *cantori*, may be taken as the type, as both sexes are known.

Tirachoidea cantori (Westwood).

1859. *Phibalosoma Cantori* Westwood, Cat. Orth. Ins. Brit. Mus., I, p. 74, Pl. XXXVII, fig. 1 (♂), and Pl. XXXVIII, fig. 1 (♀). [Malacca.]

One male; Trong, Lower Siam. (Dr. W. L. Abbott.) [U. S. N. M.]

This specimen agrees perfectly with Westwood's figure, except that the ninth abdominal segment is very slightly shorter and the two arms of the same less curved.

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[23] As some orthopterists do not recognize this genus as distinct from *Palophus* Westwood, and both names being ostensibly published in 1859, the author examined the works containing each, to ascertain, if possible, which had priority. Stål's work was presented for publication in 1858, but obviously did not appear until 1859, the copy of the work in the library of the Academy having been received May 22, 1860; and while the *Proceedings of the Entomological Society of London* give no clue as to the date of receipt of the 1858 volume, the 1859 volume is stated to have been received during 1860. Assuming the numbers to have appeared regularly, this would place the 1858 portion as appearing during 1859. Westwood's work, bearing the date June 1, 1859, on the Preface, was received at the Academy January 10, 1860, but is not mentioned in the *Proceedings of the Entomological Society of London* until August 6, 1860. In the *Proceedings of the Boston Society of Natural History*, the 1858 *Öfversigt* is entered as received between April and June 30, 1860. From the above it will be seen that the dates of publication are very close, and the question of priority is one I am unable to settle at present.

Genus **ORXINES** Stål.

1875. *Orxines* Stål, Recensio Orthopterorum, III, pp. 43 and 87.

Included *Phasma* (*Lopaphus*) *macklottii* Haan, *Anophelepis xiphias* Westwood, and *Necroscia zeuxis* Westwood; of which *xiphias* may be selected as the type, as Westwood has given good figures of both sexes.

Orxines xiphias (Westwood).

1859. *Anophelepis Xiphias* Westwood, Cat. Orth. Ins. Brit. Mus., I, p. 71, Pl. IV, fig. 4 (♂) and fig. 5 (♀). [Amboina.]

Four specimens; one male, three females; Island of Obi, Moluccas. [Coll. of Mr. Morgan Hebard and Acad. Nat. Sci. Phila.]

These specimens differ slightly from Westwood's figures, the mesonotum and metanotum (without the median segment) being slightly longer, but the discrepancies are so slight it would be very difficult to satisfactorily differentiate them from the Amboina form.

Subfamily NECROSCINÆ.

Genus **SOSIBIA** Stål.

1875. *Sosibia* Stål, Recensio Orthopterorum, III, pp. 42 and 87.

Type.—*S. nigrispina* Stål.

Sosibia nigrispina Stål.

1875. *S*[*osibia*] *nigrispina* Stål, Recensio Orthopterorum, III, p. 87. [Malacca.]

One female; Trong, Lower Siam. (Dr. W. L. Abbott.) [U. S. N. M.]

This specimen, which otherwise agrees very well with Stål's description, has the cephalic spines with more greenish than blackish coloration. The median tibiæ are exceptionally short, but Stål makes no mention of this rather striking condition.

Genus **CALVISIA** Stål.

1875. *Calvisia* Stål, Recensio Orthopterorum, III, pp. 42 and 87.

Included *Necroscia sangarius, medora, virbius* and *hemus* Westwood, of which the first can be selected as the type.

Calvisia viridilineata (Bates).

1866. *Necroscia viridilineata* Bates, Trans. Linn. Soc. London, XXV, p. 352. [Ceram.]

One female; Island of Obi, Moluccas. [Coll. of Morgan Hebard.]

This agrees perfectly with Bates' description, except that the general tint of the limbs is more brownish than greenish, but this of course may be due to drying. Stål's *maculiceps* and *thisbe* from the Philippines[24] appear to be closely related to this species.

[24] *Öfversigt af K. Vetensk.-Akad. Förhandlingar,* 1877, No. 10, p. 42.

Calvisia graminea (Bates).

1866. *Necroscia graminea* Bates, Trans. Linn. Soc. London, XXV, p. 356. [Batchian.] (♀)
1866. *Necroscia smaragdula* Bates, Trans. Linn. Soc. London, XXV, p. 357. [Gilolo and Batchian.] (♂)

Eight specimens; four males, four females; Island of Obi, Moluccas. [A. N. S. Phila. and collection of Morgan Hebard.]

It appears to me that the above names were based on different sexes of the same species. The specimens examined agree almost absolutely with the descriptions, and such characters as the annulation of the antennæ and the structure of the pronotum and the head, as well as the extent of the rugosity of the mesonotum, are identical in the two sexes. Bates says the tegmina of the male "are of a yellowish colour, brown towards their tips, but sometimes uniform yellow." All the four males examined have the coloration uniform.

The rugosity of the mesonotum of both sexes is distinctly more pronounced anteriorly, which also holds true regarding the mesosternum.

The range of this species now covers Gilolo, Batchian and Obi, of the Moluccan group.

Calvisia maculicollis (Westwood).

1848. *Phasma (Necroscia) maculicollis* Westwood, Cabinet Orient. Entom., Pl. XXXVIII, fig. 2. [Assam and Sylhet.]
1893. *C[alvisia] atrosignata* Brunner, Ann. Mus. Civ. Stor. Nat. Genova, XXXIII, p. 85, tab. III, fig. 27. [Bhamò, Burma and Meetan, Tenasserim.]

One female; Trong, Lower Siam. (Dr. W. L. Abbott.) [U. S. N. M.]

After critically examining the figures of Westwood's *maculicollis* and Brunner's *atrosignata*, there appears to be no doubt but that they are based on the same species. Brunner's specimens are described as being more uniform in the coloration of the costal portion of the wings, but the Trong specimen agrees exactly with Westwood's figure.

This species has been recorded from Java by Westwood and Sumatra by Brunner, as well as from the localities mentioned above.

Calvisia nigrofasciata (Haan).

1842. *P[hasma] (Necroscia) nigrofasciatum* Haan, Verhandel. Natuurlijke Geschied. Nederl. overzees. Bèzitt., Orth., p. 122. [Batang Singalang.]

One male; Goenong Soegi, Lampong, Sumatra. October–November, 1901. (A. C. Harrison, Jr., and Dr. H. M. Hiller.) [A. N. S. Phila.]

This specimen agrees very well with Haan's very brief description. A peculiar coloration not noticed in the original diagnosis is the longitudinal black and greenish-white lined limbs and antennæ.

Genus **MARMESSOIDEA** Brunner.

1893. *Marmessoidea* Brunner, Ann. Mus. Civ. Stor. Nat. Genova, XXXIII, pp. 84 and 85.

Included *marmessus* Westwood and *rubescens* Saussure, of which the former was considered the type by Brunner (*vide supra*, p. 86).

Marmessoidea marmessus (Westwood).

1859. *Necroscia Marmessus* Westwood, Cat. Orth. Ins. Brit. Mus., I, p. 149, Pl. XIX, figs. 1 and 7, Pl. XXIX, fig. 4. [Malacca; Sarawak, Borneo; Sumatra.]

Four specimens; two males, two females; Trong, Lower Siam. (Dr. W. L. Abbott.) [U. S. N. M.] Goenong Soegi, Lampong, Sumatra. October–November, 1901. (A. C. Harrison, Jr., and Dr. H. M. Hiller.) [A. N. S. Phila.]

The male from Sumatra has the maculations of the tegmina circular, as in the form provisionally named *eurybates* by Westwood. The two Trong specimens are both typical individuals.

Marmessoidea cercyon (Westwood).

1859. *Necroscia cercyon* Westwood, Cat. Orth. Ins. Brit. Mus., I, p. 146, Pl. XXXIV, fig. 1. [Pulo Penang, Malacca.]

One female; Khow Sai Dow, Trong, Lower Siam (1,000 feet). January–February, 1899. (Dr. W. L. Abbott.) [U. S. N. M.]

As the female of this species has never been described, a few notes on the abdominal appendages and the measurements may be of interest.

Ninth dorsal segment strongly tectate, the median ridge very prominent, apex bluntly angulate. Cerci subequal, apically blunt, very slightly exceeding the apex of the subgenital opercule. Subgenital opercule cymbiform, acuminate; apex very deeply and narrowly emarginate.

Measurements.

Total length,	76.3	mm.
Length of pronotum,	4	"
Length of mesonotum,	13.5	"
Length of abdomen,	41	"
Length of tegmina,	7.2	"
Length of wings,	44	"
Length of anterior femora,	21	"
Length of anterior tibiæ,	22	"
Length of median femora,	13.5	"
Length of posterior femora,	19.5	"

Marmessoidea phluctainoides[25] n. sp.

Types.—♂ and ♀; Yokohama, Japan. (Rev. H. Loomis.) [Coll. A. N. S. Phila. (types) and A. N. Caudell.]

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[25] *φλυκταινοειδής*, *i.e.*, pimply.

Allied to *M. sumatrensis* Brancsik[26] from Sumatra, but differing in the shorter mesonotum, the compressed ninth abdominal segment, the non-annulate antennæ and the different color pattern of the tegmina. Brancsik's *Necroscia papuana* from New Guinea and Westwood's *ismene* from Borneo are apparently related to *phluctainoides*, but very distinct species.

♂.—Size rather small; form slender; surface of head subglabrous, of thoracic segments granulose. Head rather large, moderately depressed, somewhat inflated, the posterior portion subequal in width, occiput with a faint median sulcus; eyes ovate, prominent; basal joint of the antennæ slightly depressed, longer than broad, second joint longer than broad and not equal to the basal joint in size, total length of the antennæ about equal to that of the abdomen. Pronotum quadrate, with a fine median longitudinal sulcus and a well-marked transverse sulcus which is placed before the middle. Mesonotum somewhat over three times the length of the pronotum, subequal anteriorly, slightly expanded posteriorly, very distinct median and lateral carinæ present, all becoming rather evanescent posteriorly, surface rugoso-tuberculate. Tegmina short, subtruncate apically, raised portion of moderate elevation, rounded. Wings large, damaged in the type, but apparently reaching the apex of the abdomen in the perfect specimen. Abdomen slender, the six basal segments longitudinal and slightly decreasing in length apically; eighth segment slightly longer than the seventh, both carinate, the seventh slightly expanded apically, the eighth slightly compressed; ninth segment about equal to the seventh in length, compressed, subtectate, apex truncate when viewed from the dorsum; cerci about reaching to the apex of the ninth segment, subequal, slightly incurved; supra-anal plate absent; subgenital opercule reaching to the apex of the eighth dorsal segment, rotundato-truncate. Anterior femora somewhat exceeding the pronotum and mesonotum in length, considerably curved basally; tibiæ slightly shorter than the femora; metatarsi very slender, equal to the remaining tarsal joints in length. Median and posterior limbs absent.

General color purplish-brown, rather pale on the proximal portion of the anterior femora. Tegmina with the elevation black, bordered laterally by a longitudinal bar of pinkish-white, which extends to the apex of the tegmina. Wings pinkish-purple.

♀.—Size medium; form rather robust; surface of mesonotum and tegmina rugose. Head inflated, slightly elongate; eyes ovate, mod-

[26] *Jahresheft des Naturwissenschaftlichen Vereines des Trencséner Comitates*, XIV–XV, p. 201, tab. xi, fig. 11 (♂).

erately prominent; antennæ slightly exceeding half the length of the body, basal joint longitudinal and considerably depressed, second joint cylindrical, considerably smaller than the basal joint. Pronotum quadrate, very slightly constricted posteriorly, anterior margin with a shallow emargination, median sulcus not marked posteriorly, the transverse ante-median sulcus very distinct. Mesonotum equal in length to the posterior tibiæ, rather broad, gradually expanding posteriorly; median and lateral carinæ very distinct; surface rugoso-tuberculate. Tegmina short, subquadrate; apex subtruncate; elevated point slight, low and rounded. Wings short, reaching to the apex of the third abdominal segment, width about three-fourths of the length; costal area coarsely reticulate; radial vein furcate. Abdomen somewhat inflated, the six basal segments all transverse and subequal in length, the second and third of the greatest and the sixth of the least width; seventh and eighth segments tectate, subequal in length; ninth segment slightly longer than the eighth, the apex somewhat produced, truncate and with a slight triangular median emargination; supra-anal plate with the apex alone visible; cerci straight, reaching to the apex of the ninth segment; subgenital opercule tectate, acuminate, the tip acute and reaching to the apex of the eighth segment. Egg almost ready to deposit in position in oviduct, general shape apparently oval, surface rugose. Limbs short, terminal tarsal joint of each foot provided with a large arolium. Anterior femora slightly exceeding the mesonotum in length, basal section strongly bowed; tibiæ slightly shorter than the femora; metatarsi slightly shorter than the remaining tarsal joints. Median femora and tibiæ short, the former slightly longer than the latter, neither exceeding the length of the two basal segments of the abdomen; metatarsi considerably shorter than the remaining joints of the tarsi. Posterior femora but slightly shorter than the pronotum and mesonotum together; tibiæ slightly shorter than the femora; metatarsi much shorter than the remaining tarsal joints, the second joint alone being half the length of the metatarsus.

General color grass-green, most intense on the mesonotum, tegmina and costal region of the wings. Antennæ dull purplish, pale basally; eyes wood-brown, with a narrow longitudinal bar of darker brown; postocular region with a faint line of yellowish. Mesonotum with the lateral carinæ chrome-yellow. Tegmina with the chrome-yellow line of the mesonotum continued to the apical margin, flanked internally by a line of blackish. Wings with the posterior portion roseate-pink.

Measurements.

	♂	♀
Total length,	40 mm.	50 mm.
Length of pronotum,	1.7 "	2.5 "
Length of mesonotum,	7 "	10 "
Length of tegmina,	2.5 "	3 "
Length of wings,	19+ "	16.5 "
Length of abdomen,	22.5 "	26.5 "
Length of anterior femora,	11 "	11.5 "
Length of anterior tibiæ,	9.5 "	9.5 "
Length of median femora,		7.5 "
Length of posterior femora,		11.7 "

This species is based on a series of sixteen individuals, fifteen of which are females. No appreciable difference exists in all the series, except in the intensity of the green coloration of the body, which is clearly due to the fading of the natural tint.

Genus **SIPYLOIDEA** Brunner.

1893. *Sipyloidea* Brunner, Ann. Mus. Civ. Stor. Nat. Genova, XXXIII, pp. 84 and 86.

Included *Necroscia chlorotica* Serville, *N. sipylus, samsoo, sarpedon* and *panœtius* Westwood, of which Brunner selected *sipylus* as the type.

Sipyloidea sipylus (Westwood).

1859. *Necroscia Sipylus* Westwood, Cat. Orth. Ins. Brit. Mus., I, p. 138, Pl. XVIII, fig. 4. [Assam; Java.]

Three specimens; one male, two females; Trong, Lower Siam. (Dr. W. L. Abbott.) [U. S. N. M.]

This species has been recorded from Bhamò and Carin Chebà, Burma, Assam, Malacca, Sumatra, Java and Borneo. The form from the latter island was provisionally separated by Westwood as *warasaca*.

Sipyloidea scabra (Stål)?

1877. *N[ecroscia] scabra* Stål, Öfversigt af K. Vetensk.-Akad. Förhandlingar, 1877, No. 10, p. 43. [Philippines.]

Two males; Island of Obi, Moluccas. [Coll. of Morgan Hebard and A. N. S. Phila., presented by Mr. Hebard.]

These specimens agree fairly well with Stål's very brief description, but that individuals from the two localities are identical is, to say the least, doubtful. A very peculiar feature of these individuals is the continuous ventral line extending from the prosternum to the apical portion of the abdomen. Several other species related to this form are *sarpedon* and *samsoo* Westwood, and possibly *janus* Bates and *ceramia* Westwood.

Sipyloidea pœciloptera[27] **n. sp.**

Types.—♂ and ♀; Island of Obi, Moluccas. [A. N. S. Phila., presented by Mr. Morgan Hebard.]

As this species does not appear to be closely related to any of the previously known species, I have compared it with the type of the genus. The new form differs from *S. sipylus* in the smaller size, the very weak character of the granulations on the mesonotum, the somewhat slenderer and less coriaceous tegmina, the blunter character of the apex of the ninth dorsal abdominal segment and the more acuminate apical portion of the subgenital opercule.

♂.—Size medium; form elongate; surface smooth. Head slightly oblong, dorsal surface flat, the occiput with a slight median longitudinal sulcus; eyes ovate, prominent; antennæ slightly exceeding the body in length. Pronotum longitudinal, about twice as long as broad, subequal in width, transverse sulcus in advance of the middle. Mesonotum about three and a half times the length of the pronotum, very slender, very slightly constricted centrally; surface with a few obsolete granulations and a weak longitudinal median carina. Tegmina ovate, the apex sub-truncate, median protuberance of medium height and rather blunt. Wings equal to the mesonotum and about two-thirds the abdomen in length. Abdomen with the seventh and eighth segments subequal in length, and exceeding the ninth, which is somewhat tectate and apically subtruncate with a very shallow median emargination; cerci short, stout, subequal, extending but slightly beyond the ninth dorsal segment; subgenital opercule not quite reaching the apex of the eighth dorsal segment, moderately compressed, apex rather broadly rounded. Limbs very slender. Anterior femora equal to about half the length of the abdomen, basal flexure slight; tibiæ about equal to the femora in length; metatarsi considerably exceeding the remaining joints in length. Median femora equal to the mesonotum and tegmina in length; tibiæ slightly shorter than the femora in length; metatarsi very slightly longer than the remaining tarsal joints. Posterior femora about equal to the anterior femora in length; tibiæ equal to the femora in length; metatarsi exceeding the remaining tarsal joints in length.

♀.—Size medium. Head suboval, not constricted posterior to the eyes; occiput with a distinct longitudinal median sulcus; eyes ovate; antennæ about two-thirds the length of the body. Pronotum as in the male, but the transverse sulcus is not so anterior in position. Mesonotum three times the length of the pronotum, slightly expanding posteriorly, median carina very fine, subobsolete. Tegmina ovate,

[27] ποικιλόπτερος—variegated wings.

the apex somewhat truncate; costal region very broadly arcuate; median protuberance longitudinal, low and rounded. Wings equal to the abdomen in length; when in repose the tips are distinctly acuminate. Abdomen with the seventh, eighth and ninth dorsal segments subequal in length, the latter subtectate and distinctly acuminate; subgenital opercule acuminate, reaching to the middle of the ninth dorsal segment. Anterior femora slightly compressed, almost equal to the head, pronotum and mesonotum in length; tibiæ slightly shorter than the femora. Median femora equal to the mesonotum and half of the pronotum in length; tibiæ about five-sixths the length of the femora; metatarsi but slightly shorter than the remaining tarsal joints. Posterior femora about as long as the head, pronotum and mesonotum; tibiæ equal to the femora.

General color pea-green, dark dull in the female. Antennæ greenish-brown, with the base of each joint encircled by a narrow whitish annulus, this latter character more apparent in the male than in the female. Pronotum in the male flecked with small circular blotches of cream. Tegmina and costal region of wings pea-green, in the female the tips of the latter touched with rosy red; posterior field of the wings pale pinkish. Apex of the abdomen and portions of the limbs in the female washed with rosy red.

Measurements.

	♂		♀	
Length of body,	57	mm.	73	mm.
Length of pronotum,	3	"	4	"
Length of mesonotum,	10.5	"	12.5	"
Length of abdomen,	35	"	44	"
Length of tegmina,	3.5	"	5.5	"
Length of wings,	30	"	44.5	"
Length of anterior femora,	19.2	"	19	"
Length of anterior tibiæ,	18.2	"	18.5	"
Length of median femora,	13	"	15	"
Length of posterior femora,	18	"	19.5	"

Genus **ARUANOIDEA** Brunner.

1893. *Aruanoidea* Brunner, Ann. Mus. Civ. Stor. Nat. Genova, XXXIII, p. 84.

Included *salmanazar*, *aruana* and *osmylus* of Westwood, of which *aruana* may be considered the type.

Aruanoidea aruana (Westwood).

1859. *Necroscia Aruana* Westwood, Cat. Orth. Ins. Brit. Mus., I, p. 134, Pl. XXXIX, fig. 4. [Aru Islands.]

Fifteen specimens; eleven males, four females; Island of Obi, Moluccas. [Coll. of Mr. Morgan Hebard and A. N. S. Phila., presented by Mr. Hebard.]

This species has two well-marked color phases, one pea-green, the other dull wood-brown. The males all belong to the latter phase, and have the internal edge of the tegmina and the internal edge of the basal portion of the wings with a rather broad longitudinal bar of dull yellowish.

The following description is of the male, which appears never to have been recorded.

Size medium; form elongate; surface granulose. Head somewhat depressed, posterior portion of subequal width; occiput with a very deep longitudinal sulcus; eyes subovate; ocelli distinct; antennæ equal to the body in length. Pronotum distinctly longitudinal, twice as long as broad; anterior margin broadly emarginate, posterior margin broadly arcuate, lateral margins bearing a rather acute process anteriorly; transverse sulci two in number, one immediately posterior to the anterior margin, the other just anterior to the middle. Mesonotum distinctly tuberculate (a condition shared by the meso- and metasternum and pleura), slender, subequal; median carina rather broad, low. Tegmina subpyriform, apex obliquely truncate; costal field subequal in width; median protuberance very distinct. Wings about twice the length of the head, pronotum and mesonotum together. Abdomen with the seventh and eighth dorsal segments subequal in length, carinate, the ninth slightly shorter than the eighth, apical emargination very deep, expanded, the lateral portions incurved and enclosing the expanded sinus; cerci subequal in width, not quite equal to the ninth segment in length; subgenital opercule reaching to the tip of the eighth dorsal segment, cymbiform, apex narrowly rounded. Anterior femora with the basal flexure moderately distinct, equal to the head, pronotum, mesonotum and tegmina in length; tibiæ equal to the femora in length; metatarsi nearly twice as long as the following tarsal joint. Median femora equal to the pronotum and mesonotum in length; tibiæ somewhat shorter than the femora; metatarsi about equal to the remaining tarsal joints in length. Posterior femora and tibiæ about equal to the anterior in length; metatarsi slightly longer than the remaining tarsal joints.

General color dull wood-brown, blotched and suffused with dull ochraceous, the limbs obscurely annulate. Tegmina with a spot on the median protuberance and the internal border as well as the adjoining portion of the wings dull yellow; posterior field of wings vinaceous. Antennæ dull brownish-ochraceous with obsolete annuli of a dark brown.

Measurements.

Total length,	61 mm.
Length of pronotum,	3.5 "
Length of mesonotum,	10 "
Length of abdomen,	38 "
Length of tegmina,	4 "
Length of wings,	34 "
Length of anterior femora,	19.5 "
Length of anterior tibiæ,	19.5 "
Length of median femora,	13.5 "
Length of posterior femora,	18.5 "

This locality extends the range of the species considerably to the westward.

Aruanoidea punctata (Gray).

1835. *Platycrana punctata* Gray, Synopsis Phasm., p. 37. [East Indies.]

Two males; Trong, Lower Siam. (Dr. W. L. Abbott.) [U. S. N. M.]

These specimens are identical in the pattern and intensity of the coloration.

Subfamily CLITUMNINÆ.

Genus **MACELLA** Stål.

1875. *Macella* Stål, Recensio Orthopterorum, III, pp. 13, 70.

Included *Bacillus souchongia* Westwood and *Macella dentata* Stål, of which the former may be considered the type as it is well figured.

Macella caulodes[28] n. sp.

Types.—♂ and ♀; Trong, Lower Siam. (Dr. W. L. Abbott.) [Cat. No. 7,345, U. S. N. M.]

Apparently not closely allied to any of the previously known species of the genus; the unarmed character of the eighth abdominal segment and the rather straight cerci are very distinctive.

♂.—Size rather small; form elongate; surface subsericeous. Head elongate, somewhat depressed, evenly constricted posteriorly; eyes subglobose, rather prominent; antennæ with the first joint elongate-ovate, depressed, median longitudinal portion rounded, half the length of the linear second joint. Pronotum longitudinal; anterior margin broadly emarginate; posterior margin truncate; lateral margins with the anterior half broadly and evenly emarginate, median longitudinal carina distinct. Mesonotum over five times the length of the pronotum, very slender, median carina distinct anteriorly. Metanotum (with median segment) about three-fourths the length of the mesonotum; median segment very short, transverse. Abdomen with the

[28] καυλώδης, *i.e.*, resembling a stem.

first to sixth segments distinctly longitudinal; seventh dorsal segment not more than two-thirds the length of the sixth; eighth segment tectate, slightly shorter than the seventh, lateral portions with the posterior angles simple and not developed into distinct spines; ninth segment slightly shorter than the eighth, fornicate, apically truncate and with a transverse costa, median carina narrow and distinct; cerci about equal in length to the ninth dorsal segment, and inserted near the apex of the latter, slender, hardly curved; subgenital opercule not quite reaching the apical margin of the eighth dorsal segment, apex broad, truncate. Limbs very slender. Anterior femora but slightly shorter than the mesonotum and metanotum together, basal flexure slight; tibiæ slightly longer than the femora, very slender; metatarsi nearly three times the length of the remaining joints of the tarsi. Median femora slightly exceeding the pronotum and mesonotum in length, slightly bowed, tibiæ slightly longer than the femora, metatarsi about half again as long as the remaining tarsal joints. Posterior femora equal to the five basal abdominal segments in length, slightly bowed; tibiæ exceeding the femora by about the length of the first abdominal segment; metatarsi considerably over twice as long as the remaining tarsal joints.

♀.—Size rather small; form moderately slender; surface generally subsericeous, rather granulose on the mesonotum. Head elongate, depressed, very slightly compressed posteriorly, posterior margin with a distinct narrow median depression; eyes subglobose; antennæ almost equal to the head and pronotum in length, basal joint as in the male, the second joint rather stout. Pronotum similar to that of the male. Mesonotum slightly more than four times the length of the pronotum, very slightly and very gradually enlarging posteriorly; median carina anteriorly distinct, but very narrow, and becomes obsolete posteriorly. Metanotum (with median segment) two-thirds the length of the mesonotum; median carina as in the mesonotum; median segment very short, decidedly transverse. Abdomen equal to the head and thorax in length, median carina distinct and becoming quite prominent posteriorly, where the segments are decidedly tectate; first to sixth segments longitudinal, the length increasing from the base; seventh segment longitudinal, the apical portion considerably expanded; eighth segment somewhat transverse, carina not very distinct; ninth segment moderately produced, strongly carinate, apical margin with a median triangular emargination, which exposes the acuminate apex of the supra-anal plate; cerci acuminate, extending beyond the ninth dorsal segment by about two-thirds the length of the latter; subgenital opercule reaching to the apical margin of the eighth dorsal segment, apex rotundato-truncate. Anterior femora equal to the head, pronotum and mesonotum in length, moderately compressed, basal flexure distinct; tibiæ slightly shorter than the femora; metatarsi about three times the length of the remaining tarsal joints. Median femora almost equal to the pronotum and mesonotum in length; tibiæ slightly exceeding the femora in length; metatarsi not quite twice the length of the remaining tarsal joints. Posterior femora exceeding the four basal segments of the abdomen in length, somewhat bowed; tibiæ slightly longer than the femora; metatarsi twice as long as the remaining tarsal joints.

General color dull ochraceous-brown, deeper in the male than in the female and also exhibiting some trace of greenish. Head with a postocular streak of blackish-brown more or less evident.

Measurements.

	♂	♀
Total length,	51 mm.	54 mm.
Length of pronotum,	2 "	2.2 "
Length of mesonotum,	12 "	13 "
Length of metanotum (including median segment),	9.5 "	9 "
Length of median segment,	1.2 "	1.5 "
Length of abdomen,	25.5 "	26.2 "
Length of anterior femora,	21.7 "	17 "
Length of anterior tibiæ,	22.7 "	16.5 "
Length of median femora,	14.5 "	12.2 "
Length of posterior femora,	18 "	14.2 "

Another Trong specimen, a female, I have provisionally referred to this species. However, it exhibits several discordant characters, as the antennæ beyond the second joint are slenderer, the terminal segments of the abdomen are supplied with longitudinal rugæ, and the size is greater.

Genus **GRATIDIA** Stål.

1875. *Gratidia* Stål, Recensio Orthopterorum, III, pp. 14, 70.

Type.—*Gratidia sansibara* Stål.

As the material studied in this connection was quite limited, no attempt has been made to determine the propriety of uniting *Clonaria* with *Gratidia*, as Karsch has proposed to do in his paper on this genus.[29] The relegating of *Paraclonaria* to the synonymy seems unwarranted, in spite of the arguments Karsch advances in defense of his action. The structural characters of *Paraclonaria* are of sufficient importance

[29] *Entom. Nachrich.*, XXIV, pp. 370–380.

to place it on an equal footing with many recognized genera of Phasmidæ.

Gratidia natalis (Westwood).

1859. *Bacillus Natalis* Westwood, Cat. Orth. Ins. Brit. Mus., I, p. 6, Pl. XXIII, figs. 7 and 8. [Port Natal.]

One female; Zulu Mission, South Africa. [A. N. S. Phila.]

This specimen is from alcohol, and in consequence badly shriveled and distorted.

Gratidia inclinata Karsch.

1898. [*Gratidia*] *inclinata* Karsch, Entom. Nachrich., XXIV, pp. 372, 375. [Darema, Usambara, German East Africa.]

Three males; Mombasa, British East Africa. [Coll. of Morgan Hebard.]

These specimens have been badly broken, but they appear to be clearly referable to this species.

Genus PARACLONARIA Schulthess-Schindler.

1893. *Paraclonaria* Brunner, Ann. Mus. Civ. Stor. Nat. Genova, XXXIII, p. 89. [Name untenable, as no included species are cited.]
1898. *Paraclonaria* Schulthess-Schindler, Ann. Mus. Civ. Stor. Nat. Genova, XXXIX, p. 182.

Included *P. longelaminata*, *affinis* and *hamuligera* Schulthess, the first of which was removed to *Phthoa* by Karsch. Of the remaining forms *hamuligera* may be selected as the type.

Paraclonaria postrostrata (Karsch).

1898. [*Gratidia*] *postrostrata* Karsch, Entom. Nachrich., XXIV, pp. 373, 378. [Mombasa, East Africa.]

Two males; Mombasa, British East Africa. [Coll. Morgan Hebard.]

These specimens agree very well with Karsch's description, except for the fact that he gives the length of the anal segment as 7.5 millimeters, while in the specimens examined the plate itself is considerably shorter than the type measurements. Possibly personal equation or a different comprehension of the "analsegment" may be responsible for the difference, as the structure and other proportions agree perfectly.

Genus MARANSIS Karsch.

1898. *Maransis* Karsch, Entom. Nachrich., XXIV, pp. 365, 381.

Type.—*Bacillus mozambicus* Westwood.

Maransis rufolineatus Schulthess.

1899. *M*[*aransis*] *rufolineatus* Schulthess, Bull. Soc. Vaudoise Sci. Nat., Lausanne, XXXV, p. 200, Pl. VII, fig. 4. [Delagoa.]

Five specimens; two males, three females (two immature); Zulu Mission, South Africa. [A. N. S. Phila.]

Genus **PARAPACHYMORPHA** Brunner.

1893. *Parapachymorpha* Brunner, Ann. Mus. Civ. Stor. Nat. Genova, XXXIII, p. 95.

Included *P. nigra* and *spinosa* Brunner.

NEOHIRASEA[30] n. subgen.

Allied to *Parapachymorpha* s.s., but differing in the greater size of the second antennal joint, the unarmed limbs, the transverse first abdominal segment, the emarginate ninth dorsal segment, as well as the accentuated character of the major body spines and the comparative suppression of the minor ones.

Type.—*Phasma* (*Acanthoderus*) *japonicum* Haan.

Parapachymorpha (Neohirasea) japonica (Haan).

1842. *Phasma* (*Acanthoderus*) *japonicum* Haan, Verhandel. Natuurlijke Geschied., Orth., p. 135, tab. 12, fig. 4. [Japan.]

Three females; Kyoto, Japan. (Y. Hirase, No. 48.) [A. N. S. Phila.]

Nikko, Japan. [U. S. N. M.]

The Nikko specimen, while badly broken, represents an individual considerably bulkier than either of the Kyoto specimens.

Subfamily ACROPHYLLINÆ.[31]

Genus **DIMORPHODES** Westwood.

1859. *Dimorphodes* Westwood, Cat. Orth. Ins. Brit. Mus., I, p. 80.

Type.—*D. prostasis* Westwood.

Dimorphodes mancus Bates.

1856. *Dimorphodes mancus* Bates, Trans. Linn. Soc. London, XXV, p. 345, Pl. XLIV, figs. 3 and 8. [Batchian and Ternate.]

Thirteen specimens; eight males, five females; Island of Obi, Moluccas. [Coll. of Morgan Hebard.]

In this fine series of specimens two individuals, one a male and the other a female, are decidedly more spinose than the remainder of the series. This is almost wholly due to the development of the low tuberculous excrescences of the other specimens into distinct spines, and may be considered a purely individual feature. Considerable discrepancy exists in the length of the anterior limbs, two undoubtedly

[30] Dedicated to Mr. Y. Hirase, of Kyoto, Japan, who has devoted a great amount of time and labor to collecting representatives of the Mollusca and Orthoptera of his native land.

[31] As Kirby has already noticed (*Proc. Royal Dublin Soc.*, n. s., VI, p. 573), *Acrophylla* and *Diura* are directly synonymous. The former name was proposed to replace the latter, which is preoccupied. Accordingly the use of the names as distinct genera is a gross error.

adult individuals showing the range of variation in the length of the femora to be 4.5 millimeters.

Genus GRAEFFEA Stål.

1875. *Graeffea* Stål, Recensio Orthopterorum, III, pp. 40, 85.

Type.—*Lopaphus coccophagus* Westwood (=*Alopus cocophages* Newport).

Graeffea cocophages (Newport).

1844. *Alopus cocophages* Newport, Philosoph. Trans. Royal Soc. London, 1844, Pt. I, p. 288, Pl. XIV, fig. 4. [Navigator's Island.]

Three specimens; one male, two females; Savaii, Samoan Islands. (Sir Charles Eliot.) [U. S. N. M.]

This species has also been recorded from the Tonga group, the Feejees, and Rotuma near the latter group. The Loyalty Islands possess another species of the genus, *lifuensis* Sharp, and possibly *fulvescens* Saussure, from the Marquesas, may be distinct, as the cerci of the female are subspatulate instead of acuminate or terete, as in the other two forms of the genus.

Genus ARRHIDÆUS Stål.

1875. *Arrhidæus* Stål, Bihang till K. Svenska Vet.-Akad. Handl., **Bd. 2,** No. 17, p. 15.

Type.—*Necroscia styxius* Westwood.

This genus contains a number of Oriental and Papuan species, a list of which may prove of service:

Arrhidæus styxius (Westwood). Philippines.
Arrhidæus palinurus (Westwood). Philippines.
Arrhidæus nigricornis Stål. Philippines.
Arrhidæus ståli Kirby. Albay, N. E. Luzon, Philippines.
Arrhidæus capito (Westwood). Sarawak, Borneo.
Arrhidæus longiceps (Bates). Kaioa Island, near Batchian.
Arrhidæus apalamnus n. sp. Obi.
Arrhidæus roseus (Stoll). Amboina and Ceram.
Arrhidæus cephalotes (Bates). New Guinea.
?*Arrhidæus vittatus* (Serville). Java.

Arrhidæus apalamnus[32] n. sp.

Types.—♂ and ♀; Island of Obi, Moluccas. [A. N. S. Phila., presented by Mr. Morgan Hebard.]

Near *longiceps* Bates,[33] but differing in the longer pronotum, shorter tegmina and wings, distribution of the femoral spines and coloration.

[32] *ἀπάλαμνος*, *i.e.*, helpless.
[33] *Trans. Linn. Soc. London*, XXV, p. 350, Pl. XLV, fig. 6.

Stoll's description of *rosea*,[34] from Amboina is so brief that even with the aid of his figure little can be made out of it. It is very apparent, however, that it has much longer wings than *apalamnus*, which latter has very short wings in both sexes.

♂.—Size rather small; form moderately elongate; surface glabrous. Head very large, almost twice the width of the pronotum, oblong, slightly and evenly constricted in the posterior portion; occiput with a broad shallow longitudinally disposed sulcus, another of similar character extending posteriorly from the eye and another on the side of the head; ocelli obsolete; eyes hemispherical; antennæ slender, filiform, about equal to the anterior femora in length. Pronotum oblong, about twice as long as broad, very slightly broader anteriorly than posteriorly, transverse sulcus centrally placed, lateral portions with a broad shallow longitudinal depression extending almost the entire length. Mesonotum slender, slightly expanding anteriorly and posteriorly, over three times the length of the pronotum, surface obsoletely tuberculate; median carina replaced by a very weak sulcus. Tegmina ovate; apex rounded; median protuberance extremely low; venation very irregular and somewhat reticulate in character. Wings short, not reaching to the middle of the third abdominal segment; costal and mediastinal regions with the transverse nervures distinct and parallel. Abdomen bacilliform; eighth dorsal abdominal segment slightly longer than the seventh, both of which are somewhat tectate; ninth segment compressed, carinate, apical incision deep and circular, the inferior lateral lobes strongly dentate; cerci about equal to the ninth segment in length, filiform, apex acuminate; subgenital opercule reaching to the tip of the eighth dorsal segment, cymbiform, the apex moderately acuminate. Limbs rather slender. Anterior femora equal in length to the head, pronotum, mesonotum and tegmina, basal flexure slight, apical portion of the inferior surface with four spines; tibiæ slightly longer than the femora; metatarsi half again as long as the remaining tarsal joint. Median femora equal to the mesonotum and half of the pronotum in length, apical spines four in number, three placed anteriorly, one posteriorly; tibiæ equal to the femora in length; metatarsi slightly longer than the remaining tarsal joints. Posterior femora slightly shorter than the four basal abdominal segments, the apical spines six or seven in number, one at the extreme apex placed posteriorly; tibiæ slightly longer than the femora; metatarsi about equal to the remaining tarsal joints in length.

[34] *Natuurlijke Afbeeldingen en Beschrijvingen, Spooken,* pp. 13 and 76, Pl. V, fig. 17.

General color sea-green, prothoracic and mesothoracic pleura and lines on the anterior and median coxæ, as well as the posterior part of the prosternum black. Eyes wood-brown with a longitudinal bar of blackish which is continued to the posterior margin of the head. Tegmina with the median protuberance pale ochraceous. Wings with the venation of the costal and mediastinal regions of the general tint on a smoky ground; posterior field vermillion.

♀.—Size medium. Head much as in the male, but the sulci less distinct; antennæ very slender, not more than two-thirds the length of the anterior femora. Pronotum half again as long as broad, subequal in width; three moderately distinct transverse sulci in the anterior half. Mesonotum four times the length of the pronotum; median carina replaced by a very fine longitudinal sulcus. Tegmina subovate, apex rounded; median protuberance not perceptible. Wings extremely short, not quite reaching the apex of the first abdominal segment; costal and mediastinal regions with the apex subacuminate. Abdomen with the eighth dorsal segment considerably longer than the seventh; ninth segment shorter than the seventh, apex broadly acuminate; cerci not equalling the ninth segment in length, depressed, acuminate; subgenital opercule compressed, scoop-like, extending to the middle of the ninth dorsal segment, apex narrowly emarginate, surface subcoriaceous. Limbs with the femoral spines much as in the male, but much weaker. Anterior femora equal to the mesonotum and wings in length, basal flexure slight; tibiæ about equal to the femora in length; metatarsi half again as long as the remaining tarsal joints. Median femora and tibiæ subequal and each somewhat shorter than the mesonotum. Posterior femora slightly longer than the four basal joints of the abdomen; tibiæ exceeding the femora by half the length of the four abdominal segments; metatarsi slightly exceeding the remaining tarsal joints in length.

General color pale yellowish-green, becoming ochraceous on the abdomen. Head glaucous-green, with two longitudinal stripes of chrome-yellow which extend from the basal antennal joints back along the lateral margins of the pronotum and mesonotum; a postocular streak of darker green is faintly indicated. Mesonotum and pronotum scrumbled with wood-brown, the mesothoracic pleura longitudinally lined with chrome-yellow. Tegmina viridian-green, the mediastinal region chrome-yellow. Wings with the apex of the costal and discoidal region smoky-brown, with the venation rich verdigris-green; posterior field vermillion. Limbs dull yellowish lined with blackish, which also suffuses the coxæ.

Measurements.

	♂	♀
Total length,	53.5 mm.	74.2 mm.
Length of pronotum,	3 "	4.1 "
Length of mesonotum,	10.5 "	16.5 "
Length of tegmina,	4 "	4.7 "
Length of wings,	14.9 "	10 "
Length of abdomen,	30.5 "	39.5 "
Length of anterior femora,	21.5 "	28.5 "
Length of anterior tibiæ,	22.1 "	29 "
Length of median femora,	12 "	15 "
Length of posterior femora,	16 "	19.5 "

Genus **ANCHIALE** Stål.

1875. *Anchiale* Stål, Recensio Orthopterorum, III, pp. 36 and 84.

Type.—*Anchiale maculata* (Olivier) (=*Phasma necydaloides* Stoll [not of Linn.] and *Phasma nævium* Lichtenstein).

Anchiale nævia (Lichtenstein).

1787. [*Phasma*] *necydaloides* Stoll, Natuurlijke Afbeeldingen en Beschryvingen, Spooken, pp. 8, 10 and 76, Pl. III, fig. 8, Pl. IV, fig. 11. [Amboina.] (Not *Gryllus* (*Mantis*) *necydaloides* Linnæus.)
1792. *Mantis maculata* Olivier, Encycl. Method., Ins., VII, p. 636. [Amboina.][35] (Not of Thunberg and Lundahl, 1784.)
1802. [*Phasma*] *nævium* Lichtenstein, Trans. Linn. Soc. London, VI, p. 13. [Amboina.][35]

Two rather immature females; Island of Obi, Moluccas. [Coll. of Morgan Hebard.]

One of these specimens has the right anterior limb regenerated, the whole leg not equalling the normal left femur in length. The synonymy of this species is very much involved, but after considerable study *nævia* seems to be the correct name.

Sharp[36] has given some space to a discussion of the names of the species of the genus, but as he did not have the Moluccan form, the question as to a name for it was left unsettled. The nominal species known to date are as follows:

Anchiale nævia (Lichtenstein). Amboina and Obi.

Anchiale stolli Sharp. New Britain.

Anchiale confusa Sharp. New Britain (Westwood credits this form, which he calls *maculata*, to the Sandwich Islands).

The insect figured and described by Blanchard[37] from Warou, on the coast of Ceram, may represent a distinct form.

[35] Based on Stoll's figures.
[36] Willey, *Zoological Results*, I, p. 90.
[37] *Voyage au Pole Sud., Zool.*, IV, p. 358, Orth., Pl. I, fig. 8.

Subfamily HETEROPTERYGINÆ (*Cladomorphinæ* Brunner).

Genus **HETEROPTERYX** Gray.

1835. *Heteropteryx* Gray, Synopsis Spec. Ins. Phasm., pp. 13 and 32.

Type.—*Phasma dilatatum* Parkinson.

Heteropteryx dilatata (Parkinson).

1798. *Phasma dilatatum* Parkinson, Trans. Linn. Soc. London, IV, p. 190, tab. 18. [Asia.]

Two specimens, male and female; Trong, Lower Siam. (Dr. W. L. Abbott.) [U. S. N. M.]

The male of this species has never been described, and appears to be remarkable for the great length of the tegmina and wings. It resembles the male of *mülleri* Haan closer than any other species the male of which is known. From *mülleri* it can readily be distinguished by the shorter mesonotum, the longer tegmina (55 mm.) and wings (70 mm.), and the more ample lateral flaps of the seventh and eighth abdominal segments.

The range of the genus *Heteropteryx* covers Malacca and Trong (*dilatata, castelnaudii, rollandi*), Sumatra (*mülleri*), Java (*rosenbergi*), Borneo (*grayii, dehaanii* and *dilatata*), Celebes (*westwoodii*) and Australia (*australis*).

Genus **DATAMES** Stål.

1875. *Datames* Stål, Recensio Orthopterorum, III, pp. 51 and 93.

Type.—*Acanthoderus oileus* Westwood.

Datames æqualis[38] n. sp.

Type.—♀; Island of Obi, Moluccas. [A. N. S. Phila., presented by Mr. Morgan Hebard.]

Closely allied to *D. mouhotii* Bates[39] from Cambodia, but differing in the peculiar form of the ninth dorsal abdominal segment, and the almost entire absence of oblique ridges on the abdominal segments. The Javan and Malaccan *oileus* Westwood, rather curiously, is not at all closely allied.

Size small; form elongate, tectate, subequal; surface obscurely tuberculate. Head subequal in width, slightly longitudinal; occiput elevated and bearing two converging cristate crenulate ridges, which, when united posteriorly, form a jagged projecting lobe; interocular region with a structure somewhat similar to that found on the occiput, but on a smaller scale, the ridges not meeting posteriorly and being trituberculate, the anterior tubercle developed into a distinct curved

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[38] In allusion to the uniform breadth of the thoracic and abdominal segments.
[39] *Trans. Linn. Soc. London*, XXV, p. 342.

claw-like spine; lateral aspect of the head with a distinct longitudinal rounded ridge passing through the eye; eyes globose, rather small; antennæ equal to the mesonotum and metanotum in length, basal joint triquetrous, subconcave, rectangular, the external margin with a distinct submedian and apical spine, second joint longitudinal, depressed. Pronotum slightly transverse, anterior margin concave, posterior margin truncate; median portion with a pair of longitudinal tuberculous ridges; lateral portions with a broad distinct continuous ridge. Mesonotum two and one-half times the length of the pronotum; median carina sprinkled with tubercles, the anterior and posterior portions each bearing a distinct symmetrically disposed pair; lateral ridge distinct, gently curved upward in the supra-coxal region. Metanotum (including the median segment) two-thirds the length of the mesonotum and similar in structure, except that the anterior portion of the median carina is without tubercles; median segment slightly more than one-fourth of the whole metanotal length. Abdomen almost equal to the head and thorax in length, subequal in width, all segments transverse, the oblique lateral lines present in the other species of the genus subobsolete; median carina very distinct on the fourth and eighth segments, bifurcate on the former, cristate on the latter; ninth dorsal abdominal segment basally rectangular, the posterior median portion produced into a subtriangular process, the apex of which is truncato-emarginate; subgenital opercule reaching to the apex of the eighth dorsal segment, carinate, produced, the apex rounded. Limbs short and stout. Anterior femora about three-fourths the length of the mesonotum, basal flexure slight, but occupying half the entire length, dorsal carina high; tibiæ slightly shorter than the femora; metatarsi not exceeding the succeeding joint in length. Median femora slightly shorter than the metanotum in length, superior margin obscurely trilobate; tibiæ slightly shorter than the femora; metatarsi not different in character from the succeeding joint and but very slightly longer. Posterior femora equal to the median segment and first and second abdominal segments in length, superior margin trilobate, the third low and subobsolete in character; tibiæ slightly shorter than the femora in length; metatarsi as in the median limbs.

General color ochraceous and wood-brown, the two tints irregularly intermingled, and distinctly contrasted in but few places.

Measurements.

Total length,	44	mm.
Length of pronotum,	3	"
Length of mesonotum,	9.1	"

Measurements.

Length of metanotum (including median segment), . . .	6	mm.
Length of abdomen, ...	21.5	"
Length of anterior femora, ...	7	"
Length of anterior tibiæ, ...	5.8	"
Length of median femora, ...	6	"
Length of posterior femora, ...	7	"

Subfamily ANISOMORPHINÆ.

Genus **DECIDIA** Stål.

1875. *Decidia* Stål, Recensio Orthopterorum, III, pp. 57 and 96.

Type.—*Phasma soranus* Westwood.

Decidia soranus (Westwood)?

1859. *Phasma Soranus* Westwood, Cat. Orth. Ins. Brit. Mus., I, p. 127, Pl. XVII, fig. 3. ["In Colombiæ regione frigida Quindensi."]

One immature female; La Paz, Bolivia. [A. N. S. Phila.]

This specimen shows rudiments of the tegmina and wings, and while resembling Westwood's figure of *soranus* very closely in general appearance, it is much smaller (*circa* 45 mm.) than even the immature condition of the specimen would seem to warrant. The metatarsi are much shorter than in the figure of *soranus*, and the probabilities are that mature Bolivian specimens will show the existence of a form distinct from the type species.

Subfamily PSEUDOPHASMINÆ.[40]

Genus **STRATOCLES** Stål.

1875. *Stratocles* Stål, Recensio Orthopterorum, III, pp. 57 and 96.

Type.—*Stratocles cinctipes* Stål.

Stratocles multilineatus n. sp.

Type.—♂; San Carlos, Costa Rica. (Schild and Burgdorf.) [Cat. No. 7,347, U. S. N. M.]

Near *S. forcipatus* Bolivar,[41] with which it agrees fairly well in general measurements, but is separated by a number of other characters. Some slight resemblance appears to exist to the insufficiently described *Phasma bennettii* Gray.

Size small; form moderately elongate. Head slightly depressed, subequal in width; ocelli large; eyes ovate, prominent; antennæ somewhat exceeding the body in length, basal joint subquadrate, second joint cylindrical, equal to the basal joint in length. Pronotum

[40] I have followed Kirby (*Trans. Linn. Soc. London*, n. ser., VI, pp. 473–474) in using this name for the *Phasmidæ* of Brunner.

[41] *Actas Soc. Espan. Hist. Nat.*, XXV, p. 11.

equal to the head in length, longitudinal, subequal except for a slight anterior constriction; anterior and posterior margins subtruncate; cruciform longitudinal and transverse sulci finely marked, but distinctly visible; anterior angles rotundato-emarginate; posterior half with four more or less distinct raised longitudinal ridges. Mesonotum slightly longer than the pronotum, longitudinal, subequal in width, posterior portion considerably but gradually inflated, surface with four longitudinal rows of small tubercles, which posteriorly fuse into rough ridges; mesopleura smooth, with a longitudinal low ridge; mesosternum smooth, rounded. Metanotum twice as long as the mesonotum; metasternum plane. Tegmina ovoid, not half the length of the metathorax, discoidal protuberance rather sharp, longitudinal; apex rather narrowly rounded. Wings large, reaching to the apex of the seventh abdominal segment, slightly over twice as long as wide. Abdomen about half again as long as the head and thorax; the six basal segments longitudinal, gradually decreasing in length toward the apex; seventh dorsal segment transverse, not quite half the length of the sixth; eighth segment about twice the length of the seventh, very much inflated apically; ninth dorsal segment bullate, bearing a shallow median depressed area which gives the plate a bimammillate appearance, apical margin subtruncate; cerci not quite equal to the ninth dorsal segment in length, subequal and slightly depressed basally, acuminate apically; subgenital opercule but slightly shorter than the eighth dorsal segment, and exceeding the apical margin of the same, apical margin evenly rounded with a very slight shallow median emargination. Limbs very slender, the anterior and posterior femora subequal to their respective femora in length. Anterior femora slightly exceeding the entire thorax in length, basal flexure hardly visible; metatarsi very slightly shorter than the remaining tarsal joints. Median femora equal to the mesonotum and metathorax in length; tibiæ somewhat shorter than the femora; metatarsi slightly shorter than the remaining joints of the tarsi. Posterior femora reaching slightly beyond the apex of the fourth abdominal segment; metatarsi slightly shorter than the remaining tarsal joints.

General color of the upper surface slate-black lined and spotted with emerald-green; head with seven distinct longitudinal lines; pronotum with two large irregular blotches on the anterior half, four longitudinal lines on the posterior part, and the entire margins of the same green tint; mesonotum with the lateral ridges and the four distinct rows of tubercles of the overlying tint; tegmina with the basic color solid except in the discoidal and basal regions which are ochraceous-rufous, veins of the costal and posterior fields emerald-green; wings with the costal and discoidal of the same color scheme as the tegmina, posterior field smoky-hyaline, the veins distinctly blackish, the basal portion whitish; abdomen with the upper surface blackish, touched with ochraceous toward the apex. Under surface pale ochraceous, touched with reddish anteriorly and posteriorly. Antennæ blackish with very minute whitish annuli at the apex of each segment, the terminal joint ochraceous-rufous; eyes mottled wood-brown. Limbs with the femora blackish, lined along the carinæ with emerald-green, the proximal portion with the latter color predominating; tibiæ dull blackish-ochraceous; tarsi ochraceous.

Measurements.

Total length,	46	mm.
Length of pronotum,	3	"
Length of mesonotum,	3.7	"
Length of metathorax,	7.8	"
Length of tegmina,	4.5	"
Length of wings,	29.5	"
Length of abdomen,	29	"
Length of anterior femora,	15	"
Length of anterior tibiæ,	14.5	"
Length of median femora,	12.5	"
Length of posterior femora,	15.5	"

Stratocles costaricensis n. sp.

Type.—♀; Costa Rica. (Schild and Burgdorf.) [Cat. No. 7,346, U. S. N. M.]

Apparently related to *Phasma perspicillare* Stoll,[42] from which it differs in the longer limbs and rather different color pattern, which, however, resembles *perspicillaris* closer than any other species.

Size medium; form elongate subfusiform; surface generally velutinous and evenly pilose on the pronotum, mesonotum, limbs and ventral surface. Head suborbicular when viewed from the dorsum, considerably broader than the pronotum; occiput rounded; ocelli of medium size; eyes ovate, moderately prominent; antennæ exceeding the body by over half the length of the latter. Pronotum longitudinal, about twice as long as wide, subequal; anterior and posterior margins subtruncate; cruciform depression very slight. Mesonotum shorter than the pronotum, posterior half sharply yet evenly elevated, width subequal and slightly narrower than the pronotum. Metathorax considerably longer than the prothorax and mesothorax; metasternum plane. Tegmina rather short, irregularly elongate-ovate; costal area large and

[42] *Natuurl. Afbeeld. Besch., Spooken*, pp. 67 and 77, Pl. XXIII, fig. 86.

distinctly emarginate apically; discoidal area with the tubercles compressed, longitudinal, triangular in outline. Wings ample, reaching to the apex of the abdomen in repose, almost twice as long as broad; apex rather narrowly rounded. Abdomen with the six basal segments longitudinal, decreasing in size toward the apex; seventh and eighth dorsal segments each about three-fourths the length of the sixth segment, tectate; ninth segment tectate, slightly shorter than the preceding segment, apex obtuse with a slight median emargination exposing the triangular apex of the supra-anal plate; cerci slender, simple, extending but a slight distance beyond the tip of the ninth segment; subgenital opercule large, cymbiform, extending to the apex of the ninth dorsal segment, apex produced, rectangulate. Limbs moderately slender. Anterior femora injured; tibiæ somewhat shorter than the thorax; metatarsi shorter than the remaining tarsal joints. Median femora equal to the mesothorax and metathorax in length; tibiæ distinctly shorter than the femora; metatarsi about two-thirds the length of the remaining tarsal joints. Posterior femora equal to the four basal segments of the abdomen; tibiæ equal to the femora in length; metatarsi equal to the remaining tarsal joints in length.

General color dull black, becoming brownish-black on the abdomen and limbs; mesonotum, mesopleura, mesosternum, metapleura and metasternum with several obscure lines of dull ochraceous. Femora each with several very obscure annuli of dull ochraceous. Tegmina ochre-yellow, suffused on the apical portion of the discoidal and posterior fields with pale glaucous-green; longitudinal veins of the discoidal and posterior fields apically, and the posterior margin entirely lined with black. Wings with the costal and discoidal regions pale ochre-yellow, fading into pale glaucous-green apically; anterior margin, a spot before the base and the veins of the discoidal area blackish; posterior field with the disk very pale clay color, the periphery and apex dark smoky-hyaline.

Measurements.

Total length,	52.2 mm.
Length of pronotum.	3.7 "
Length of mesonotum,	3 "
Length of metathorax,	9 "
Length of tegmina,	6.7 "
Length of wings,	39 "
Length of abdomen,	31 "
Length of anterior tibiæ.	16.5 "
Length of median femora,	13.1 "
Length of posterior femora.	18 "

Genus **PSEUDOPHASMA** Kirby (*Phasma* Auct.).[43]

1896. *Pseudophasma* Kirby, Trans. Linn. Soc. London, 2d ser., VI, p. 473.

Type.—*Gryllus necydaloides* Linnæus (=*phthisicus* Linnæus).

After examining the literature on the subject, I fully agree with Kirby as to the necessity of a new name for the *Phasma* of most authors.

Pseudophasma phæton n. sp.

Type.—♀; San Carlos, Costa Rica. (Schild and Burgdorf.) [Cat. No. 7,348, U. S. N. M.]

Closely related to *P. urazi* Bolivar[44] from the Rio Atalapo, but differing in the hyaline posterior field of the wings, the longer mesonotum, and the different proportions of the limbs.

Bolivar's *P. perezi*[45] from Coca, Ecuador, also appears to be an allied species.

Size rather large; form very slender and elongate. Head considerably longer than the pronotum, very slightly constricted posteriorly; eyes ovate; antennæ with each joint somewhat thickened apically, basal joint oblong, slightly depressed. Pronotum not quite half the length of the mesonotum, almost twice as long as broad, subequal, anterior and posterior margins subtruncate; anterior angles with a slight emargination caused by a distinct spiraculous aperture; cruciform depression slightly marked. Mesonotum rather elongate, subequal in width; lateral margins each with a distinct longitudinal carina; median portion with a constant slight longitudinal sulcus; surface of the anterior three-fifths sprinkled with rounded tubercles, surface of the posterior two-fifths smooth; mesosternum obscurely tuberculate with a distinct, though irregular, longitudinal carina. Metathorax equal to the mesothorax in length; metasternum strongly longitudinal, and bearing a distinct, but very narrow, median sulcus. Tegmina slightly over three-fourths the length of the mesonotum, subrectangular, the apical margin obliquely truncate; costal margin arcuate; anal margin

[43] The name *Pseudophasma* was proposed almost simultaneously by both Kirby and Bolivar, the former to replace *Phasma* of authors, the latter to designate a new genus near to the one Kirby renamed. Considerable trouble was experienced in ascertaining the exact dates of the respective papers. Kirby's article (*supra*, pp. 447–475) was read December 5, 1895, and in the contents of the volume the date July, 1896, is given. Bolivar's paper (*Actas Soc. Espan. Hist. Nat.*, XXV, pp. 11–18) was presented January 8, 1896, and the date of publication of the part is given on the cover sheet as September 30, 1896. From the *Zoologischer Anzeiger* (*Bibliographia Zoologica*, I, pp. 552 and 650) we learn that Kirby's paper was received first, and this no doubt has priority of a month at least. Accordingly Bolivar's *Pseudophasma* requires another name, and I propose *Ignacia*, as a slight tribute to the worth of a master mind.

[44] *Actas Soc. Espan. Hist. Nat.*, XXV, p. 13.

[45] *An. Soc. Espan. Hist. Nat.*, X, p. 479.

straight; median tubercle elongate and relatively low; venation, except for the principal longitudinal veins, irregularly reticulate. Wings reaching to the middle of the fifth abdominal segment, slightly less than twice as long as broad; marginal costal field with the transverse veins irregularly disposed, all other cross veins (except those of the posterior field) regularly disposed. Abdomen with the six basal segments distinctly longitudinal, the sixth about two-thirds the length of the fifth; seventh segment about two-thirds the length of the sixth, and with the eighth and ninth strongly compressed and distinctly tectate; eighth and ninth segments subequal in length, the latter with the apical margin truncate; cerci equal to the ninth dorsal segment in length, elongate fusiform; subgenital opercule slender, reaching to the middle of the ninth dorsal segment, apex very strongly acuminate. Limbs slender, and relatively small. Anterior femora equal to the head, pronotum and mesonotum in length; basal flexure distinct and occupying slightly more than the basal third; tibiæ equal to the femora in length. Median femora two-thirds the length of the anterior femora; tibiæ about three-fourths the length of the femora; metatarsi about half as long as the remaining tarsal joints. Posterior femora slightly exceeding the apex of the second abdominal segment; tibiæ about four-fifths the length of the femora; metatarsi about three-quarters the length of the remaining tarsal joints.

General color mars-brown, closely and almost uniformly sprinkled with minute specks of vandyke-brown. Head with a distinct postocular streak of ecru-drab, which is bordered superiorly and inferiorly by a line of blackish, genæ ecru-drab; eyes vandyke-brown; antennæ with each joint bearing a distinct apical blackish annulus. Pronotum with a few subobsolete blackish blotches. Mesonotum with the ground color of the anterior tuberculous portion dull cinnamon, several of the larger tubercles blackish, posterior smooth portion suffused with greenish-blue; lateral carinæ dull cinnamon bordered inferiorly by a line of blackish. Metapleura and metasternum dull whitish. Tegmina with an irregular longitudinal blackish line passing to the exterior of the median tubercle. Wings with the costal and discoidal fields of the general color; posterior field hyaline. Limbs irregularly and rather obscurely annulate with mummy-brown on a ground of wood-brown.

Measurements.

Total length,	79	mm.
Length of pronotum.	3.5	"
Length of mesonotum.	9	"
Length of metathorax.	11	"

Measurements.

Length of tegmina,	6.5 mm.
Length of wings,	48 "
Length of abdomen,	49.5 "
Length of anterior femora,	15 "
Length of anterior tibiæ,	15.5 "
Length of median femora,	11 "
Length of posterior femora,	16 "

Pseudophasma phthisicum (Linnæus)?

1758. [*Gryllus* (*Mantis*)] *phthisicus* Linnæus, Syst. Nat., X ed., p. 425. ["In Indiis."]

One male; Carrillo, Costa Rica. [Coll. Morgan Hebard.]

This specimen appears to be referable to this species, though differing considerably in coloration from the descriptions. The S-shaped mark on the tegmina is but little crved, while the posterior part of the tegmina is as black as the general color of the insect. The wings also carry a longitudinal dull ochraceous line along the greater portion of the discoidal region, in continuation of the median line on the tegmina.

The following measurements may be of interest:

Total length,	55.5 mm.
Length of pronotum,	4 "
Length of mesonotum,	4.7 "
Length of metathorax,	9.1 "
Length of tegmina,	6.5 "
Length of wings,	38.5 "
Length of abdomen,	33 "
Length of anterior femora,	17.5 "
Length of anterior tibiæ,	17.5 "
Length of median femora,	15.8 "
Length of posterior femora,	20 "

Pseudophasma menius (Westwood).

1859. *Phasma Menius* Westwood, Cat. Orth. Ins. Brit. Mus., I, p. 118, Pl. XVII, fig. 2. [Colombia.]

Twelve specimens, all males; Carrillo, Costa Rica. [Coll. Morgan Hebard.] Carrillo and San Carlos, Costa Rica. (Schild and Burgdorf.) [U. S. N. M.]

This series ranges from mars-brown to seal-brown in general color, while the posterior field of the wings shows all intermediates between ecru-drab and cinnamon. Size, according to the series examined, appears to be subject to but little variation. Stål[46] has recorded this species from Chiriqui, and Griffini[47] has mentioned a female specimen

[46] *Recensio Orthopterorum*, III, p. 97.

[47] *Bollet. Mus. Zool. Anat. Comp.*, Torino, XI, No. 236, p. 2.

from the vicinity of the Rio Cianati, Darien, localities which connect those above mentioned and that of the type.

Pseudophasma cryptochlore[48] n. sp.

Type.—♂; San Carlos, Costa Rica. (Schild and Burgdorf.) [Cat. No. 7,349, U. S. N. M.]

Apparently closely allied to *P. gambrisius* (Westwood),[49] from Venezuela, but differing in the structure of the apex of the abdomen, the shorter mesonotum and quite different coloration. Relationship also exists with *prasinum* (Serville) and *pholcus* (Westwood).

Size small; form slender. Head slightly longitudinal, subequal, considerably wider than the pronotum; occiput with several fine longitudinal lines; ocelli very distinct, the anterior one considerably in advance of the others; eyes subglobose, very prominent; antennæ equal to the body in length, first and second joint cylindrical, the latter considerably smaller and shorter than the basal joint, third joint equal to the fourth and fifth together. Pronotum about two-thirds the length of the mesonotum; anterior and posterior margins subtruncate; cruciform impression slight, the transverse arm toward the lateral margins deflected posteriorly; anterior angles normal though spiraculiferous. Mesonotum rather short and slender, slightly and evenly constricted toward the middle; surface sparsely granulate; median longitudinal sulcus slight but distinct; mesosternum rugulose with a distinct, though somewhat irregular, median carina. Metathorax about equal to the prothorax and mesothorax in length, beneath with a slight median sulcus. Tegmina not more than half the length of the metathorax, ovate; median tubercle low and somewhat elongate; longitudinal veins rather regularly disposed, transverse veins irregularly placed and producing a reticulate effect. Wings almost equal to the body in length, twice as long as broad; costal area with the transverse veins rather regularly disposed. Abdomen with the six basal segments longitudinal, very gradually decreasing in size toward the apex; seventh and eighth segments subequal in length, each shorter than the sixth; ninth segment rather shorter than the eighth, apically subtruncate; cerci rather short, terete, slightly curved; subgenital opercule slightly exceeding the apex of the eighth dorsal segment, cymbiform, the margin rounded, but developed into a distinct lip or rim. Limbs of moderate length, the anterior and median femora considerably exceeding their respective tibiæ in length. Anterior femora equal to the pronotum,

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[48] κρυπτος, *hidden*, and χλωρος, *green*, in allusion to the green of the ventral surface.

[49] *Catal. Orth. Ins. Brit. Mus.*, I, p. 118, Pl. XIV, fig. 2.

mesonotum and tegmina in length; metatarsi slightly shorter than the remaining tarsal joints in length. Median femora about equal to the pronotum and mesonotum in length; metatarsi equal to the three succeeding joints in length. Posterior femora not quite reaching the apex of the third abdominal segment; tibiæ slightly shorter than the femora; metatarsi about equal to the remaining tarsal joints in length.

General color above dull blackish; eyes umber; ocelli dull luteous; antennæ blackish, toward the apex bearing two broad annuli of obscure whitish, which is almost entirely due to the silvery pubescence. Tegmina with the principal longitudinal veins lined with pale greenish; wings with the costal and discoidal areas blackish, the longitudinal veins of the lateral regions lined with apple-green, posterior field of the wings blackish-hyaline, clear whitish basally, the area of the latter tint being comparatively small. Abdomen blackish, becoming dull brownish on the anterior portion of the ventral surface. Ventral and pleural surfaces of the thoracic segments apple-green. Limbs apple-green with the distal portion of each joint blackish, this color on the anterior limbs being very extensive and considerably limiting the greenish area.

Measurements.

Total length,	40	mm.
Length of pronotum,	2.5	"
Length of mesonotum,	4	"
Length of metathorax,	6.1	"
Length of tegmina,	3.5	"
Length of wings,	28	"
Length of abdomen,	25.5	"
Length of anterior femora,	10.5	"
Length of anterior tibiæ,	7	"
Length of median femora,	6.5	"
Length of posterior femora,	10	"

A paratype male has also been examined.

Pseudophasma cyllarus (Westwood).

1859. *Necroscia Cyllarus* Westwood, Catal. Orth. Ins. Brit. Mus., I, p. 155, Pl. XIII, fig. 2, Pl. XIV, fig. 5. [Jamaica.]

One male; Kingston, Jamaica. (T. D. A. Cockerell.) [U. S. N. M.] This species falls quite naturally into this genus, but that it is very aberrant there can be no doubt.

Genus **PLANUDES** Stål.

1875. *Planudes* Stål, Recensio Orthopterorum, III, pp. 59 and 98.

Type.—*P. perillus* Stål.

Planudes crenulipes n. sp.

Type.—♀; Tucurrique, Costa Rica. (Schild and Burgdorf.) [Cat. No. 7,350, U. S. N. M.]

Allied to *P. paxillus* (Westwood)[50] and *P. perillus* Stål.[51] From the former it differs in the absence of distinct spines on the head, the more ovate tegmina, the much longer wings, the slightly longer mesonotum and the lobate posterior femora. From the latter it differs in the larger tegmina and wings, the rather different coloration of the wings, the smaller size, and apparently in the lobate posterior femora, although Stål does not state the condition of the limbs in the specimen examined.

Size medium; form elongate; surface rugoso-tuberculate. Head longitudinal, equal in width and not broader than the pronotum; occiput with the tubercles rather low and grouped into longitudinal series, the median pair of which diverge posteriorly; eyes globose, rather small, prominent; antennæ slightly exceeding the head and thorax in length, basal joint rather oblong, slightly depressed. Pronotum slightly longer than the head, subequal; anterior and posterior margins truncate; tubercles of even size, disposed in distinct longitudinal series; longitudinal sulcus very slight, transverse sulcus broad and shallow, but very marked. Mesonotum slightly over twice the length of the pronotum, gradually expanding posteriorly, surface rugoso-tuberculate; metapleura finely rugulose; metasternum with an irregular median longitudinal carina. Metathorax about as long as the mesothorax, rather sparsely tuberculate. Tegmina elliptical; veins irregularly reticulate; median protuberance high, blunt, the posterior portion curved inward toward the anal margin. Wings four times as long as the tegmina, reaching to the middle of the fourth abdominal segment, not quite twice as long as wide; venation rather regular proximally becoming subreticulate distally. Abdomen over half again as long as the head and thorax, the six basal segments longitudinal, the first and second shorter than the succeeding divisions; seventh segment subquadrate; eighth and ninth segments distinctly transverse, the latter shorter than the former, and with the apical margin subtruncate and distinctly crenulate; cerci very short, slight and simple, lateral in position; subgenital opercule short, reaching the apex of the seventh dorsal segment, carinate, apex acuminate. Limbs short. Anterior femora about equal to the mesonotum in length, margins crenulate; tibiæ slightly shorter than the femora, margins crenulate; metatarsi not more than half as long as the remaining tarsal joints. Median femora

[50] *Catal. Orth. Ins. Brit. Mus.*, I, p. 127, Pl. XI, fig. 5.
[51] *Rec. Orthopt.*, III, p. 98.

slightly shorter than the anterior tibiæ in length, margins very slightly crenulate; tibiæ slightly over two-thirds the length of the mesonotum, margins moderately and irregularly crenulate; metatarsi less than half the length of the remaining tarsal joints. Posterior femora about equal to the mesonotum in length, superior margins dentato-crenulate, the anterior one with the processes very large, inferior margins with distinct rounded foliaceous lobes; tibiæ slightly shorter than the femora, the superior margins with distinct hemispherical lobes; metatarsi about half as long as the remaining tarsal joints.

General color olive, irregularly blotched and sprinkled with patches of wood-brown and bearing a very pale suffusion of pea-green on the wings and tegmina. Wings with the base of the costal and the whole discoidal area suffused with a wash of vinaceous pink; posterior area pale smoky-hyaline, the veins pale brownish, the whole surface bearing an indefinable bloom of pinkish vinaceous, best seen by viewing the wing obliquely.

Measurements.

Total length,	63	mm.
Length of pronotum,	4	"
Length of mesonotum,	8	"
Length of metathorax,	8.5	"
Length of tegmina,	7	"
Length of wings,	26	"
Length of abdomen,	40	"
Length of anterior femora,	9.5	"
Length of anterior tibiæ,	8.5	"
Length of median femora,	7	"
Length of posterior femora,	8	"

Genus **XEROSOMA** Serville.

1831. *Xerosoma* Serville, Ann. Sci. Nat., XXII, p. 61.

Type.—*Xerosoma canaliculatum* Serville.

Xerosoma glyptomerion[52] **n. sp.**

Types.—♂; San Carlos, Costa Rica. (Schild and Burgdorf.) [Cat. No. 7,351, U. S. N. M.] ♀; Carrillo, Costa Rica. [A. N. S. Phila., presented by Mr. Morgan Hebard.]

Apparently closer allied to *senticosa* Stål[53] than any other member of the genus, but still very distinct. It can readily be separated by the absence of distinct spines on the pronotum, the greater number of cephalic spines, the shorter mesonotum of the female and a number of other characters.

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[52] *γλυπτος, sculptured,* and *μηριον, thigh.*

[53] *Recensio Orthopterorum,* III, p. 99.

♂.—Size rather small; form elongate; surface generally rugulose. Head moderately elongate, subequal; occiput with four distinct spiniform processes; interocular region with three triangularly disposed rather blunt processes, the anterior one smaller than the other two, and bearing upon their summits the ocelli; eyes subglobose, very prominent; antennæ equal to the body in length, first and second joint about equal in length, the basal joint somewhat depressed; whole surface with a number of evenly distributed spiniform tubercles. Pronotum about equal to the head in length, rather narrower than the head, subequal in width, anterior angles with a slight projecting process; anterior and posterior margins truncate; cruciform depression with the transverse arm stronger than the longitudinal branch. Mesonotum about twice the length of the pronotum, subequal in width, somewhat elevated posteriorly; median longitudinal sulcus very distinct posteriorly, obsolete anteriorly; surface rugoso-tuberculate, four spiniform symmetrically disposed tubercles flank the median line; mesosternum rugose. Metathorax about equal to the pronotum and mesonotum in length, metapleura and the metasternum sparsely and weakly tuberculate. Tegmina about equal to the metathorax in length, cylindrical-ovate in outline, the base and apex produced and angulate; median protuberance very distinct, high, rounded, compressed; veins subreticulate, surface rather coriaceous. Wings extending to the middle of the sixth abdominal segment, twice as long as broad; apex subrectangulate. Abdomen with the six basal segments longitudinal, decreasing in length distally; seventh dorsal segment two-thirds the length of the sixth; eighth segment considerably shorter than, and ninth about equal to, the seventh segment, the latter compressed, subrostrate and with the apical margin with a shallow median V-shaped emargination; cerci slender, straight and equal to the ninth dorsal segment in length; subgenital opercule slightly exceeding the apical margin of the eighth dorsal segment, basally bullate, apical portion compressed, rather rostrate, the apex itself with a shallow triangular emargination. Limbs slender and simple; tibiæ about equal to their respective femora in length. Anterior femora equal to the tegmina, mesonotum and half of the pronotum in length, basal flexure marked; metatarsi slightly shorter than the remaining tarsal joints. Median femora about equal to the pronotum and mesonotum in length; metatarsi slightly shorter than the remaining tarsal joints. Posterior femora reaching to the middle of the third abdominal segment; metatarsi very slightly shorter than the succeeding joints.

General color dull paris-green and prout's-brown intermingled.

Head with the spines clear green; eyes walnut-brown; antennæ greenish, each segment with a narrow apical annulus of brown. Mesonotum with the larger spines tipped with clear brown. Tegmina with the median protuberances clear green. Wings with the costal and discoidal regions bearing strongly contrasted blotches of the two colors washed with an ochraceous tint; posterior field smoky-hyaline. Limbs with the usual coloration, but the tibiæ have the green clear and vitreous.

♀.—Size medium; form moderately elongate; surface rugoso-tuberculate. Head somewhat longitudinal, subequal in width; occiput bearing about twelve formidable spines ranged in four longitudinal series, of which the median pair contain the greatest number of spines and the posterior ones of which are recurved and considerably larger than any of the others; interocular region with the ocellar spines much reduced, the anterior one practically obsolete, the ocellus but slightly raised above the surrounding surface; eyes subglobose, moderately prominent; antennæ with the basal joint strongly depressed; entire dorsal surface sprinkled with small spiniform tubercles. Pronotum slightly shorter than the head, very strongly emarginate over the anterior coxæ; anterior margin broadly and evenly emarginate, posterior margin truncate; median line flanked by a longitudinal row of several short spines. Mesonotum not quite twice the length of the pronotum, subequal in width; no median carina or sulcus present; surface strongly rugoso-tuberculate; mesopleuræ and mesosternum rugoso-tuberculate, the lower margins of the former and the lateral borders of the latter bearing distinct tuberculous ridges. Metathorax slightly longer than the other thoracic segments together; metasternum obsoletely tuberculate; metapleuræ bearing along their lower margins a series of four distinct rounded tubercles. Tegmina equal to the head, pronotum and mesonotum in length, elongate-elliptical; apex narrowly rounded; tubercle placed distinctly anterior to the middle, high, rounded, compressed; surface coriaceous, subreticulate, and bearing a number of small node-like projections. Wings about equal to the abdomen in length; costal and discoidal areas with the transverse nervures rather regular in character. Abdomen depressed, each segment with the lateral margins developed into a more or less crenulate foliaceous flap; the five basal segments longitudinal, the fifth broader than the others; sixth segment quadrate; seventh, eighth and ninth segments transverse, decreasing in length distally, median carina present on the seventh and represented by two parallel ridges on the eighth, ninth segment crenulato-truncate; cerci slender, almost equal to the ninth dorsal segment in length, apex blunt; subgenital opercule rather short, reaching to the middle of the eighth dorsal segment, V-shaped in section, the apex subtruncate with a triangular median projection. Limbs rather short;[54] tibiæ about equal to their respective femora in length; femora with nearly all their carinæ bearing distinct subdentiform lobes, those of the superior carinæ being the more prominent; tibiæ with superior margins only bearing such lobes. Anterior femora almost equal to the tegmina in length, basal flexure distinct and strongly bowed, superior external margin bearing five lobes,[55] superior internal margin four lobes, the inferior internal margin none, the inferior external margin ten; tibiæ bearing four very large and distinct lobes on the external margin, internal margin with four smaller lobes placed in juxtaposition to those of the external margin; metatarsi considerably shorter than the remaining tarsal joints, and bearing several small jagged lobes on its superior surface. Median femora equal to the mesonotum and half of the metanotum in length, superior margins with five lobes placed in juxtaposition, inferior margins with four distinct lobes placed as on the superior carinæ, median carina of the lower surface with several obsolete lobes; tibiæ with five more or less distinct lobes placed as on the anterior limbs; metatarsi not exceeding the second and third tarsal joints in length, unarmed.

General color olive and drab, intermingled and suffused on the head, portions of the thorax and anterior limbs with very pale cinnamon. Eyes walnut-brown. Tegmina pale paris-green, which becomes rather clear and subvitreous on the protuberances.

Measurements.

	♂		♀	
Total length,	54	mm.	65	mm.
Length of pronotum.	2.6	"	3	"
Length of mesonotum.	6.2	"	6.5	"
Length of metanotum.	8.1	"	11	"
Length of tegmina,	8	"	14	"
Length of wings,	33	"	50	"
Length of abdomen.	33	"	49	"
Length of anterior femora,	14.5	"	13	"
Length of anterior tibiæ,	14.5	"	12	"
Length of median femora,	8.5	"	8	"
Length of posterior femora,	12	"		

Further study may possibly show that the two sexes here described as one species represent two forms. In such a case the name can be restricted to the male.

[54] Posterior pair missing in the type.

[55] As the left leg appears abnormal in a number of ways, these figures have been taken from the right limb.

Genus **METRIOTES** Westwood.

1859. *Metriotes* Westwood, Catal. Orth. Ins. Brit. Mus., I, p. 158.

Type.—*Metriotes diocles* Westwood.[56]

Metriotes agathocles Stål.

1875. *M[etriotes] Agathocles* Stål, Recensio Orthopterorum, III, p. 100. ["Australia? Sine dubio species americana."]

One female; Costa Rica. (Schild and Burgdorf.) [U. S. N. M.]

This specimen fully agrees with the very insufficient description of the specimen Stål had in hand, but unfortunately the anterior limbs are missing, and a portion of Stål's diagnosis treats of these appendages.

Genus **PRISOPUS** St. Fargeau and Serville.

1825. *Prisopus* St. Fargeau and Serville, Encyc. Method., Insect., X, p. 444.

Included *Prisopus draco* Olivier (=*Phasma nympha* Stoll) and *sacratus* Olivier (=*Phasma flabelliformis* Stoll).

Prisopus berosus Westwood.

1859. *Prisopus Berosus* Westwood, Catal. Orth. Ins. Brit. Mus., I, p. 168, Pl. XX, fig. 7. ["Litt. occid. Americæ septentrionalis. Panama."]

Two specimens; ♂ and immature female: Nicaragua. [U. S. N. M.] Carrillo, Costa Rica. [Coll. Morgan Hebard.]

Subfamily PHYLLINÆ.

Genus **PHYLLIUM** Illiger.

1798. *Phyllium* Illiger, Verzeichniss Käfer Preussens, p. 499.

Type.—*Mantis siccifolia* Fabricius = *Gryllus* (*Mantis*) *siccifolius* Linnæus.

The three species treated below all belong to Griffini's subgenus *Pulchriphyllium*.[57]

[56] Westwood's genus included the following species:
stollii.
blanchardi.
santara—Isagoras Stål, 1875.
bubastes—Isagoras Stål, 1875.
obscura—Isagoras Stål, 1875.
dictys—Prexaspes Stål, 1875.
myrsilus.
diocles.
venosa.
acuticornis.
servillei—Prexaspes Stål, 1875.
brevipennis.
rugicollis.
Of these *diocles* can be selected as the type.

[57] *Bollettino Musei Zool. ed Anat. Comp.*, Torino, XIII, No. 312, p. 2.

Phyllium bioculatum Gray.

1832. [*Phyllium*] *bioculatum* Gray, in Griffith's Anim. Kingdom, XV, p. 191, Pl. 63, fig. 3. [Locality unknown.]

One female; Seychelles. (Dr. W. L. Abbott.) [U. S. N. M.]

This specimen is of a very pale yellowish-green color.

Westwood[58] states regarding this species that the "male seems to me scarcely to differ materially from that of *Ph. Scythe.*" Such is by no means true of the female, as this sex of the two species presents very different appearances.

Phyllium pulchrifolium Serville.

1839. *Phyllium pulchrifolium* Serville, Orthoptères, p. 292. [Java.]

Three specimens; two adult females, one immature male:

Java. [A. N. S. Phila.]

Near Buitenzorg, Java, July, 1897. (D. G. Fairchild.) [U. S. N. M.] "Collected on leaves of *Nephelium lappaceum.*"

The female from Buitenzorg has the tegmina and limbs wood-brown, while the body is faded greenish. Information with the specimen states the color is due to imperfect drying. While this is quite likely true of the body, it is hardly probable that the tegmina have changed. In the event of the specimen having possessed brown tegmina, it would approach the brown variety described by Lucas[59] from Batavia.

Phyllium scythe Gray.

1843. *Phyllium Scythe* Gray, Zoologist, I, p. 122, figure (on page 121). [Sylhet.]

One female; Trong, Lower Siam. (Dr. W. L. Abbott.) [U. S. N. M.]

This specimen differs slightly from the figure given by Westwood,[60] the apex of the abdomen being more constricted, in fact somewhat approaching *pulchrifolium* in this respect. After carefully examining the literature, it appears very much as if the *scythe* and *pulchrifolium* were simply geographic races of the same species, the Trong specimen being a direct intermediate, both structurally and geographically. Gray's reference of Haan's figure[61] of *pulchrifolium* to *scythe* appears erroneous, as the form of the abdomen and almost all the accessory lobes of the limbs represent true *pulchrifolium.* The Trong specimen has the right posterior limb regenerated and about one-fifth the normal size.

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[58] *Catal. Orth. Ins. Brit. Mus.*, I, p. 175.

[59] *Bull. Soc. Ent. France* (5), VII, p. xxxiii.

[60] *Catal. Orth. Ins. Brit. Mus.*, I, Pl. XXXI, fig. 2.

[61] *Natuurl. Gesch. Nederl. Overzeesche Bezitt.*, Insecta, Pl. XV, fig. 6.

Another specimen, a very immature female, from Khow Sai Dow, Trong, collected in January or February, 1899, by Dr. Abbott, may be referable to this species, but considering the condition of the specimen a positive determination is impossible.

Remarks on the General System of the Family.

While not prepared to bring forward any very radical departures from Brunner's table of the divisions of this group,[62] it may not be out of place to mention the impressions received while studying the material herewith recorded. Brunner's *Lonchodidæ, Bacunculidæ* and *Bacteridæ* appear to be much closer related than his arrangement would lead one to suppose. The *Heteroneminæ* (*Bacunculidæ* Brunner) is very close to the *Bacterinæ;* in fact, it is extremely difficult to settle into which division to put certain genera, and this is so marked that Kirby has transferred some genera placed by Brunner in the *Bacunculidæ* to the *Bacterinæ.*

The genera *Phyllium* and *Chitoniscus* are such extremely aberrant types that the division including them should have higher taxonomic rank than generally accorded to it.

Laying aside the question as to whether the divisions should be of family or subfamily rank, it appears evident that Brunner's *Lonchodidæ, Bacunculidæ* and *Bacteridæ* are simply divisions of a group not exceeding in rank the well-marked *Necroscidæ.* Again, the *Phyllidæ* should have a rating practically equal to the other members of the "Phasmodea," a position warranted by its extreme differentiation.

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[62] *Ann. Mus. Civ. Stor. Nat. Genova,* XXXIII, pp. 79–81.

THE ROSES OF PECOS, NEW MEXICO.

BY T. D. A. COCKERELL.

Pecos, New Mexico, is on the upper Pecos river, about 6,800 feet above sea level and no very great distance from Santa Fé. It has essentially the flora made familiar to botanists everywhere by the collections of Fendler and Heller, the cañon a few miles above the village furnishing *Galpinsia fendleri* (Gray), *Cereus triglochidiatus* Engelm., *Sphæralcea fendleri* Gray, *Viola neomexicana* Greene, *Berberis fendleri* Gray, *Linum australe* Heller, *L. puberulum* (Engelm.), *Verbena macdougali* Heller, *Philadelphus microphyllus* Gray (the flowers of which have an odor like that of spoiled oranges), *Salix irrorata* Anders., *Sidalcea neomexicana* Gray, etc., etc. The bottom land through which the Pecos river flows is thickly wooded for a few miles on the Kin Kale Ranch, the trees being *Populus angustifolia* James, with a mixture of willows, *Alnus tenuifolia* Nuttall, and on the outskirts *Quercus novomexicana* (A.DC.), *Q. leptophylla* Rydberg (new to New Mexico), etc. Under the shade of the trees it is cool and moist, so that members of the Canadian zone flora are able to grow, while a few hundred yards away the dry bluffs possess a typically austral and xerophytic assemblage of plants. As a result of these conditions the locality, taken as a whole, is remarkably rich in species of both plants and animals. The roads and cultivated fields are skirted by oak-bushes, including the peculiar *Quercus havardi* Rydberg, only known previously from Texas. Roses are abundant, and a few species of climbing plants (*Clematis ligusticifolia* Nutt., *Humulus lupulus neomexicanus* Nelson and Ckll., *Parthenocissus quinquefolia* (L.) Planch) are very conspicuous. The common weeds include *Grindelia inornata* Greene, *Lathyrus decaphyllus* Pursh, *Argentinia anserina* (L.), *Vicia americana* Muhl., *Salsola tragus* L., *Anogra coronopifolia* (T. and G.), *Verbascum thapsus* L., *Erodium cicutarium* (L.), *Physalis pubescens* L., *Allionia viscida* (*Oxybaphus angustifolius* var. *viscidus* Eastwood, *Pr. Cal. Ac. Sci.*, 1896, p. 313), *Solanum jamesii* Torrey, *Helianthus petiolaris* Nutt., *H. annuus* L., etc. Quite a surprise was the discovery of a large quantity of *Chrysanthemum leucanthemum* in a field on the Kin Kale Ranch, this plant being hitherto unknown in New Mexico. The austral *Solanum elæagnifolium* was seen growing near Harrison's Store, while *Sophia halictorum* Ckll. (with the beetle *Phyllotreta pusilla* Horn, living upon it), occupied the roofs of adobe houses in the village. At the Old Pecos Pueblo, a few miles to the south, we found *Astragalus simulans* Ckll., hitherto only known from Las Vegas. *Malvastrum cockerelli* A. Nelson, was very common on the Kin Kale Ranch; so also was the beautiful *Touterea rusbyi* (Wooton). *Fallugia acuminata* (*F. paradoxa acuminata* Wooton) and *F. acuminata micrantha* (*F. micrantha* Ckll.) formed large patches, and were very attractive to insects. The scarlet *Castilleia integra* Gray, with the large-bracted form *intermedia* Ckll., were very conspicuous. A single plant of *Datura tatula* L., is worth recording; it is, of course, an accidental introduction. *Onosmodium thurberi* Gray, grew in some quantity by the Pecos river.

Spending a summer in this beautiful place, I took the opportunity to study the native roses. The result of this study is here presented, not because I have reached any final or dogmatic opinions, but because it seems that field-study in many different localities is the only method whereby the species of the group Cinnamomeæ will ever be understood. When we have accumulated a sufficient number of observations on the living plants, some talented botanist may find himself able to tell us what they all mean; but for the present observations are perhaps of more consequence than deductions.

A large part of the material studied was collected and brought to me in the living state by Dr. M. Grabham, of Jamaica, who spent part of the summer at Pecos. I was able to distinguish three main forms, two of which are here introduced as new. While it is difficult, if not impossible, to state definitely how many valid species exist among the Cinnamomeæ, it seems much better to designate the recognizable forms by name, than to lump them indiscriminately under the few specific titles. It is just this process of lumping which has made so much confusion, the same name being applied to a different plant by each of several authors. The characters of the three forms referred to may best be set forth in parallel columns.

Rosa arkansana Porter, var. *a*.	*R. prætincta*, n. sp. (or var.?).	*R. pecosensis*, n. sp. (or var.?).
Low bush.	Rather low bush.	Usually high bush.
Flowers about 45 mm. diam., pink, petals white at base.	Flowers pale pink.	Flowers about 50 mm. diam., deep crimson, petals white at base.
Flowers many together. Anthers longer.	Flowers usually in threes (2+1), sometimes 2 only, sometimes 4.	Flowers in pairs, or often single. Anthers shorter.
Stigmas pinkish in bud, without any pink in open flower.	Stigmas deep red in bud, pale pinkish in open flower.	Stigmas pinkish in bud, pale yellow in open flower.
Sepals foliolar-tipped, narrow, with woolly edges, entire, with many reddish stout gland-hairs beneath and on the sides of the apical half.	Sepals quite glandular, the outer with linear lobes.	Sepals foliolar-tipped, narrow, with woolly edges, with linear lateral lobes, and wholly without reddish gland-hairs.
Sepals very long (up to 21 mm.), projecting far beyond bud.	Sepals short (up to 13 mm.), not projecting much beyond bud.	Sepals medium (up to about 15 mm.), projecting moderately beyond bud.
Fruit (Aug. 13) smooth, globose, neckless, the sepals erect.	Fruit globose.	Fruit globose, 8 mm. diameter, with hardly any neck; sepals persistent, erect, but reflexed immediately after flowering
Buds very glandular. Peduncles glabrous, shining.	Buds glandular.	Buds minutely pubescent, not glandular. Peduncles sparsely sublanate with scattered hairs.
Prickles slender and scattered on stems; few and scattered on flowering branchlets; straight.	Prickles on old growth few and straight; green parts unarmed.	Prickles slender and scattered on stems; few and scattered on flowering branchlets, where they are more or less hooked.
Infrastipular spines none, or not distinguishable from the others.	No infrastipular spines.	Infrastipular spines absent, or sometimes present in pairs, all on same branch.
Stipules broad (diam. about 12 mm.), resinous, not villous.	Sitpules often narrow.	Stipules narrow (diam. about 6 mm.), sparingly villous beneath, not glandular.

Rosa arkansana Porter, var. *a.*	*R. prætincta*, n. sp. (or var.?).	*R. pecosensis*, n. sp. (or var.?).
Petioles glabrous, with numerous knobbed gland-hairs.		Petioles minutely pubescent, not glandular.
Leaflets 7 on flowering branches, 9 on new shoots from base.	Leaflets commonly only 5, often 7, often 5+ an odd basal one.	Leaflets 7, sometimes 9, sometimes 5, with an odd basal leaflet making 6.
Leaflets mostly smaller and broader, *e.g.*, 20 mm. long, 16 broad; lateral leaflets almost sessile, except on basal shoots; midrib beneath glabrous, with numerous short red gland-hairs; serrations minutely serrulate, with numerous small knobbed glands.	Leaflets unusually long and narrow, *e.g.*, 25 mm. long, 13 broad; cuneate at base; resin-dotted beneath, midribs without obvious gland-hairs; serrations deep and simple, margin without gland-hairs.	Leaflets mostly larger and narrower in proportion, *e.g.*, 33 mm. long, 20 broad; lateral leaflets distinctly petiolulate; midrib beneath lanulate with short hairs, not glandular; serrations simple, sharp, margin minutely hairy, not glandular.

All these plants have dull green foliage, not shiny, as Elias Nelson describes *R. woodsii*. This also separates them from *R. neomexicana* Ckll., of southern New Mexico, described in *Entomological News*, February, 1901, p. 41.[1] This *Rosa neomexicana* is further distinguished by the oblong fruits, which are small and scarlet, with persistent erect sepals. It also has normally pairs of infrastipular spines, and mostly solitary flowers.

Rosa pecosensis is one of the most beautiful roses known to me. The type was collected by my wife and Dr. Grabham, about six miles up the cañon above the Kin Kale Ranch, June 1, 1903; but the plant is also common down as far as the village of Pecos. When the flowers first open the petals are depressed, so that they lie below the plane, the surface of the flower becoming convex. A curious character observed is the presence of a deep notch in one petal only, always an inner one. The flowers vary in size down to about 42 mm. diameter, or occasionally only 37 mm.

If the three roses described above always held their characters, there would be no hesitation about regarding them as distinct species. Specimens occur, however, which vary in different ways, and some of them

[1] The article containing this description was intended for *Proc. Acad. Nat. Sci. Phila.*, but was transferred to the *News*, for which it is altogether too botanical.

appear to connect the main types. It is possible that this may in part be the result of hybridization, but we are not entitled to assume this without better evidence. The observed variations are as follows:

Rosa pecosensis.

(1) Upper Pecos-town, June 19. Flowers very fragrant, about 37 mm. diameter; sepals entire, rarely with linear lobes; leaflets minutely resin-dotted beneath; leaflets on basal sheets sometimes eleven. Infested sparingly by *Eulecanium.*

(2) Kin Kale Ranch, June 21 (Grabham). Flowers bright pink, not so dark as some; 45 mm. diameter; no strongly notched petal; sepals rarely with linear lobes; stipules 5 mm. broad or rather more; leaflets 7.

(3) Kin Kale Ranch, June 21. (Grabham.) As usual, except that the sepals sometimes show some marginal red knobbed gland-hairs.

(4) Kin Kale Ranch, June 21. (Grabham.) Flowers very deep red; outer sepals with quite a number of red gland-hairs; midribs of leaflets beneath with scattered very short and minute red gland-hairs; leaf-margins inclined to be doubly serrate, the secondary serrations gland-tipped; leaflets almost sessile; flowers single. This is in many respects like the *R. arkansana* var. *a*, and could be a hybrid, if hybrids occur.

(5) Kin Kale Ranch, June 21. (Grabham.) Typical, but stipules variable up to 8 mm. broad.

(6) Kin Kale Ranch, June 21. (Grabham.) Flowers paler, rose-pink, about 36 mm. diameter; leaves unusually large (upper lateral leaflets up to 33 mm. long); midribs of leaflets lanulose beneath, with only rudimentary gland-hairs; leaflets deeply and simply notched; sepals lanulose, not glandular, with linear lateral lobes; flowers solitary or in pairs; stigmas yellowish in rather advanced bud. This is essentially *pecosensis*, the only material difference being in the paler flowers. Seen from a distance, the flowers of *R. pecosensis* always appear single, as one bud of a pair comes out before the other. The plants are sometimes infested by prickly leaf-galls, of the species *Rhodites spinosellus* Ckll.

Rosa prætincta.

No varieties were found. In Watson's table this species runs to *R. blanda*, except that the sepals are not entire. In Crépin's table it also runs to *blanda*, except that the flowers are comparatively small. There is no *R. blanda* in New Mexico, however.

Rosa arkansana var. *a*.

I had considered this to be the true *R. fendleri* of Crépin, not of S. Watson. Dr. Rydberg, to whom I sent a copy of my description, wrote that he could not agree with this, but that I apparently had the long-lost *R. arkansana* Porter, only certainly known by the original collection by Brandegee. As this seems reasonable, I provisionally call my plant *arkansana*, the more willingly since the name has priority over *fendleri*, supposing them to refer to one species. The material described above grows by a small irrigation ditch in open unshaded ground, which except for the ditch is very dry. On August 13 a fruiting bush of the same species was found close to the Pecos river, more or less in the shade. It possessed the following characters:

Fruit very shiny, smooth, globose (long. 9½, lat. 9, to long. 12, lat. 10 mm.), slightly longer than broad, without the slightest indication of a neck. Sepals erect, 15 mm. long, some with linear lobes; the margins woolly, the dorsal surface with loose arachnoid hairs and scattered gland-hairs. Peduncles perfectly glabrous and somewhat glaucous, 5–10 mm. long. Infrastipular spines variable, present or absent. Spines on flowering branchlets straight. Stipules very narrow, diameter 2–4 mm., beneath with loose arachnoid hairs and short reddish-gland-hairs; petioles minutely pubescent, with scattered short red gland-hairs; leaflets 7 to 9, rather narrow (*e.g.*, long. 23, lat. 12½ mm.), resin-dotted beneath, simply toothed, edges not glandular, lateral leaflets briefly petiolulate. A low bush.

It will be seen that this in many respects approaches *R. pecosensis*. *R. arkansana*, var. *a*, was infested by an aphid, which appears to be identical with *Myzus rosarum* Walker.

In order to appreciate the characters of the Pecos roses, it is necessary to review the described North American species of the same group, and also certain forms occurring in other parts of New Mexico.

The Described Species.

(1) **Rosa grosseserrata** E. Nelson.

Bot. Gaz., August, 1900, p. 119.

Type from the Yellowstone Park, collected in fruit. I am indebted to Prof. Aven Nelson for a specimen. This is quite like typical *R. pecosensis* in the serrations and pubescence of the leaves; the serrations are long and pointed, perfectly simple and not glandular. The stipules are broader than in *pecosensis*. The fruit is considerably larger, about 12 mm. diameter. The author of this species-name thinks the plant is intermediate between *R. pisocarpa* and *R. woodsii*, and I believe that it is not so close to *pecosensis* as the resemblance of the leaves might suggest. The absence of paired infrastipular spines or prickles seems to remove *R. grosseserrata* from the vicinity of *R. pisocarpa* and *woodsii*, but I am convinced that the value of this character has been much exaggerated. Crépin in his table (1896) indicates the variability of *pisocarpa* in this respect.

(2) R. arkansana Porter.

Much emphasis has been placed upon the statement in the original description that the sepals are reflexed in fruit. This seems to distinguish my plant from the true *arkansana* (the fruit was unknown when I consulted Dr. Rydberg), but I strongly suspect that, as is usual in the group, the sepals are more or less reflexed at first, but ultimately erect. Another discrepancy is in the leaflets, which are 9 to 11 in true *arkansana*, but 7 to 9 in my plant. The other characters seem very similar in both plants.

(3) R. fendleri Crépin.

I regret very much that I cannot make sure of *fendleri*, but this is perhaps not surprising, as Crépin himself did not know what to do with it twenty years after its description. Dr. Rydberg writes: "My idea of *R. fendleri* is a low shrub with evident infrastipular spines, and with stipules, petioles and peduncles glandular." No such rose as this was found at Pecos. Rehder's account of *R. fendleri* (in Bailey's *Cyclopedia of American Horticulture*) indicates a totally different plant from that indicated by Dr. Rydberg, much more in the manner of *R. pecosensis*. However, the sepals are said to be quite entire, and the flowers normally in clusters.

(4) R. gymnocarpa Nuttall.

Easily separated from ours by the deciduous sepals.

(5) R. neomexicana Ckll.

Fruits oblong; see above.

(6) R. aciculata (Ckll.).

Wet Mountain Valley, Colorado. Described as *R. blanda* var. *aciculata* in *Science Gossip*, 1889, p. 188. Type at Kew; photographs distributed to several herbaria. This has the flowers not very large, bright pink; prickles straight, slender, pale; sepals entire, hispid; stipules dilated, entire or slightly toothed at apex; leaflets 5 to 7, broad-oval, simply serrate, pale beneath. There are no paired infrastipular prickles. This appears to be allied to *R. sayi*, which occurs in the same vicinity, but the leaves are very much smaller, and their marginal teeth are normally simple.

(7) R. sayi Schwein.

Low, with large, thin, doubly-serrate leaflets; grows in moist places, and occurs as far south as Beulah, New Mexico. Just how far the characters of this rose result directly from its surroundings is perhaps an open question. If it could be transferred to a dry sunny place the result might be something not very different from *aciculata;* but this is mere guessing. The type locality of *sayi* is somewhere near the British boundary.

(8) **R. engelmanni** S. Wats.

Rehder gives this and *sayi* both as varieties of *R. acicularis* Lindley, but this seems unreasonable. I have found *R. engelmanni* abundantly near the Halfway House on Pike's Peak, Colorado, and it seems very distinct by its greatly elongated fruit.

(9) **R. pratincola** Greene.

The prairie species, formerly confused with *arkansana.* It is only one or two feet high, and has 7 to 11 leaflets. The stipules are only softly pubescent.

(10) **R. suffulta** Greene.

A low form of open ground, described from Las Vegas, New Mexico, where I have collected it. I found it many years ago at Ula, Colorado, and described it in MS. as a new variety of *R. arkansana,* but the description was not published. My specimen is at Kew. The flowers are quite large, 66 mm. across, the petals pale, and often inclined to be streaked.

(11) **R. manca** Greene.

W. Mancos Cañon, S. Colorado, at 10,000 feet. Another of the small species, about a foot high. The recurved prickles, small flowers, very narrow stipules, etc., distinguish it.

(12) **R. macounii** Greene.

Assiniboia to Cheyenne, Wyoming. A low shrub of dry elevated plains; leaves wholly glandless, leaflets mostly 9 or 11; flowers solitary, small and rather pale; fruits depressed-globose.

(13) **R. woodsii** Lindley.

A northern species, apparently not found in New Mexico. According to Watson, it is distinguished by the presence of infrastipular spines and laterally lobed outer sepals, and is usually a low bush, not over three feet high. Rydberg (*Flora of Montana*) states that the *R. fendleri* of Watson and Coulter is the true *R. woodsii,* and remarks that the character of lobed sepals is inconstant, and that in Lindley's original description they are said to be entire. The fruit is small and red, and the leaves are nearly glabrate, and according to E. Nelson shiny, those of *R. fendleri* being dull. Rehder in his table says the sepals of *R. pisocarpa* and *fendleri* are quite entire, while those of *woodsii* are lobed; in this he doubtless merely follows Watson. He suggests, however, that *pisocarpa* and *fendleri* may be varieties of *woodsii.* Crépin, in 1896, dismissed *woodsii* as a doubtful species. Lindley, in his first description, said the prickles were scattered, becoming paired (under the stipules) toward the extremities. In *Bot. Reg.*, XII, Pl. 976, he figured them as quite regularly paired, both on the branches and floriferous branchlets; the leaflets are represented as oboval and attenuate at base, with simple teeth. It will be apparent from all this that *R. woodsii* is not well understood, but it seems to be a low northern form allied to the *R. neomexicana* of New Mexico, and not to any of the Pecos roses.

There is in the Kew herbarium a rose labelled *R. arkansana*, from Medicine Hat, June 1, 1894, John Macoun, 4,567. It has the leaflets in sevens, pale, more or less cordate or truncate, varying to more rounded, sharply serrate; flowers rather small, corymbose; sepals reflexed after flowering, without lateral lobes. This is certainly not *R. macounii*, nor can it very well be the real *arkansana;* may it be the genuine *woodsii* ?

(14) **R. maximiliani** Nees.

A species of western Nebraska, differing from *woodsii* by its larger yellow fruit and more pubescent leaves.

(15) **R. blanda** Aiton.

A smooth, slightly prickly rose of Hudson's Bay and Newfoundland. Various Rocky Mountain plants have been confused with it.

(16) **R. acicularis** Lindley.

An Arctic species of the Old World (Siberia and northern Europe), said by Watson to occur in northern Alaska. It has oblong fruit; leaves with five leaflets, with simple teeth and not glandular beneath. The Rocky Mountain representative is *R. engelmanni.*

(17) **R. californica** C. and S.

This Californian rose is represented in the Rocky Mountains by var. *ultramontana* Watson, which Crépin thought rather a variety of *R. pisocarpa.* Dr. Rydberg, after seeing my description of *R. pecosensis*, suggested that it might be "*R. californica ultramontana*, a good species not closely related to *R. californica*, and growing in Utah, Wyoming and Colorado." However, when this suggestion was made the fruit of *R. pecosensis* had not been discovered.

(18) **R. pisocarpa** Gray.

A species of Oregon, with oval leaflets, stipules and bracts entire, small flowers and small globose fruits. Extends northward to British Columbia.

(19) **R. nutkana** Presl.

Alaska to Utah, but there is no evidence that it occurs as far south as New Mexico. Rydberg says: "Recognized by its large flowers, stout spines, doubly serrate firm leaves and large fruit." This suggests *sayi*, but the latter has thin leaves, and lacks the infrastipular spines of *nutkana*.

(20) **R. macdougali** Holz.

A species of the northern Rocky Mountains, distinguished from *nutkana* by the densely bristly peduncles, and the infrastipular spines much smaller.

(21) **R. melina** Greene.

A Colorado species confused with *nutkana*, but distinct by its small glabrous foliage, short and hooked prickles, and sepals neither long-attenuate nor glandular on the back. The fruit is very large, somewhat obpyriform, nearly 1½ inches in diameter. Perhaps the Utah "*nutkana*" will also be found to belong here.

There are still other species of Cinnamomeæ, but from their distribution and characters they do not require consideration here. It is hoped that the above summary will facilitate the identification of Rocky Mountain roses.

Some New Mexico Roses.

(1) Manzanares Valley, New Mexico (Mary Cooper). A rose with large leaves, having the characters of *R. sayi*, but the serrations only very slightly compound. Inflorescence one-flowered, flowers bright pink. A moderate number of prickles on flowering branch. The lateral leaflets are about 30 mm. long and 20 broad. I refer this to *R. sayi*, variety.

(2) Santa Fé, New Mexico (Cockerell); in herb. N. M. Agric. College. Flowering stems with numerous slender straight prickles; stems not dark; leaflets often in elevens, cuneiform with broadly rounded ends, very slightly inclined to be doubly serrate, about 28 mm. long and 18 broad, color on both sides nearly the same; sepals narrow, covered with large knobbed gland-hairs; fruit red, rather large, obpyriform, almost globular; sepals persistent. This runs to *R. arkansana* in Crépin's table; it is nearly the same as *R. suffulta*, differing by the very obtuse leaflets and more glandular sepals. Can this be the genuine *R. fendleri*?

(3) White Mountains, New Mexico (Turner); in herb. N. M. Agric. College. This was found labelled "*fendleri*," but it is very different from the Santa Fé plant by its dark flowering stems, with few but

straight and strong ochreous spines; leaves pale beneath, leaflets 5 or 7; flowers bright pink, not large. This is *R. neomexicana.*

In 1895 Prof. Wooton collected a rose on White Mountain, New Mexico, with corymbose flowers and very long and narrow leaflets having very long sharp teeth. The stem is dark, with rather numerous light ochraceous slightly curved prickles. This is much like an Illinois specimen of *R. blanda,* and requires further investigation.

JANUARY 19.

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

Twenty-two persons present.

The Publication Committee reported that the following papers had been received for publication:—

"Observations on Tupaia, with Reflections upon the Origin of Primates," by Henry C. Chapman. (January 5.)

"New Japanese Marine Mollusca," by Henry A. Pilsbry. (Jan. 9.)

"The Arachnida of Florida," by Nathan Banks. (January 12.)

"Sabellidæ and Sorpulidæ from Japan," by J. Percy Moore. (January 18.)

"New Japanese Marine Mollusca: Pelecypoda," by Henry A. Pilsbry. (January 18.)

A paper entitled "A Collection of Fishes from Sumatra," by Henry W. Fowler, had been accepted for publication in the JOURNAL and would conclude the twelfth volume.

Note on the Characinidæ.—MR. HENRY W. FOWLER desired to place on record the following:

EUCYNOPOTAMUS nom. nov.

> *Evermannella* Eigenmann, Smithsn. Miscel. Coll., XLV, December 9, 1903, p. 146 (*biserialis*).

Mr. Fowler was indebted to Mr. E. L. Goldsborough, of the United States Fish Commission, for calling attention to the name *Evermannella*, which has recently been employed by Dr. Eigenmann for a genus of *Characinidæ*. The speaker had previously applied the name to the *Odontostomidæ*.[1] (*Εὖ*, properly; *κύων*, dog; *ποτἀμὸς*, river.)

The following were ordered to be printed:

[1] *Proc. Acad. Nat. Sci. Phila.*, LIII, 1901 (1901–2), p. 211.

THE ARACHNIDA OF FLORIDA.

BY NATHAN BANKS.

For about the past twelve years I have been receiving spiders from Florida, and now have accumulated a larger number of species than from any other State, except where collected for years by an arachnologist. From time to time I have published descriptions of the new species, so that there are few new forms to record now. However, it will be interesting to publish the entire list of Floridan spiders, as a means of comparing the fauna with that of other portions of the United States.

The list is, of course, incomplete, yet it is doubtless a fair representation of the arachnid fauna, since the materials have come from widely separated parts of the State. Northwestern Florida is, however not represented. Various writers have questioned the propriety of including subtropical Florida as a faunal part of the State. Similar reasoning would throw out portions of many States; therefore I accept political boundaries. The collections upon which this list is based were made by the following persons, at the places noted:

Mrs. Annie T. Slosson: Punta Gorda, Palm Beach, Biscayne Bay, Lake Worth.

Mr. Philip Laurent: Miami, Jacksonville, Enterprise.

Mr. A. Dobbin: Altoona.

Prof. C. M. Weed: Citrus county.

Nathan Banks: Runnymede.

Others: a number of *Chernetidæ* have been taken by Mr. H. G. Hubbard, and several others have sent me one or two species apiece.

In this list are enumerated 211 spiders and 68 other arachnids, a total of 279 species. The spiders are arranged in 21 families, 7 of them being represented by but one species. The Epeiridæ stands highest in point of numbers, 45 species being included in it; the Theridiidæ follow with 44 species, and the Attidæ with 38 species. The Lycosidæ have but 19 species and the Thomisidæ the same. In many localities these families equal or surpass the Attidæ in number. The collection is more brightly colored than one from the Northern States, and contains many more bizarre forms. Of the arachnids other than spiders, the mites have 35 species and the Pseudoscorpions 16 species; there are 6 daddy-long-legs.

The affinity of the fauna is with that of the general coast fauna of the Southern States; the southern tip shows relation to the West Indies. Few species are abundant in specimens, but there are many genera represented. The Pseudoscorpions are more abundant than anywhere else in our country. All but about twenty species are in the writer's collections; these few exceptions being chiefly species recorded by Dr. Marx.

Of noteworthy mention, one may refer to three species for the first time recorded from our country: *Theridium volatile* Keys., previously known from northern South America; *Cupiennius sallei* Keys., known from Mexico and Central America, and *Wala grenada* Peck., recorded from several West Indian localities. Several other spiders which have a tropical distribution have previously been recorded from southern Florida. Characteristic ones are *Wagneria tauricornis, Epeira spinigera, E. undecimtuberculata, Leucauge argyra, Heteropoda venatoria* and *Opisthacanthus elatus*. The occurrence of a Gamasid mite of the cosmotropical genus *Megisthanus* is also of much interest. Other rare and curious forms are *Gamasomorpha floridana, Dictyna floridana, Kaira alba* and *Phidippus pulcherimmus*. Thirteen species are described as new—eight spiders, three mites and two scorpions.

In 1892–93 Dr. Einar Lönnberg visited Florida and made a small collection of spiders, chiefly from Orange county. Dr. Albert Tullgren has reported on this collection, describing eleven species as new. They are as follows:

Aysha orlandensis=*Anyphæna gracilis* Hentz.

Lycosa angusta=*Lycosa lenta* Hentz.

Lycosa albopuncta=*Lycosa riparia* Hentz.

Lycosa (*Pirata*) *lœnnbergi*=*Sosippus floridanus* Simon.

Lycosa (*Pirata*) *transversolineata*—unknown to me.

Pardosa bilobata=*Pardosa milvina* Hentz.

Pardosa longispinata—unknown to me.

Oxyopes laminatus=*Oxyopes scalaris* Hentz.

Phidippus clarconensis=*Phidippus insolens* Hentz.

Phidippus oaklandensis=*Phidippus cardinalis* Hentz.

Phidippus bilineatus—unknown to me, but I think it can scarcely be new.

Order ARANEIDA.

FILISTATIDÆ.

Filistata hibernalis Hentz.

Various specimens from Punta Gorda, Jan.; Altoona, June; and Miami, April. It is one of the most common species in buildings in the South.

ŒCOBIIDÆ.

Thalamia parietalis Hentz.

A few specimens from Punta Gorda, Jan.

Thalamia floridana Banks.

Two specimens from Lake Worth, the types, all that are known.

SCYTODIDÆ.

Loxosceles rufescens Lucas.

Young specimens from houses at Runnymede.

OONOPIDÆ.

Gamasomorpha floridana Banks.

Two specimens from Punta Gorda, Febr. and April.

DYSDERIDÆ.

Ariadne bicolor Hentz.

Recorded by Dr. Marx from the State.

PHOLCIDÆ.

Pholcus phalangioides Fuess.

One young specimen from Lake Worth.

DRASSIDÆ.

Micaria punctata Banks.

A specimen from Punta Gorda, Febr., and others from Lake Worth; it is the smallest of our species.

Micaria agilis Banks.

A few from Palm Beach, March.

Sergiolus variegata Hentz.

Recorded by Dr. Marx from the State.

Sergiolus cyaneoventris Simon.

Several examples from Runnymede, Biscayne Bay, April, and Enterprise, April (Laurent). A male from Punta Gorda, Febr. This is more slender than the female, but similar in appearance.

Cephalothorax bright yellowish-red; sternum pale yellowish, also legs, but darker on tarsi; a white band across base of abdomen, beyond shining brown till the middle white band, then iridescent black or greenish to tip; venter bluish-black, pale at base; spinnerets black. No spines under tibia I except at tip; one pair under metatarsus I; hind legs more numerously spined; mandibles small; sternum very long.

Gnaphosa sericata Koch.

Specimens from Biscayne Bay, and from Runnymede.

Eilica bicolor Banks.

A few from Punta Gorda, Febr., and Biscayne Bay, March and April. It looks much like the next species.

Callilepis imbecilla Keyserling.

From Lake Worth; Punta Gorda, April, and Palm Beach, March.

Prosthesima depressa Emerton.

One from Palm Beach.

Prosthesima ecclesiastica Hentz.

From Lake Worth, and Punta Gorda, April. One specimen is suffused with reddish throughout.

Prosthesima floridana Banks.

One female from Punta Gorda, Febr., the type.

CLUBIONIDÆ.

Clubiona tibialis Emerton.

One from Runnymede, Nov.

Chiracanthium inclusa Hentz.

Many specimens from Runnymede, Nov.; Punta Gorda, Jan.; Altoona, June; Enterprise, April (Laurent), and Miami, April. Extremely common on herbage.

Chiracanthium albens Hentz.

One male of this rather rare species from Punta Gorda, April.

Anyphæna velox Becker.

Many examples from Lake Worth; Punta Gorda, Febr.; Biscayne Bay, March and April; Palm Beach, March; Enterprise, April (Laurent); and Miami (Laurent). It is abundant in south Florida, but much rarer north.

Anyphæna fallens Hentz.

From Punta Gorda, Jan.

Anyphæna gracilis Hentz.

Immature example from Runnymede.

Anyphæna fragilis Banks.

Type specimen from Jacksonville, April (Laurent).

Anyphæna floridana Banks.

One from Lake Worth, the type.

Gayenna parvula Banks.

One female from Runnymede, Nov.; sweeping herbage.

Thargalia crocata Hentz.

From Punta Gorda, Febr.; and Altoona, July. This is the true *T. crocata* of Hentz, and is not his *T. descriptus*, a very different form.

Thargalia floridana Banks.

Cephalothorax brownish-red, femora and patellæ similar, but a little paler, tibiæ very pale, metatarsi and tarsi darker; sternum like cephalothorax; mandibles a darker brownish-red; coxæ pale; abdomen brown above and below, sides almost black, without particular marks except some faint transverse lines near the tip, partly clothed with white hair. Cephalothorax rather slender; A.M.E. fully diameter apart, plainly closer to larger A.S.E., P.M.E. one and one-half diameters apart, about diameter from equal P.S.E., quadrangle of M.E. much higher than broad, and a little broader behind than in front, a long black bristle under each A.S.E., and one at outer corner. Legs slender, one spine under middle of tibiæ I and II, two pairs under these metatarsi. Abdomen scarcely longer than cephalothorax, truncate at base, broadest behind middle; spinnerets not very prominent.

Length 6 mm.

One specimen from Punta Gorda, Febr.

Thargalia longipalpis Hentz.

Recorded by Dr. Marx from the State.

AGALENIDÆ.

Agalena nævia Hentz.

Common from Punta Gorda, April; Altoona, July; Citrus county (Weed); and Jacksonville, April. This spider is not nearly so abundant in Florida as it is in the North.

Tegenaria derhami Scopoli.

A few from Punta Gorda, March; probably introduced.

Hahnia sp.

One young specimen from Punta Gorda, April.

DICTYNIDÆ.

Dictyna foliacea Hentz.

From Punta Gorda, April. Species of this genus are not common in Florida.

Dictyna sublata Hentz.

From Punta Gorda, April, and Palm Beach, March.

Dictyna floridana n. sp.

Cephalothorax and mandibles reddish; legs, sternum and spinnerets yellowish; abdomen gray, mottled with white. Legs and body evenly clothed with dark hairs. Head in male elevated, the M.E. subequal, they form a quadrangle broader than high. In the male there is a strong tooth-like process on the outer base of each mandible. The male palpi are peculiar; the patella is large, swollen, globular; the palpal organ has a long slender process that, arising from the base, extends up one side, across the tip of palpus and down the other side, where its end is curved. This process has a groove on outer side, in which rests the long style. At the base on the outer side is a bifid black process, and two curved broad white hooks. Elsewhere the species is of the usual structure.

Length 2.4 mm.

One pair from Lake Worth (Slosson). Readily known from all other Dictynas by the globose patella of the male palpus.

ULOBORIDÆ.

Uloborus plumipes Lucas.

Several from Lake Worth, Biscayne Bay, March and April.

Dinopsis spinosus Marx.

A few examples from Palm Beach, March, and Miami, April.

THERIDIIDÆ.

Theridium studiosum Hentz.

Quite common, from Runnymede, Nov.; Punta Gorda, Jan.; Biscayne Bay, March and April; Levy county, April (Laurent), and Lake Worth. The most common *Theridium* in Florida.

Theridium volatile Keyserling.

A couple from Runnymede, Nov. It was not previously known from the United States; but these specimens agree with the description and figures of the South American form.

Theridium floridensis Banks.

Theridium lyra Keys. *nec.* Hentz.

From Runnymede, Nov., and Lake Worth, Febr.; not known outside of the State.

Theridium differens Emerton.

One specimen from Punta Gorda.

Theridium inornatum Banks.

One from Runnymede, Nov.; described from Louisiana.

Theridium globosum Hentz.

Several from Runnymede, Nov., and Punta Gorda, March and April; some swept from herbage.

Theridium tepidariorum Koch.

In houses at Runnymede, Nov. It has not been sent in by any of the collectors, so cannot be common.

Theridium pictipes Keyserling.

Recorded by Dr. Marx from the State.

Theridium amputatum Keyserling.

Described from the State.

Theridium punctosparsum Emerton.

Recorded by Dr. Marx from Florida.

Theridium immaculatum Emerton.

Recorded by Dr. Marx from the State.

Theridium sp.

A small male from Punta Gorda, Febr., of an unknown species.

Theridula sphærula Hentz.

Several from Runnymede, Nov.; not as common as the next species.

Theridula quadripunctata Keyserling.

Several from Runnymede, Nov.; Jacksonville, April; and Enterprise, April.

Argyrodes globosum Keyserling.

One specimen from Punta Gorda, Febr.

Argyrodes trigonum Hentz.

One from Runnymede, Nov.; swept from herbage.

Argyrodes nephilæ Taczanowski.

Several from Runnymede, Nov., from their own webs on the porch of a house.

Argyrodes floridana Banks.

Two females from Punta Gorda, Febr. Readily known by the peculiar shape of the abdomen.

Romphea fictilium Hentz.

One specimen from Runnymede, Nov.; swept from herbage.

Spintharus flavidus Hentz.

Recorded by Dr. Marx from the State.

Bellinda cancellata Keyserling.

Recorded from Florida by Dr. Marx.

Gaucelmus augustinus Keyserling.

Described from the State.

Ulesanis americana Emerton.

Recorded by Dr. Marx from Florida.

Euryopis argentea Emerton.

Recorded by Dr. Marx.

Mysmena bulbifera Banks.

From Runnymede, Nov.; Biscayne Bay, March and April; and Lake Worth. They make webs in low plants.

Mysmena quadrimaculata Banks.

Two specimens from Punta Gorda, April.

Lathrodectus mactans Koch.

Common from Runnymede, Nov.; Punta Gorda, Jan., April; Altoona, July; Palm Beach; Biscayne Bay, April; and Citrus county. Abundant throughout the State.

Dipœna crassiventris Keyserling.

Two females from Punta Gorda, April.

Lithyphantes fulvus Keyserling.

Three specimens from Citrus county.

Lithyphantes 7-maculatus Keyserling.

Several from Punta Gorda, Jan., Febr.; Palm Beach; and Biscayne Bay, April. A handsome and characteristic Floridan spider.

Asagena americana Emerton.

One male from Palm Beach, March.

Mimetus interfector Hentz.

A few examples from Runnymede; and Altoona, July.

Histiagonia rostrata Emerton.

Several specimens from Punta Gorda, March and April; Palm Beach; and Biscayne Bay, April.

Ceratinella emertoni Cambridge.

A few examples from Punta Gorda, March and April; Palm Beach; and Lake Worth.

Ceratinopsis similis Banks.

Described from Runnymede, Nov., under fallen leaves.

Grammonota maculata Banks.

A few pairs from Runnymede, Nov., among dead leaves.

Tmeticus tridentatus Emerton.

One male from Palm Beach.

Linyphia communis Hentz.

Recorded from the State by Dr. Marx.

Frontina coccinea Hentz.

Moderately common from Punta Gorda, March and April; Palm Beach, April; and Enterprise, April.

Coleosoma floridana Banks.

Coteosoma blanda Keyserling *nec.* Cambridge.

One male from Punta Gorda., April.

Chrysso albomaculata Cambridge.

Several specimens from Runnymede, Nov.; and Lake Worth.

Bathyphantes micaria Emerton.

A few from Palm Beach, March.

Bathyphantes anglicanum Hentz.

Common from Runnymede, Nov.; Punta Gorda, Jan., Feb.; Biscayne Bay, March and April; and Palm Beach, April. A characteristic Southern spider.

Bathyphantes floridana Banks.

A few from Runnymede, Nov.; and Punta Gorda, April; the former among dead leaves.

Bathyphantes sp.

One female of a brown, unmarked species from Enterprise, April 15.

EPEIRIDÆ.

Gastercantha cancriformis Linné

Quite common from Punta Gorda, Jan.; Altoona, June; Citrus county; and Miami, Febr.

Acrosoma rugosa Hentz.

Recorded by Dr. Marx from Florida.

Acrosoma spinea Hentz.

A few from Palm Beach, March; and Punta Gorda, April.

Mahadeva verrucosa Hentz.

From Palm Beach, March.

Wagneria tauricornis Cambridge.

Two specimens from Miami.

Gea heptagon Hentz.

Several from Runnymede; and Palm Beach, March.

Plectana stellata Hentz.

Rather common from Runnymede; and Altoona, July.

Plectana venusta Banks.

A few examples from Punta Gorda, Febr., April; and Biscayne Bay, March.

Epeira domiciliorum Hentz.

Quite common at Punta Gorda, March; and Altoona, June and July.

Epeira trivittata Keyserling.

Common from Punta Gorda, Jan., Febr.; Miami, March; Biscayne Bay, April; Jacksonville, April (Laurent); and Enterprise, April.

Epeira strix Hentz.

A few specimens from Punta Gorda, Jan., Febr.

Epeira labyrinthea Hentz.

Common from Runnymede; Lake Worth; Punta Gorda, Febr.; and Altoona, July.

Epeira wittfeldæ McCook.

Quite common at Runnymede; also at Biscayne Bay.

Epeira thaddeus Hentz.

Recorded from Florida by Dr. Marx.

Epeira pratensis Hentz.

A few specimens from Palm Beach, March; and Altoona.

Epeira balaustina McCook.

Several specimens from Punta Gorda, Febr.; Altoona; Biscayne Bay, April; Miami, March; and Enterprise, April. Young specimens are often strikingly marked with yellow.

Epeira gigas Leach.

A few specimens from Altoona and Punta Gorda.

Epeira septima Hentz.

One from Punta Gorda, Febr.; a species nearly related to *E. gigas*, but distinct by shape and sexual characters.

Epeira globosa Keyserling.

Quite common from Altoona, July; Biscayne Bay, March and April; and Miami, April.

Epeira floridensis n. sp.

Cephalothorax pale yellowish, without markings, mandibles and sternum same color, legs rather paler, faintly darker at tips of the tibiæ. Abdomen covered with silvery irregular areas; two black dots, widely separated, on the posterior part; between them sometimes two gray curved lines reaching toward the tip; sometimes the basal part of the abdomen is covered with a large reddish-brown mark, darker in middle, more reddish on the humps, and enclosing behind two oblong yellow spots; venter silvery white. Similar in shape to *E. scutulata*. The humps are rather more prominent and sharp-pointed; the legs long and slender; the epigynum shows a short median finger with upcurved end, each side is a dark circular cavity.

Length 2.8 mm.

Three specimens from Miami, in March (Laurent); readily distinguished from *E. scutulata* by its much smaller size, as well as different markings.

Epeira fuscovittata Keyserling.

Cyclosa thorelli McCook.

Recorded by McCook from the State.

Epeira scutulata Hentz.

Several specimens from Punta Gorda, April.

Epeira juniperina Emerton.

A number of examples from Altoona, in July.

peira spinigera Cambridge.

Two from Lake Worth and Biscayne Bay; also recorded by McCook.

Epeira undecimtuberculata Keyserling.

One male from Punta Gorda, in April; this and the preceding species are representatives of the tropical fauna.

Kaira alba Hentz.

One from Runnymede, Nov.; beaten from shrubs

Vixia infumata Hentz.

One male from Punta Gorda, March and April.

Eustala prompta Hentz.

A common species at Runnymede, Punta Gorda, Miami, Palm Beach, Altoona, Jacksonville and Enterprise. Adults were taken in March, April, June and July. It varies extremely in markings, more so than in northern localities

Acacesia foliata Hentz.

From Biscayne Bay, March and April; and Miami, April.

Mangora placida Hentz.

A few specimens from Palm Beach; Enterprise, April; and Miami, March.

Mangora gibberosa Hentz.

Recorded from the State by Dr. Marx.

Singa maculata Emerton.

Recorded by Dr. Marx from Florida.

Singa nigripes Keyserling.

Recorded by Dr. Marx.

Singa floridana Banks.

A few from Punta Gorda, April.

Singa modesta Banks.

A few specimens from Lake Worth, and Punta Gorda, April.

Singa pratensis Emerton.

A few examples from Palm Beach, April; and Biscayne Bay, in March and April.

Cyclosa bifurca McCook.

One specimen from Citrus county (Weed).

Carepalexis tuberculata Keyserling.

One from Miami, Febr.; recorded by Dr. Marx under the genus *Cyrtophora*.

Argiope argentata Fabricius.

A few specimens are from Altoona, July.

Argiope aurantia Lucas.

I have seen specimens at Runnymede, Nov.

Argiope trifasciata Försk.

Epeira fasciata Hentz.
Argiope transversa Emerton.

Several specimens from Punta Gorda, Febr.; and Altoona, June and July.

Nephila plumipes Koch.

A few from Citrus county: and Punta Gorda, March; and Miami, Febr.

Leucauge hortorum Hentz.

Specimens from Punta Gorda; Jacksonville, April; and Enterprise, April.

Leucauge argyra Walckenaer.

A few examples from Biscayne Bay, April. It is a tropical species. Both this and *L. hortorum* were formerly placed in *Argyroepeira*, but Mr. Cambridge has shown that this is the same as White's earlier genus, *Leucauge*.

Larinia directa Hentz.

Several from Runnymede, Nov.; oblique webs in grass.

Theridiosoma argentea Keyserling.

One female from Runnymede, Nov.

TETRAGNATHIDÆ.

Tetragnatha grallator Hentz.

Several from Punta Gorda, in Jan.; Jacksonville, April; and Enterprise, April.

Tetragnatha laboriosa Hentz.

Common, Punta Gorda; Lake Worth; and Enterprise, April (Laurent).

Tetragnatha banksi McCook.

A few specimens from Runnymede, Nov.; swept from herbage.

Eugnatha pallida Banks.

A few examples from Palm Beach, Runnymede Nov., and Enterprise, April.

Eucta caudata Emerton.

Not rare at Runnymede, Nov.; also from Punta Gorda, in Jan. and Febr.; beaten from grass.

Pachygnatha sp.

Two young specimens from Punta Gorda, in April.

THOMISIDÆ.

Xysticus cunctator Thorell.

A few specimens from Runnymede.

Xysticus floridanus Banks.

One pair from Punta Gorda, March and April.

Coriarachne versicolor Keyserling.

From Runnymede, Nov.; Biscayne Bay, March, April; and Punta Gorda, April.

Coriarachne floridana Banks.

Only the type from Punta Gorda, Febr.

Oxyptila floridensis Banks.

One specimen from Punta Gorda, March.

Synæma bicolor Keyserling.

Recorded from the State by Dr. Marx.

Runcinia aleatoria Hentz.

A few from Altoona, July, and Jacksonville, April.

Misumena spinosa Keyserling.

Several specimens from Runnymede and Punta Gorda, April

Misumena rosea Keyserling.

Very common, from Runnymede; Altoona, July; Punta Gorda; Palm Beach; Biscayne Bay, April; and Enterprise, April.

Misumena oblonga Keyserling.

A few specimens from Punta Gorda, Jan.

Misumena bellula Banks.

A few examples from Punta Gorda, Febr., April.

Misumena viridans Banks.

A few specimens from Punta Gorda, April.

Tibellus duttoni Hentz.

A few from Runnymede and Enterprise.

Tmarus floridensis Keyserling.

Not rare at Runnymede, in long moss; also Enterprise and Miami, April.

Tmarus caudatus Hentz

A few specimens from Palm Beach, March.

Tmarus griseus Keyserling.

Recorded by Keyserling from the State.

Philodromus vulgaris Hentz.

Not rare, from Runnymede; and Altoona, July.

Philodromus ornatus Banks.

Several from Punta Gorda, Feb., April; and Enterprise, April.

Philodromus floridensis n. sp.

Head pale grayish, behind with a white V-mark; sides of cephalothorax broadly dark brown, leaving a large median pale area; legs brownish-yellow; darker at tips of femora, and near middle of femora II and III; sternum white; abdomen pale brownish-yellow with a dark brown spear-mark in middle of anterior part, margined on its posterior sides by a narrow white line, and posterior part of abdomen covered by a large dark brown spot with oblique anterior margins and containing two rows of indistinct pale dots each side; venter pale, with three pale brown stripes. Second pair of legs plainly longer than the first. Tibia I with two pairs of spines below, metatarsus I also with two pairs. P.S.E. larger than the others, which are subequal; A.M.E. four diameters apart, two diameters from A.S.E., latter two diameters from P.M.E., and these three diameters from the P.S.E. Cephalothorax broad and flat; abdomen truncate at base, broadest behind the middle.

Length 4 mm.

One female from Lake Worth.

SPARASSIDÆ.

Selenops aissa Walckenaer.

Recorded by Dr. Marx from southern Florida.

Heteropoda venatoria Linné.

Taken at Runnymede; Jacksonville; Altoona, June, and Miami.

LYCOSIDÆ.

Lycosa carolinensis Walckenaer.

L. carolinensis Hentz.

One specimen from Punta Gorda, Febr.

Lycosa helluo Walckenaer.

L. babingtoni Blackwall.

A few from Punta Gorda, April; they do not differ from northern specimens.

Lycosa riparia Hentz.

Common from Punta Gorda, April; Palm Beach; and Enterprise, April (Laurent).

Lycosa lenta Hentz.

Several specimens from Altoona, July; and Runnymede. Nov.; *L. ruricola* Hentz is, I think, the male of *L. lenta.*

Lycosa floridana Banks.

A few from Punta Gorda, Febr., the types.

Lycosa erratica Hentz.

Taken at Enterprise, April (Laurent).

Lycosa posticata n. sp.

Cephalothorax red-brown; a narrow median pale stripe from eyes to tip, and a pale stripe on each side; a pale spot each side of clypeus; mandibles dark red-brown; leg IV wholly pale yellow; other legs heavily mottled with brown; the femora beneath almost wholly dark, above with two pale bands; patella pale, with a middle dark band; tibia dark, with pale band at base and one on middle; metatarsi dark, tarsi pale. Stenurm rather reddish, uniform. Coxæ and maxillæ yellowish. Abdomen black, with a pale stripe each side on base reaching halfway back, and thence broken into spots. Venter gray.

Length 10 mm.

Two specimens from Miami (Laurent). Readily distinguished from all other Lycosas known to me by the pale hind legs, in contrast with the darker other pairs.

Lycosa punctulata Hentz.

Several from Punta Gorda, April.

Lycosa rabida Walckenaer.

L. scutulata Hentz.

Many specimens from Altoona, in June.

Lycosa hentzi n. sp.

Cephalothorax pale brownish-yellow; eyes on black band; a brown stripe extending back from each posterior eye, its upper edge definite, its lower edge fading off into the paler sides, between these is a brighter yellow streak, extending forward between the eyes, but much narrower. Mandibles scarcely darker than cephalothorax; sternum pale; abdomen pale, the upper sides streaked and spotted with brown, indicating toward middle two brown streaks, leaving a broader yellowish median stripe, sometimes broken up behind by brown chevrons; venter pale, unmarked; legs pale, the tarsi more red-brown. First eye-row practically straight, as long as second row, its eyes subequal; second and third rows about equal in size, and the third row scarcely broader than the second. Head rather high, and square in front; abdomen rather longer than usual, tapering behind. Legs quite slender; three pairs of spines under tibiæ I and II, two pairs under these metatarsi; metatarsi and tarsi weakly scopulate. Tarsus I of male not curved.

Length 12 mm.

Several specimens from Altoona, July; also from Covington, Louisiana. It looks like *L. rabida*, except for pale median stripe on abdomen, and pale anterior legs of male.

Trochosa cinerea Fabricius.

A few from Lake Worth, Palm Beach, March, and Altoona, July.

Trochosa floridana Banks.

Several from Punta Gorda, April; and Palm Beach, March.

Sosippus floridanus Simon.

Not rare at Runnymede; and Altoona, July.

Allocosa funerea Hentz.

Not rare, Punta Gorda, March; Biscayne Bay, March; and Palm Beach, March.

Pardosa milvina Hentz.

Quite common, Punta Gorda, April; Runnymede, Nov.

Pardosa saxatilis Hentz.

One specimen from Lake Worth, Febr.

Pardosa venustulata Hentz.

One from Biscayne Bay, April.

Pardosa minima Keyserling.

One male from Lake Worth, Febr., agrees with northern examples.

Pardosa floridana n. sp.

Cephalothorax yellowish, head black, a broad brown stripe from each posterior eye to the hind margin, and the lateral margins narrowly brown. The pale median area is broadest in front, and there indents the black head with a narrow projection each side. Abdomen black, with numerous small white dots; a basal spear-mark, and four pairs of geminate patches follow the spear-mark, each is separated by a narrow transverse line; venter yellow, with a few black spots in three lines; sternum yellow, with a median black stripe forked on anterior half, and three black dots each side; coxæ yellow, with black marks above; clypeus yellow, with two black spots; mandibles yellowish, with a black line in front. Legs yellow, more reddish toward tip, faintly marked with black on femora and base, middle and tip of tibia and metatarsus.

Length 6 mm.

One female from Enterprise, April 22. A paler specimen, with legs scarcely marked, but with a dark sternum, comes from Punta Gorda, Febr.

PISAURIDÆ

Dolomedes sexpunctatus Hentz.

One specimen from Lake Worth.

Dolomedes albineus Hentz.

One female from Altoona, July. It is easily recognized by the yellow ventral stripe. The head is much elevated in this species. I have a spider from Punta Gorda which agrees with *Micromata pinicola* Hentz; it is immature, and, I think, the young of *D. albineus*.

Pisaurina undata Hentz.

Several specimens from Punta Gorda, April.

Maypacius floridanus Simon.

Described from the State; I have not seen it.

Thanatidius dubius Hentz.

A young specimen from Punta Gorda, April; it is adult in late summer.

CTENIDÆ.

Cupiennius sallei Keyserling.

One specimen from Lake Worth. This is the first time this Mexican spider has been recorded from the United States.

OXYOPIDÆ.

Peucetia viridans Hentz.

Common, Runnymede; Jacksonville; Biscayne Bay, April; and Altoona, June and July. Usually on large shrubs.

Oxyopes salticus Hentz.

A few from Jacksonville, April, and Enterprise, April.

Oxyopes scalaris Hentz.

Several from Punta Gorda, April, and Altoona, July.

Hamalatiwa grisea Keyserling.

Taken at Jacksonville, April; Altoona, June and July; Enterprise, April; and Runnymede.

ATTIDÆ.

Phidippus cardinalis Hentz.

Several from Biscayne Bay, in March, and Punta Gorda and Enterprise, April.

Phidippus variegatus Lucas.

Phidippus otiosus Hentz.

Two specimens from Levy county, April (Laurent).

Phidippus rufus Hentz.

From Runnymede, Nov., and Punta Gorda, Febr., April.

Phidippus pulcherrimus Keyserling.

One female from Biscayne Bay, in March. I have not seen it before, and evidently is quite rare.

Phidippus miniatus Peckham.

Many specimens from Punta Gorda, Jan.; Citrus county (Weed); Jacksonville, May; Enterprise, April; and Levy county, April (Laurent).

Phidippus audax Hentz.

Attus tripunctatus Hentz.

A few specimens from Runnymede, Nov., and Miami, April.

Phidippus insolens Hentz.

Recorded by Dr. Marx in his *Catalogue* as from the State.

Philæus militaris Hentz.

A few from Palm Beach, March.

Philæus rimator Walckenaer.

Recorded from Florida by Prof. Peckham.

Dendryphantes octavus Hentz.

Common from Runnymede, Nov.; Punta Gorda, Jan.; Jacksonville, April; Fernandina, April (Laurent), and Enterprise, April.

Dendryphantes floridanus n. sp.

Cephalothorax reddish; eyes on black spots; mandibles reddish-brown; sternum pale yellowish; legs similar, first pair rather more reddish-brown, the patella and tibia tipped with a dark spot on inner side; abdomen pale yellowish, with some small scattered brown spots, behind with a larger brown spot, pointed in front (sometimes blunt), indented each side, and with a brown patch each side in front of it. This spot is sometimes broken up into smaller spots. Venter pale, spinnerets a little darker. Male is similar, but more reddish-brown. Tibiæ I and II have three pairs of spines beneath, two pairs under these metatarsi; hind tibiæ with many spines, especially at tip. Tibia of male palpus has a short tooth on outer side at tip. Similar in structure to *D. octavus* Hentz.

Length, ♀, 7 to 8 mm.; ♂, 5 mm.

Several examples from Altoona, July.

Thiodina retarius Hentz.

Many specimens from Punta Gorda, April; Biscayne Bay, April; Enterprise, April; Miami, April, and Lake Worth, Febr. A very common species in the South.

Plexippus paykulli Aud. and Sav.

Specimens from Punta Gorda, March and April; Palm Beach, March; Biscayne Bay, April; Runnymede, Nov.; Altoona, May and June; Miami, April. A very common spider in Florida.

Tapinattus melanognathus Lucas.

A pair from Runnymede, Nov., and others from Ft. Drum.

Wala palmarum Hentz.

Specimens from Punta Gorda, Palm Beach, Biscayne Bay and Enterprise, in Jan. and April.

Wala grenada Peckham.

A few specimens from Miami, April. Not before recorded from the United States.

Wala mitratus Hentz.

A few examples from Palm Beach, March; and Biscayne Bay, March.

Icius wickhami Peckham.

Icius floridana Banks.

A few from Palm Beach, March; and Punta Gorda, April.

Icius pleuralis Banks.

One female from Punta Gorda, April.

Icius elegans Hentz.

Two from Punta Gorda, in Jan.

Fuentes lineata Koch.

One from Runnymede, Nov.

Marpissa undata De Geer.

Attus familiaris Hentz.

From Citrus county (Weed); and Punta Gorda, Jan., April.

Hyctia pikei Peckham.

From Runnymede, Nov.; Palm Beach, March; and Lake Worth, Febr. Occurs on marsh grass.

Mævia vittata Hentz.

Several examples from Runnymede, Nov., and Enterprise, April (Laurent).

Metacyrba tæniola Hentz.

Rather common; Runnymede, Nov.; Biscayne Bay, March; Punta Gorda, Febr.; and Lake Worth.

Prostheclina aurata Hentz.

Not uncommon; Punta Gorda, April; and Biscayne Bay, April.

Pellenes cristatum Hentz.

From Punta Gorda, a few specimens.

Pellenes peregrinum Peckham.

One male from Punta Gorda, April.

Pellenes viridipes Hentz.

A few examples from Palm Beach, in March, and Biscayne Bay

Pellenes brunneus Peck.

Described from Florida.

Habrocestum pulex Hentz.

A few from Punta Gorda, in Febr.

Zygoballus sexpunctatus Hentz.

Several from Runnymede, Nov.; Palm Beach, April; Punta Gorda, April, and Jacksonville, April.

Zygoballus parvus Hentz.

A few from Biscayne Bay, March.

Zygoballus bettina Peckham.

One from Enterprise, April.

Homalattus cyaneus Hentz.

A few from Palm Beach, March and April.

Saltious albocinctus Koch.

From Biscayne Bay, March; and Punta Gorda, April.

Synemosyna formica Hentz.

One from Runnymede, Nov.

Lyssomanes viridis Hentz.

From Runnymede; Punta Gorda, April; Palm Beach, March; Biscayne Bay, April; and Altoona, July. Not uncommon sweeping.

Order PHALANGIDA.

Mesosoma niger Say.

Common at Punta Gorda, in Feb., March and April.

Liobunum vittatum Say.

From Punta Gorda, Febr. and April; Palm Beach, April; and Biscayne Bay, April.

Liobunum bicolor Wood.

A few from Runnymede, Nov., and Punta Gorda, Febr.

Liobunum formosum Wood.

A few from Punta Gorda, April.

Cynorta ornata Say.

Common; Runnymede, Nov.; Punta Gorda, Jan.; Biscayne Bay, March; and Lake Worth.

Scotolemon spinigera Pack.

A couple of specimens from Biscayne Bay.

Order PSEUDOSCORPIONIDA.

Chelifer floridanus Banks.

One specimen from Biscayne Bay (E. A. Schwarz).

Chelifer biseriatum Banks.

Many specimens from Punta Gorda, Febr.; and from Lake Poinsett (Hubbard).

Chelifer muricatus Say.

Various examples from Punta Gorda, Jan.; also St. Lucie and Sand Point (Hubbard), and Citrus county (Weed).

Chelanops oblongus Say

Many specimens from Lake Worth; Biscayne Bay, March; and Punta Gorda, Febr., March and April.

Chelanops latus Banks.

A few from Runnymede, Nov.; and Lake Worth.

Chelanops floridæ Balzan.

A few from Punta Gorda, Febr., March and April; and Biscayne Bay, April.

Chelanops dentatus Banks.

One specimen from Florida, without more definite locality (Hubbard).

Chelanops latimanus Banks.

One specimen from Punta Gorda.

Chelanops affinis Banks.

The type is from Crescent City, from a burrow of the gopher (Hubbard).

Chelanops tumidus Banks.

Several specimens from under logs on the sea beach at Indian River Inlet, April (Hubbard).

Garypus floridensis Banks.

Collected under driftwood on ocean beach near St. Lucie river, April, by the late H. G. Hubbard; Miami, March (Laurent).

Obisium parvulum Banks.

One specimen from Florida, without more definite locality (Hubbard).

Atemnus elongatus Banks.

A. floridanus Tullgren.

Specimens from Lake Worth; Biscayne Bay, April; Punta Gorda, Febr. and April. Mr. Hubbard took it at St. Lucie river, Sand Point and Enterprise.

Olpium obscurum Banks.

One from Runnymede, one from Punta Gorda and several from Palm Beach, April.

Chthonius pennsylvanicus Hagen.

A few specimens from Punta Gorda, Febr.; one from Lake Poinsett (Hubbard).

Chthonius spinosus Banks.

Several from Citrus county (Weed).

Order SCORPIONIDA.

Centrurus gracilis Gervais.

From Citrus county (Weed); Miami, April; and Punta Gorda. Fairly common.

Centrurus carolinianus Beauvois.

From Citrus county (Weed) and Miami, March. The most common scorpion in the State.

Centrurus hentzi n. sp.

This is similar in most points to the preceding species, and may be but a variety of it, yet as the color differences are so constant I give it a separate name. The legs are marmorate with blackish; on the pedipalpi the tip of femur is blackish, the apical half of the tibia is marked with black, and also the outer side of the hand. The tail is marked with black below, leaving elongate pale spots, the basal joint only slightly marked. The stripes on the dorsum are very broad, leaving only a narrow white line between them. There is no median pale spot on anterior margin, which is seen in *C. carolinianus.*

Specimens from Runnymede, Oct., and Fort Reed.

Centrurus margaritatus Gervais.

From Biscayne Bay, several specimens, mostly immature.

Isometrus maculatus De Geer.

Dr. Marx had this species from Key West.

Tityus floridanus n. sp.

Dark red-brown; cephalothorax strongly granulate in front; an interrupted median ridge on the abdomen, and each segment with a curved middle row of granules each side, and the posterior margin granulate. Last segment of abdomen with the submedian ridges reaching nearly to base, the side ridges not half so far; below with four ridges, the side ones the longer. Tail with ten ridges on the first segment, eight on two, three and four; fifth segment with a median ridge below, as also on the last; a few lateral granules on these segments. Sting long and curved, the tooth beneath acute, but short. Pedipalpi long and slender; the femur subparallel, angular, with six ridges, a median one on inner side; tibia with two submedian ridges on inner side, a basal granule larger than others; tibia but slightly swollen. Hand swollen on base inside, not plainly angulate; the fingers longer than the hand.

Length 70 mm.

One male specimen from Key West. It has much resemblance to *Centrurus gracilis*, but the palpi are more slender and the segments of the tail are heavier.

Diplocentrus lesueurii Gervais.

One from Key West; the type was probably from Florida.

Opisthacanthus elatus Gervais.

Dr. Marx distributed specimens as coming from Southern Florida.

Order PHRYNIDA.

Admetus fuscimanus Koch.

From Runnymede, Nov.; and Punta Gorda, Febr. and April.

Order THELYPHONIDA.

Mastigoproctus giganteus Lucas.

From Runnymede, Punta Gorda, Jan.; and Altoona, July.

Order SOLPUGIDA.

Ammotrecha cubæ Lucas.

Specimens from "southern Florida," without further locality.

Order ACARINA.

TROMBIDIDÆ.

Trombidium sericeum Say.

A few from Punta Gorda, in April.

Ottonia trombidioides Banks.

Several from Punta Gorda, April.

Ottonia granulosa Banks.

Several from Punta Gorda, April.

RHYNCHOLOPHIDÆ.

Rhyncholophus maculatus Banks.

Several from Punta Gorda, Febr., April; Palm Beach.

Rhyncholophus longipes Banks.

From Palm Beach, March.

Rhyncholophus floridanus Banks.

Specimens from Punta Gorda, April.

Rhyncholophus simplex Banks.

Several from Punta Gorda, April; and Palm Beach, April.

Rhyncholophus punctatus n. sp.

Dull bluish gray, with a number of scattered small black spots above; legs paler. Body sparsely clothed with short erect hair, all of one kind. Body elliptical, rather broader before third legs. Palpi short, femora slightly swollen, penultimate joint ends in a single claw; the thumb but little swollen, and projecting beyond the claw, clothed with short hair. Legs slender, with short erect hair; leg I nearly as long as body, last joint swollen, two-thirds as long as penultimate joint; leg IV about as long as leg I, but the tarsus is not so much swollen and is barely more than one-half as long as penultimate joint.

Length 1 mm.

Several specimens from Palm Beach, in April.

Smaris australis Banks.

One from Punta Gorda, April, the type.

ERYTHRÆIDÆ.

Actineda agilis Banks.

From Punta Gorda, in March and April.

Erythræus sp.

One specimen from Palm Beach of an unknown species.

BDELLIDÆ.

Bdella cardinalis Banks.

Several from Punta Gorda, Febr., April; and Palm Beach, March.

EUPODIDÆ.

Tydeus gloveri Ashmead.

Not uncommon on oranges; it preys on the scale insects, but is not sufficiently numerous to do any great good.

TETRANYCHIDÆ.

Tetranychus mytilaspidis Riley.

This bristly species occurs throughout the State on orange leaves.

Tetranychus sexmaculatus Riley.

This species is also common in Florida on oranges.

Tetranychus tumidus Banks.

Taken at Eustis, on the leaves of the water-hyacinth (Webber).

Tetranychus bimaculatus Harvey.

Specimens from Punta Gorda, Key Largo and Eustis, on egg-plant and watermelon.

Stigmæus floridanus Banks.

Described from Florida, living in colonies upon the imbricated leaves of the pineapple.

IXODIDÆ.

Boophilus annulatus Say.

The Texas cattle tick has been recorded from Florida.

Ixodes scapularis Say.

A few from Lake Worth; Palm Beach, March; Punta Gorda, April: and Enterprise, April.

Dermacentor americanus Linn.

One from Miami, March (Laurent).

Amblyomma tuberculata Marx.

Described from Florida, as parasitic on the "gopher." I have several specimens from Enterprise.

GAMASIDÆ.

Macrocheles sp.

Two specimens of a large dark species from Punta Gorda, April.

Gamasus sp.

Various specimens of a species much like *G. coleoptratus*, and possibly identical, from Punta Gorda.

Lælaps sp.

A few specimens from Biscayne Bay, April.

Uropoda sp.

Specimens from Punta Gorda, April, and Biscayne Bay; probably representing more than one species.

Megisthanus floridanus n. sp.

Reddish-brown. Body egg-shaped; above smooth and shining, a few short hairs in front, and four longer ones on the anterior margin. Mandibles large, acute at tip. Leg I slender, about as long as width of body, with many short hairs; legs II and III short and stout, the femur tuberculate on one edge, each tubercle tipped by a stout bristle, long hairs near tip of tibia III, leg IV heavy, but longer than others, femora in front tuberculate and with bristles, behind with three rather blunt teeth, long hairs near tip of tibia; all legs, except I, end in a sucker, but apparently without claws.

Length 2.8 mm.

One specimen from Enterprise. This is the first record of this cosmotropical genus in the United States. It is a remarkable genus, readily known by the small size of the claws, the teeth on hind femora, and position of male genital orifice.

ORIBATIDÆ.

Galumna emarginata Banks.

Appears to be common at Punta Gorda, April, and Lake Worth.

Eremæus floridanus n. sp.

Pale yellowish-brown; abdomen smooth, polished, venter the same. Abdomen but little longer than broad, moderately high, no suture between it and so-called tectal plate; inferior and superior bristles very long and straight; setæ of moderate length, clavate; legs not very long, with many short hairs, all inserted on sides of body; coxal plate of two anterior pairs shows a line each side not reaching the middle, suture between third and fourth coxæ not reaching the middle; genital opening small, fully twice its diameter in front of the much larger anal opening. In general appearance it looks like *Galumna affinis*, but there is no trace of wings.

Length .6 mm.

One specimen from Punta Gorda, April.

I use the genus *Eremæus* for *Oppia* and *Oribatula* of Berlese.

Liacarus concolor Banks.

Several specimens from Punta Gorda, April. This species has about 20 or 24 short hairs on dorsum of abdomen, arranged in about 4 longitudinal rows. There is a short oblique ridge above the posterior coxæ extending up to cephalothorax.

Oribata floridana Banks.

A few specimens, the types, from Punta Gorda; it was described under the genus *Belba*. The type of this genus is unknown, but it must be very similar to the type of *Damæus*, which is congeneric with the type of *Oribata*. In place of the *Oribata* of authors I use the next name, *Galumna*. *Notaspis*, by the process of elimination, rests upon that genus for which Oudemans has proposed the name of *Kochia*. I deplore greatly the transference of the name *Oribata*, but it is a perfectly plain case; and since several European authors have adopted it, I accept it for the sake of uniformity.

Neoliodes concentricus Say.

A few specimens from Runnymede, Nov., and Enterprise.

Neoliodes floridensis Banks.

A number of examples from Palm Beach, and Lake Worth, in March.

TYROGLYPHIDÆ.

Tyroglyphus sp.

I have seen a species taken by Hubbard among scale insects on the orange trees. It is, I think, undescribed.

ERIOPHYIDÆ.

Eriophyes oleiovorus Ashmead.

The rust mite of the orange occurs commonly in most sections of Florida.

Explanation of Plates VII and VIII.

Plate VII, Fig. 1.—*Pardosa floridanus*, epigynum.
Fig. 2.—*Dendryphantes floridensis*, palpus.
Fig. 3.—*Sergiolus cyaniventris*, palpus.
Fig. 4.—*Sergiolus cyaniventris*, palpus.
Fig. 5.—*Epeira floridensis*, epigynum.
Fig. 6.—*Dendryphantes floridensis*, epigynum.
Fig. 7.—*Tityus floridanus*, pedipalp.
Fig. 8.—*Tityus floridanus*, sting.
Fig. 9.—*Philodromus floridensis*, epigynum.
Fig. 10.—*Dictyna floridana*, palpus and epigynum.
Fig. 11.—*Thargalia floridana*, epigynum.
Fig. 12.—*Mysmena bulbifera*, palpus.
Fig. 13.—*Mysmena bulbifera*, palpus.

Plate VIII, Fig. 14.—*Sergiolus cyaniventris*.
Fig. 15.—*Pardosa floridanus*.
Fig. 16.—*Lycosa hentzi*, palpus.
Fig. 17.—*Lycosa hentzi*, epigynum.
Fig. 18.—*Eremœus floridanus*.
Fig. 19.—*Anyphœna velox*, palpus.
Fig. 20.—*Megisthanus floridanus*.
Fig. 21.—*Philodromus floridensis*.

OBSERVATIONS ON TUPAIA, WITH REFLECTIONS ON THE ORIGIN OF PRIMATES.

BY HENRY C. CHAPMAN, M.D.

According to many anatomists, "the *Tupaiæ* possess a large cœcum."[1] It appears worthy of mention, therefore, that on opening recently the abdominal cavity of a specimen of *Tupaia ferruginea* from Borneo not a trace of a cœcum was to be seen (Pl. IX, fig. 1), confirming the statement recently made by the writer[2] that the cœcum was not invariably present in that Insectivore, nor was it present in a recently examined specimen of *T. pictum.* It may be stated, in a general way at least, that in mammals in which the stomach is large the cœcum is small, and *vice versa.* This inverse relation of the stomach and cœcum as regards size appears to be conditioned by the fact that in cases where gastric action is limited by the small size of the stomach, the lack of digestion is made up by the digestive action that goes on in the cœcum. It is not to be supposed, however, that the cœcum secretes a digestive juice like that of the stomach, but rather that the proteid elements of the food and the acids developed from the latter by fermentation act upon the residue of the food in the cœcum like the pepsin and hydrochloric acids of the gastric juice.

In cases, therefore, in which the stomach is large, as in that of the *Tupaia* examined, it might be expected that the cœcum would be found to be small, or even altogether absent. As a matter of fact, in the specimen of *Tupaia* dissected the stomach was relatively large, measuring in its long diameter 5 cent. (2 inches), the animal itself, from the vertex to the root of the tail, measuring only 20 cent. (8 inches).

The stomach was found distended to its utmost capacity, presenting an almost globular form, and filled with what appeared to be principally the remains of vegetable food, though some remains of insects were present. As gastric digestion appeared to be largely accomplished by the stomach in the case of the *Tupaia* examined, the entire absence of a cœcum becomes, after what has just been said, intelligible. The intestine, measuring 71.2 cent. (28.5 inches), exhibited throughout a uniform diameter, and was loosely suspended from the duodenum to the rectum by a continuous fold of peritoneum.

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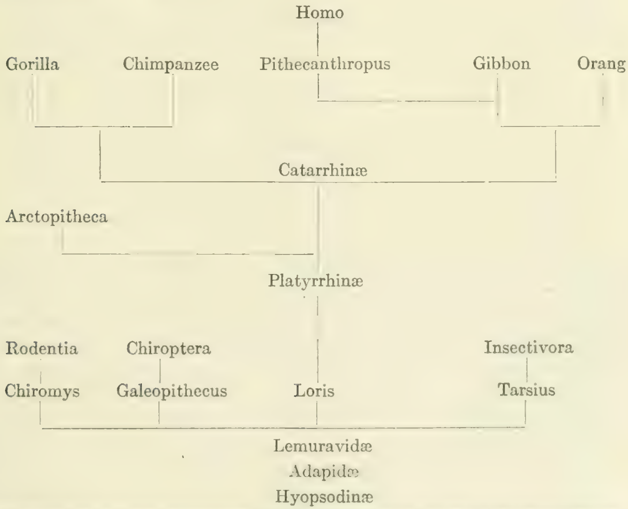
[1] HUXLEY, *Anat. of Vertebrated Animals*, 1872, p. 383; CARUS, *Zoologie*, 1868–75, S. 89.

[2] *Proc. Acad. Nat. Sci. Phila.*, 1902, p. 249.

The liver was divided into four lobes, the gall bladder lying as if in a hole in the cystic fissure.[3] The common bile duct passed into the intestine .5 cent. (one-fifth of an inch) from the pylorus, that of the pancreas about an equal distance from the orifice of the bile duct.

As *Tupaia* is usually regarded as being in its affinities the most lemurine of the Insectivora, and *Tarsius* the most insectivorous of the lemurs, the alimentary canal of *Tarsius spectrum* recently dissected by the author (Pl. IX, fig. 2) is submitted for comparison with that of *Tupaia*. It will be observed that in *Tarsius* a distinct cœcum is present, though not large, and that the stomach is very small.

In previous communications made to the Academy, the author called attention to the affinities of *Chiromys* and the Rodentia,[4] *Galeopithecus* and the Chiroptera.[5] If the structure of these animals has been correctly interpreted, and it be further admitted that *Tarsius* stands in a similar relation to the Insectivora, and *Loris* (*Stenops*) to the Simiæ, the phylum of these various orders would be related to each other somewhat as follows:



[3] Hunter, *Essays and Observations on Nat. History*, edited by Owen.
[4] *Proc. of Acad. Nat. Sci. Phila.*, 1900.
[5] *Proc. Acad. Nat. Sci. Phila.*, 1902

If speculation be further indulged in as regards the manner in which the descendants of cretaceous or eocene lemurs could be transformed into Platyrrhine monkeys like those living at the present day, it is readily seen, as suggested by Leidy,[6] "that but little change would be necessary to evolve from the jaw and teeth of *Notharctus* that of a modern monkey. The same condition which would lead to the suppression of a first premolar in continuance would reduce the fangs of the other premolars to a single one. This change with a concomitant shortening and increase of depth of the jaw, would give the character of a living *Cebus*. A further reduction of a single premolar would give rise to the condition of the jaw in the Old World apes and man." In the union of the rami of the jaw at the symphysis, in the small size of the condyle, in the number of the incisors, canines and true molars, nearly alike in their constitution and in their crowded condition, the lower jaw of *Notharctus* resembles most strikingly that of a Platyrrhine monkey. Like Leidy, both Cope and Marsh regarded the Platyrrhine monkeys, on the one hand as the descendants of extinct lemurs, and, on the other, as the ancestors of the Catarrhinæ.

Thus Cope,[7] basing his view upon the structure of *Tomitherium*, offered as a possible phylum the following:

Homo
|
Simiidæ
|
Cebus
|
Hapale
|
Lemur
|
Tomitherium

though later, as we shall see presently, he modified the above view[8] somewhat, finally regarding man and the anthropoids as having probably descended directly from extinct lemurs like *Anaptomorphus*. By similar reasoning from the study of closely affiliated, if not identical, Lemuroid genera: *Limnotherium* (*Tomitherium*), *Antiacodon* (*Anaptomorphus*), Marsh,[9] in referring to the origin of the Primates, was led to the conclusion that "we may justly claim America for the birthplace of the order."

Why the Old World apes, when differentiated, did not come to the

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[6] *Extinct Vertebrate Fauna*, 1873, p. 90.
[7] Mammalia Educabilia, *Am. Phil. Soc.*, 1873.
[8] Lemuroidea, etc., *American Naturalist*, 1885, p. 467.
[9] *Vertebrate Life in America*, 1877, p. 52.

land of their earlier ancestry is readily explained by the then intervening oceans, which likewise were a barrier to the return of the horse and rhinoceros. Man, however, came doubtless first across Behring's Straits, and at his advent became part of our fauna as a mammal and primate.

As a confirmation of the view that the Platyrrhinæ have descended from monkeys, it may be mentioned that while the remains of *Cebus, Mycetes, Callethrix,* and *Hapale* have been found, according to Ameghino,[10] in the Pleistocene strata of Brazil, extinct lemurs, such as Notopithecidæ and Homunculidæ, have been discovered recently, according to the same high authority, in the eocene deposits of South America.[11] Indeed, according to Ameghino,[12] the Homunculidæ are to be regarded as the "ancêtres de tous les singes du nouveau que de l'ancien continent les lémurs excepte." Cope appears to have taken the same view as that expressed by Ameghino. In speaking of certain extinct forms of monkeys found in Patagonia, he remarks that they "appear to be ancestors of the existing South American monkeys (Cebidæ), and possibly of the Old World monkeys also."[13]

It should be mentioned, however, that these fossils are regarded by some paleontologists as being rather the remains of Platyrrhine monkeys than lemurs. Should such prove hereafter to be the case, it will not weaken the argument, since in that case the forms in question, if not lemurs, would be intermediate in character between the latter and Platyrrhine monkeys. The remains of Catarrhine monkeys, such as *Papeo, Macacus, Semnopithecus,* and possibly even of the chimpanzee and orang, have been found in the Pliocene deposits of India.[14]

Such facts are, however, not inconsistent—indeed, have little or no bearing upon the question of the derivation of Catarrhine from Platyrrhine monkeys—since the only assumption that would be necessary would be to suppose that the Platyrrhine ancestors of the fossil Pliocene Catarrhines existed once in India or elsewhere. It may be said, however, that this is assuming the very question at issue, a case of *petitio principii;* but the reverse proposition, that the Platyrrhine have descended from the Catarrhine monkeys, is untenable, being inconsistent with the well-established fact that the more ancient members of a group of animals had always more teeth than the later more recent

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[10] *Actas Sciencias Cordoba,* T. VI, 1889, p. 101.
[11] *Bol. Acad. Nac. Buenos Aires,* T. XVII, 1902, p. 7.
[12] *Op. cit.,* T. XIII, 1902, p. 265.
[13] *Organic Evolution,* 1896, p. 154.
[14] Flower and Lyddeker, *Mammals Living and Extinct,* 1891, pp. 723, 727, 738.

members of the same. Thus among the Prosimiæ, for example, the oldest members of the group, the Hyopsodinæ, possessed 44 teeth = $\frac{3.1.4.3}{3.1.4.3}$ in each jaw, the more recent Adapidæ 40 teeth = $\frac{2.1.4.3}{2.1.4.3}$, the most recent Lemuridæ 36 teeth = $\frac{2.1.3.3}{2.1.3.3}$, the Platyrrhinæ 36 teeth with the exception of the *Arctopitheca* 32 teeth = $\frac{2.1.3.2}{2.1.3.2}$, and finally the Catarrhinæ, including the anthropoid apes and man, 32 teeth = $\frac{2.1.2.3}{2.1.2.3}$. It is highly improbable, if not impossible, therefore, to say the least, that Platyrrhine monkeys with 36 teeth should have descended from Catarrhine ones provided with only 32; that 4 premolar teeth, absent in the ancestors, once lost, should reappear again in their descendants—an objection that equally applies to Cope's derivation of *Cebus* with 36 teeth from *Hapale* with 32, as previously mentioned.

Further, the Platyrrhine monkeys resemble lemurs in many more respects than in the mere number of the teeth, thus showing their inferior position in zoological rank as compared with the Catarrhines. Thus, for example, the oblique ridge extending from the anterior internal cusp (protocone) to the posterior external cusp (metacone) of the upper molars in *Ateles* and *Mycetes*, and many other South American monkeys, is present in certain lemurs, such as *Nycticebus*, *Arctocebus*, *Loris*, as also in anthropoid apes and man, though absent in the remaining Catarrhines.[15] Now the presence of this oblique ridge in the upper molars of lemurs, apes and man was regarded by so high an authority as Cope as such an important feature in their structure that it largely influenced that great paleontologist in suggesting the view, already alluded to, that man and apes are the direct descendants of lemurs rather than of Catarrhines.

It is obvious, however, that if Cope's argument is of any force in the above instance, it must be of even greater cogency in showing that Platyrrhine monkeys have descended from lemurs, since lemurs and Platyrrhinæ not only exhibit the "oblique ridge" in their molars, but possess many other structural features in common, whereas lemurs are relatively so low in the zoological scale that they are not regarded by most anatomists as being primates at all. Indeed, Cope might just as well have argued that man has descended from a Platyrrhine monkey as from a lemur, the evidence adduced being about as good for the one view as the other; for even if the "centre of motion" of the vertebral column and the "anticlinal vertebra," the number of vertebræ entering into the formation of the sacrum, etc., are only the same in man, anthropoids and *Nycticebidæ*,[16] nevertheless in other respects—in fact,

[15] Tomes, *Dental Anatomy*, 1876, pp. 7, 370.
[16] Flower, *Osteology of Mammalia*, 1870, pp. 47, 24, 60.

in the totality of their organization—man and anthropoids resemble the Catarrhine monkeys far more than lemurs. Had Cope, at the time he described *Anaptomorphus*, been aware that the placenta of *Tarsius*, a closely affiliated lemur, was discoid in form and highly complex in structure rather than diffuse and non-deciduous, as in other lemurs, his view of the lemuroid descent of man would have been strengthened by an argument of far more weight than one based upon the presence of an oblique ridge on certain teeth and the number of sacral vertebræ, which vary even in different individuals of the same or closely allied species. Apart from the number of the teeth being the same in Platyrrhines and lemurs, the lemuroid character of dentition of the former is clearly manifested by the long narrow inferior incisors of the South American Saki (*Pithecea*).

Further, in all Platyrrhine monkeys, as in most lemurs, the base of the petrosal bone is excavated by that part of the lateral cerebral venous sinus terminating at the postglenoid fossa. Similarly in both lemurs and Platyrrhines the malar bone is perforated by that branch of the facial nerve known to the classical anatomist as the "nervus subcutaneus malæ." Again, in many Platyrrhines—as, for example, in *Cebus*, *Ateles*, *Nyctipithecus*—a small unossified vacuity is exhibited in the bony plate separating the orbital from the temporal fossa, evidently the relic of the space by which the two fossa freely communicate in the lemurs.

In all the South American monkeys the tympanic bone retains more or less its primitive ring-like form, the cavity of the tympanum lying close to the external wall of the cranium, its inferior surface, together with that of the anchylosed penotic bone, exhibiting a very swollen appearance. In this respect the Platyrrhine monkeys agree with the lemurs, in which the inferior surface of the tympanum presents a large rounded bulla, and differ from all Old World monkeys, in none of which an auditory bulla is ever present. The otosteals of the Platyrrhines resemble those of lemurs more than those of Catarrhines, monkeys, apes or man.

It is an interesting fact, also, that while the macula lutea is present in the eye of man, apes and Catarrhines, it has never been found, so far as known to the writer, in any Platyrrhine or lemur.

As reference has been made to the character of the vertebræ in man and Nycticebidæ, it may be as well mentioned in this connection that in the lemur *Galago* the posterior edges of the spinous processes of the lumbar vertebræ present a pair of processes which, projecting backward, clasp the anterior edges of the succeeding spinous process, and that similar processes, though not so well developed as in *Galago*, are present in certain species of South American monkeys, as, for example, in *Lagothrix* and *Mycetes*. The presence of these processes is quite as strong a proof that Platyrrhines have descended from lemurs as are the peculiarities in the vertebral column already referred to that man has descended directly from a lemur. It is well known that while the supracondylar perforation of the humerus is not found in any Old World monkey, nor in *Hapale, Ateles* or *Mycetes* among those of the New World, nevertheless such perforation is found in the Cebidæ and most of the lemurs. It would be tedious to show in further detail that, as regards the muscular system, the character of the brain, the larynx, the alimentary canal, and in many other respects, the Platyrrhine monkeys are less specialized than the Catarrhines, which has induced the majority of anatomists to regard the New World monkeys as of higher rank zoologically than the lemurs, but lower in the scale of life than the Catarrhines, occupying an intermediate position between the two. This is consistent with the view that they are the descendants of the one and the ancestors of the other.

This conclusion has been confirmed in late years by the remarkable researches of Selenka,[17] Strahl,[18] and others, who have shown, in a general way at least, that the transitory stages through which the placenta of man and anthropoids pass are permanently retained as the placenta of certain marsupials, lemurs, *Tarsius*, Platyrrhines, Catarrhines, illustrating the law that in the development of the placenta the ontogeny is as elsewhere the epitome of the phylogeny.

Thus while in marsupials like *Macropus* the allantois remains free, as first shown by Owen,[19] and nearly fifty years afterward by the writer,[20] in *Perameles* and *Dasyurus* the allantois, it is said, adheres to the mucous wall of the uterus, forming at least the beginning of a placenta, without, however, a decidua or chorionic villous process being developed. In lemurs, while no decidua is as yet developed, the chorion exhibits villous processes which insinuate themselves into the mucous wall of the uterus. In *Tarsius*, however, the allantois begins to form a true disk-like placenta with a veritable decidua—"nicht eine lockere gross zottige diffuse Placentation wie Lemur und Nycticebus sondern eine hoch komplicirte und diskoide Placenta besitzt."[21]

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[17] SELENKA, *Studien über Entwickelungsgeschichte der Tiere*, 1900, S. 176.

[18] STRAHL, in O. Hertwig's *Entwickelungslehre der Wirbeltiere*, Dritte Lieferung, 1900, S. 235.

[19] *Phil. Trans.*, 1834, 27.

[20] *Proc. Acad. Nat. Sci. Phila.*, 1881.

[21] HUBRECHT, *Die Keimblase von Tarsius*, 1896, S. 15.

The placenta of the New World monkeys exhibit a step further in advance the difference from the placenta of *Tarsius*, being however, one of degree rather than of kind.

In the Old World monkeys the allantois forms a double placenta, a primary large dorsal one and a secondary small ventral one (Plate X). While this appears to be normally the case, it should be mentioned that the writer observed but one placenta in the case of a pregnant female of *Macacus cynomolgus* examined by him, though the pregnancy was far advanced in both instances.[22] It will be observed that in the case of the *Macacus* (Plate X), the two placentas are not entirely separated as is usually the case in Catarrhines, being joined by a small body of tissue.

It is also a significant fact that while two umbilical veins and two umbilical arteries are always present in the umbilical cord of the New World monkeys, but one umbilical vein is present in that of the Old World ones. Finally, the placenta of the anthropoids agrees essentially with that of man.

In the opinion of the writer, therefore, the phylum submitted at p. 149, essentially that of Haeckel,[23] expresses about the truth as to the descent of man, etc., so far as can be learned at present from the facts of palæontology, comparative anatomy and embryology, that bear upon the question. That the ancient Prosimiæ, Hyopsodinæ, Adapidæ, etc., have descended from some ungulate type of life is manifested by their affinities with the latter group of mammals. Indeed, Cuvier described *Adapis* as "un autre genre de pachyderme —et que je nommerai provisoirement Adapis,"[24] while, according to Leidy, *Notharctus tenebrosus* was "a small extinct pachyderm, resembling that of some of the existing American monkeys quite as much as it does that of any of the living pachyderms."[25]

It is quite possible that future researches may show that there is no genetic connection between *Chiromys* and the Rodentia, but that the rodent-like teeth of the former and of the wombat may have been acquired independently by a process of natural selection, it being easy to see, according to Tomes,[26] "how a rodent type of dentition is beneficial to its possessor by rendering accessible articles of food wholly unavailable for creatures which have no means of gnawing through a

[22] *Proc. Acad. Nat. Sci. Phila.*, 1879, p. 146.
[23] *Anthropogenie*, Zweiter Band, 1903, S. 650.
[24] *Ossemens Fossiles*, Tome 5^{me}, 1835, p. 460.
[25] LEIDY, *op. cit.*, pp. 86, 89.
[26] *Op. cit.*, p. 249.

shell or other hard body," the theory being, according to Darwin, that a small variation arising in the dentition through some nutritive change, and being of advantage in the struggle for life, would be intensified in successive generations until, in the end, a type of tooth would be evolved such as is presented in the case of the wombat, *Chiromys*, and Rodentia living in far distant parts of the world.

Finally, in the judgment of the writer, man cannot have descended from either the gorilla, chimpanzee, the orang or gibbon, since, apart from the structural difference between any one of them and man being too great to warrant such an hypothesis, the three great anthropoid apes are obviously degenerates leading to no higher form of life, but rapidly dying out, as shown by the fact that these apes resemble man much more when very young than when adult. While it is true that the gap between man and the gibbon is greater than between man and the remaining apes, nevertheless, as *Pithecanthropus erectus*, whatever its real nature may be, is something more than a gibbon, and yet something less than a man—more ape-like than any man, and more man-like than any ape [27]—by a method of exclusion the conclusion is reached that the man and gibbon are related in some way.

It must be admitted, nevertheless, that the question of the exact origin of man is largely as yet one of speculation, and that future researches may show that our ancestors may have been extinct Catarrhine or Platyrrhine monkeys or even lemurs.

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[27] E. Dubois, *Pithecanthropus Erectus*, 1894.
O. C. Marsh, *On the Pithecanthropus*, etc., 1895.
Schwalbe, Studien über Pithecanthropus erectus, *Zeits. für Morph. v. Anthr.*, 1899, S. 16.

SABELLIDÆ AND SERPULIDÆ FROM JAPAN, WITH DESCRIPTIONS OF NEW SPECIES OF SPIRORBIS.

BY J. PERCY MOORE and KATHARINE J. BUSCH.

In these PROCEEDINGS for 1903 was published a paper describing most of the Polychæta taken in Japanese waters and elsewhere in the North Pacific in the spring of 1900 by the U. S. F. C. steamer *Albatross*. The present paper is a continuation of that contribution, and is based on the same collections. A third part will some time deal with a number of species belonging to various families, the descriptions of which are withheld until some desirable comparisons can be made. Among the species previously described a considerable admixture of circumboreal forms was found, most of them from the more northern stations. That none such is found among the Sabellidæ and Serpulidæ probably results from the fact that all of the species described in this paper came from the southeastern coast of Honshu, and especially from Station 3,707, on a sandy and gravelly bottom in Suruga Bay. Saint-Joseph's revision of these families was largely used as a guide in the generic references, but even with this help much difficulty was found in satisfactorily placing several of the species, and it will be noticed that some of them, and particularly *Sabella japonica* and *Pomatoceras auritubis*, depart widely from the generic types in some respects. In the enumeration of segments the collar setæ have been counted as belonging to the first of peristomial somite.

I take this opportunity to state that *Maldane coronata* and *Axiothea campanulata* of my former paper are synonyms respectively of *M. gotoi* and *Clymene harai* Izuka. Although Izuka's paper was published some months before mine it was not seen by me until after the correction of the final proofs.

Sabella japonica n. sp. (Pl. XI, figs. 1, 2; Pl. XII, figs. 39, 40.)

Without the branchiæ the type specimen has a length of 25 mm., of which the thorax takes 5 mm., and is 2.5 mm. in diameter; the detached branchiæ are 7.5 mm. long. A second specimen without branchiæ is 23 mm. long. As the branchiæ are detached some doubt attaches to them. They are much twisted, with 15 pairs of rather short, thick radioles slightly coiled inward at the ends; the barbs are double-ranked, very close together, and have a nearly uniform length of 1.3 mm. to the end of the radioles. No eyes are visible. The second radiole from the dorsum of the right side terminates in a membranous vesicle which is probably pathological, but which would act much like the operculum of *Apomatus*. The branchial lobes are slightly involute ventrally. The collar is stiff and erect, separated by the entire width of the body dorsally, but prolonged ventrally as a pair of abrupt prominent narrow lobes in contact at the base. Except for very slight lateral emarginations the margin is entire. The thoracic region is nearly terete, the abdominal somewhat depressed and of a uniform width except at the tapering caudal end. There are 8 setigerous thoracic and 55 or 56 abdominal somites, mostly distinctly marked and uniannulate. Thick and very distinct ventral plates occupy the neural third of the body. Those of the thorax are twice as wide as long and undivided, except the first, or peristomial one, which is as wide as long and of a sugar-loaf shaped outline. The first abdominal plate is pentagonal, the others are divided into two equal squares by the fæcal groove which is very distinct ventrally, but, after turning to the right in the furrow $^{\mathrm{IX}}/_{\mathrm{X}}$, and bending forward on IX, disappears totally on the side of the latter below the setæ. There is no trace of the dorsal groove. The setigerous and uncinigerous tori are strictly lateral and not elevated above the general surface of the body; the latter diminish in size caudally. The body cavity is filled with rather large eggs.

All of the setæ (Pl. XI, fig. 1) are of the winged capillary type, but differ considerably in length, slenderness and width of the wing. They are very nearly straight, very acute, and, although obliquely striated, the wings have entire margins. Both avicular and pick-shaped uncini occur on the thoracic, the former only on abdominal somites. Their number is always small—*e.g.*, 27 of each on III, 21 on VI, and 20 on VIII, while never more than 18 of the aviculæ only occur on abdominal somites. In both regions they rapidly diminish in size from the end of the tori nearest to the setæ, the smallest in the abdominal tori not exceeding $\frac{1}{3}$ the size of the largest. In the thoracic region the same statement applies to the pick-shaped hooks. The thoracic avicular uncini (fig. 39) have elongated bodies, about equalling the elevated neck and head, the posterior process slender and produced, and the breast small, but abrupt and strongly convex. The neck meets the body nearly at a right angle, is high and erect, and curves broadly and regularly into the stout tapering beak without any distinct enlargement into head or crest. The crest is represented by a fine striation near the vertex without any elevation or free teeth. The sinus is very open with nearly straight parallel sides. On the abdominal somites these uncini (fig. 40) differ in the much reduced posterior process, the deeper, more sloping breast and the more wedge-shaped sinus. The figure is, however, somewhat foreshortened. The smaller uncini (fig. 2) have a peculiar form, which is transitional between the avicular and the usual pick-shaped uncini. The slender stem or body is bent strongly and slightly thickened, but lacks a distinct breast. The head is slightly enlarged with a very short, stout, slightly decurved beak and a prominent cap-like crest, much subdivided; from the base of the beak projects a slender angulated filament. In the form of the small uncini this species departs widely from the typical *Sabellæ*.

Suruga Bay, 3,707, 63–75 fms. Type and one other.

Potamilla acuminata n. sp. (Pl. XI, figs. 3–6; Pl. XII, fig. 41.)

This species is elongated and slender, a complete example having a total length of 56 mm., of which the branchiæ are 20 mm. and the thorax 5 mm., the diameter being 1.9 mm.

The branchiæ are more than $\frac{1}{3}$ of the total length, and when retracted into the tube are not at all or very slightly twisted and coiled. Two specimens have 19 radioles on the right, 17 on the left, the other having 15 and 16 respectively. They are straight, slender, of nearly uniform diameter, without eye-spots, and bear barbs nearly or quite to the tips in the dorsalmost radioles, but have a free end devoid of barbs and of considerable length in the ventral ones. Most of the radioles are provided with a short membranous wing on the inner side of the base, but there is no trace of a connecting web. The barbs have the usual biserial arrangement and equal or exceed the diameter of the body, with little diminution toward the distal end. The bases are entirely simple.

The collar is scarcely evident dorsally, but becomes prominent opposite to the dorsal setæ line, just below which is a barely distinguishable fold. On each side of the median ventral line is a broadly rounded, flat, somewhat thickened process, about as long as the first somite. In the retracted specimens these overlap medially. The entire ventral portion of the collar, except the ventral lobes, is extremely thin and delicate.

Between the bases of the branchiæ is a small rounded prostomial lobe, from which a broad folded membrane extends laterally around the mouth and joins the bases of the branchiæ. Connected with the inner side of the latter also are the so-called tentacles, consisting of a pair of processes about twice as long as the second somite, with the leaf-like basal part folded longitudinally to form a groove, and the terminal $\frac{1}{3}$ attenuated.

The complete specimen has 8 setigerous thoracic and 68 abdominal somites. The body is nearly terete throughout and has a nearly uniform diameter, except at the posterior end. Anteriorly the parapodia are not at all elevated, but become rather prominent posteriorly. Except the peristomeum all somites have sharply defined ventral plates. In one specimen all, and in the others all but the first 8, are divided into 2 equal squares by a ventral groove. The pygidium has the form of a slightly oblique welt-like fold, which bounds the anus dorsally and laterally. The fæcal groove is well-marked ventrally from the anus to the somite IX, on which it passes caudad of the ventral plate to the right and then bends sharply forward and passes obliquely anterior to the seta bundle to the dorsum, where it disappears.

All of the setæ and uncini are of a pale glistening yellow color and have the arrangement usual in the genus. The setæ of II are all of the winged capillary type, but differ in length, width of wing and degree of curvature or bending. The more slender and regularly curved ones are dorsal. The 7 succeeding thoracic somites bear both capillary in the dorsal and paddle-shaped setæ in the ventral part of the bundles. The former (fig. 3) have the characters just described, but the more ventral ones exhibit transitions toward the broad form in the tendency of the wing to widen and split into two divergent symmetrical plates. The two kinds are, however, always distinct. The paddle-shaped setæ (fig. 5) are arranged in a short, close phalanx. They have relatively stout, slightly tapering, striated stems, with the short, broad wings together forming a thin ovate expansion which tapers distally into a mucronate tip, whose length equals the greatest width of the blade and which is bent out of the plane of the latter. On the abdominal somites only capillary setæ (fig. 4) again occur, and in gradually diminishing number. The more slender, elongated, nearly wingless ones are usually paired with shorter broader ones.

On the thoracic segments the uncinigerous tori are flush with the surface of the body and bear the two kinds of uncini in parallel vertical rows, the aviculæ being anterior. On somite III there are 44 of each, on VI 32, and a further reduced number on VIII. The avicular uncini (fig. 41) have the slender posterior process and the erect portion equal and meeting at a right angle; the breast nearly hemispherical; the neck erect and straight; the beak moderately long, acute and straight, and inclined sharply downward with the lower margin parallel to the breast; the crest elevated and much subdivided, with about 5 distinct teeth along the profile. The pick-shaped uncini (fig. 6) are more characteristic. They have slender, slightly curved stems, slightly increasing in diameter toward the distal end, and exceed the total length of the avicular uncini. The head is small, with a rounded back, and a short blunt beak, enclosed in a delicate and transparent hood, the base of which is often inflated, and the distal part prolonged at right angles to the stem into an exceedingly delicate and attenuated process, which, though varying considerably in length, always much exceeds the length of the head of the avicular uncini. The latter only occur on the abdomidal somites, where they form short vertical series of from 12 to 18. Except that the upper outline of the breast is more sloping, they have exactly the form of the thoracic ones.

In the form of its setæ this species closely resembles *Sabella* (*Potamilla*?) *assimilis* McIntosh, but the pick-shaped uncini of that species have not been described. It was dredged by the *Challenger* in 600 fathoms off Buenos Ayres. It also agrees fairly well with the *Potamilla torelli* of Marenzeller and Langerhans, but not with Malmgren's original description.

The tube is circular and tortuous, of a tough cartilaginous consistency, covered evenly with very fine sand and has a clear line, evidently of attachment, along one side.

Sagami Bay, 3,698, 153 fms., 2 specimens and fragments of a third, with tubes.

Hypsicomus lyra n. sp. (Pl. XI, figs. 7–13; Pl. XII, fig. 42.)

The type is very long and slender, having a total length of 84 mm., the thorax 6 mm. and the gills 20 mm.; the diameter is 1.6 mm.

As seems to be usual in the genus, the basal lobes of the gills are quite prominent, about equalling the length of the first 3 somites, and their somewhat membranous dorsal and ventral margins overlap in the middle line. The distal end is strictly transverse and even, so that the radioles all arise from the same level. The radioles are long, slender, straight, not winged, and united by a web for the basal $\frac{1}{6}$. The double-ranked barbs are very numerous, slender and long, their length about equalling the diameter of the body, but diminishing somewhat before the short, naked tip of the radiole is reached. A conspicuous zone of reddish-brown eye-spots occupies about the third $\frac{1}{10}$ of the branchiæ, though they exhibit much irregularity in arrangement, and seldom occupy this entire distance on individual radioles. Each radiole bears a series on each outer margin, but the number varies from 5 to 20 or more, and they may be widely separated, much crowded or even coalesced. They also vary much in size, and the two series on a radiole are seldom symmetrical.

The collar is simple, cleft, but in contact and slightly inturned dorso-medially. The dorsal half is low, of an even height, and has a slightly wavy margin. The ventral half rises very gradually to the apex of the triangular lobes which nearly meet in the middle line but diverge distally. There are no lateral incisions.

A pair of prominent tentacles are united with the middle of the inner face of the undivided base of the palpi. They rise freely to a length exceeding that base, and consist of a foliaceous proximal $\frac{1}{3}$, and a narrow ligulate distal $\frac{2}{3}$. Besides these a pair of minute processes occur side by side on the middle of the head disk, and probably represent the true prostomial tentacles.

The 174 to 184 somites, of which 8 are thoracic, form a slender, elongated body, terete anteriorly, but very strongly arched above and with a sole-like ridge formed by the ventral plates in the posterior part. The lozenge-shaped anus is situated in a small pygidium. In the thoracic region the segments are longer and distinct; in the abdominal they are very short and posteriorly much crowded. Here the body walls are very thin and distended by the well-filled intestine. The ventral plates of the thoracic region are not elevated above the general surface, but occupy the entire area between the tori. They are separated from each other by deep transverse grooves, and the first from the peristomial collar by a deep brown or black, apparently chitinous line. The first is about 4 times as broad as long, the second 3 times, and the others not over $1\frac{1}{2}$ times. The first abdominal plate is about $\frac{2}{3}$ as long as the last thoracic, the second is polygonal, and the others become successively shorter to the caudal end and form a deeply pigmented, narrow, sole-like ridge, divided from the anterior margin of the third one to the anus by the fæcal groove. The fæcal groove divides the ventral plates continuously to the posterior margin of somite X, around which and IX it passes obliquely to the right, and then along the middle of the dorsum of the thoracic segments, on which, however, it is very faint.

Dense tufts of setæ occupy the dorsal portion of the setigerous tori on II to VIII inclusive, and smaller tufts of very prominent setæ project from the ventral side of those of all abdominal somites. On somite I are two setigerous lines shaped like the sides of a lyre, which begin with a just perceptible curve slightly dorsad of the succeeding tuft of setæ, and diverge obliquely forward in a nearly straight line to the base of the collar, on which they extend as an inturned loop of very minute setæ. The thoracic uncinigerous tori are strictly vertical, and ventral to the setæ, and occupy an area on each side about equal to the ventral plates. The abdominal tori are dorsal to the setæ and quite short.

On somite I the collar setæ are arranged in a double series along each line. Those of the dorsalmost series (fig. 8) are stouter, nearly straight, and are terminated by an elongated conical hood or sheath more or less inflated at the base, and usually bent or wavy in the slender distal half. They are evidently intermediate in structure between the pick-shaped uncini and limbate setæ. Those of the ventralmost series (fig. 7) are more slender, sharply curved at the end, and provided on the convex side with a short but broad obliquely striated wing. The remaining thoracic somites contain curved limbate setæ in the dorsal part of the fascicles and paddle-shaped spatulate setæ ventrally. The former (fig. 9) present no noteworthy features. The latter are arranged in close double file, those of the cephalic file (fig. 10) being stouter with very broad, truncate, usually more or less asymmetrical blades; those of caudal (fig. 11) row have nearly circular blades, which usually bear a smooth-edged mucronate tip as long as or slightly longer than the blade. In the abdominal fascicles are 2 or 3 slender, nearly or quite wingless capillary setæ, and a small number of paddle-shaped setæ (fig. 12), with small ovoid blades and a prominent, stout, fringed terminal process 2 or 3 times as long.

There are about 60 of each kind of uncini in the thoracic rows beginning with II. The avicular form (fig. 42) has the base straight, much prolonged posteriorly, and with a small rounded breast. From the base the short, somewhat tapering neck inclines forward at an angle of about 120°. There is no enlarged head, but the vertex is high, prominent and narrow, with the rather short, straight conical beak bent down at a sharp angle. The crest is scarcely differentiated, the front of the vertex being only faintly striated and not at all subdivided. Pick-shaped uncini (fig. 13) are well differentiated and regularly paired with the larger ones. They have straight, column-like stems, and hollow sheath-like heads (sometimes slightly inflated), running into slender, tapering processes nearly at right angles to the stem. The abdominal uncini are fewer, smaller, and have longer necks than the thoracic avicular uncini, but are otherwise quite similar.

The tube is slightly sinuous, nearly round in section and about 2.3 mm. in diameter. It has a peculiar tough horny texture, is thin-walled and deep brown or almost black.

From *H. phæatænia* (Schmarda) Marenzeller this species differs especially in the presence of mucronate paleæ in the thoracic tori and in the greater number of setæ and paleæ in the abdominal somites, as well as in the form of the paleæ and pick-shaped uncini and the arrangement of the eyes.

Suruga Bay, 3,707, 63–75 fms., 4 specimens, with tubes.

Dasychone japonica McIntosh.

The specimens have a length of 40 mm., the branchiæ being 13. There are 8 setigerous thoracic and 76 abdominal somites and 28 to 30 branchial plumes. With the exception of occasional variations having a second small accessory tooth, the uncini are exactly as figured by McIntosh. The tentacles are lanceolate, $\frac{1}{3}$ the length of the branchiæ and thickly spotted with reddish-brown. Two specimens, one in a membranous tube to which various foreign bodies are attached, from an unknown station.

The first dorsal appendage of each branchial radiole is fully twice as long as and much thicker than any of the others, and is single, and not paired, as the others are. The collar begins dorsally as a prominent lobe, which includes the first fascicle of setæ; ventrally it is thickened and the ventral lobes overlap medially for nearly their entire width. There are no lateral incisions.

Laonome tridentata n. sp. (Pl. XII, fig. 44.)

The type and only specimen is 44 mm. long without branchiæ, which are 9 mm. in length; the thorax is 7 mm. long and 4 mm. diameter.

The detached branchiæ found in the same bottle are not known with absolute certainty to belong to this species. The basal part of each palp forms an undivided plate about twice the length of the peristomium and of a scroll-like form with a slightly spiral roll. Each bears 15 rather thick short radioles not exceeding twice the diameter of the thorax. The longest barbs or filaments at the base have a length equalling about $\frac{1}{4}$ of the body diameter, and they diminish toward the end, where the radiole terminates in a slender naked filament longer than the longest barbs. There are no eyes.

The peristomial collar is about as long as the second somite, slightly more produced on the ventral side and consequently somewhat oblique. It is deeply cleft in the middle line dorsally and slightly so ventrally, but without lateral incisions. It is thick and stiff, with the margin entire and slightly produced, but not lobed ventrally.

There are 8 setigerous thoracic and 62 abdominal somites. The body is slightly flattened, with a nearly uniform width, tapering somewhat toward the posterior end, where it terminates in a slightly oblique pygidium with a somewhat ventral anus. The peristomium and the base of the collar are dusky with numerous minute spots, which continue also on to the sides of several of the succeeding somites. No distinct ventral plates are developed, but the entire body wall appears to be somewhat glandularly thickened. Throughout the abdominal region the fæcal groove is very narrow but distinct. Reaching the ventral middle line of IX it bends to the right and passes obliquely across that segment to the level of the setæ, then in the furrow VIII/IX for a short distance, and obliquely across the dorsum of VIII to its anterior border at the dorsal middle line, from which point it continues forward, becoming very deep on II and I, and finally disappears in the dorsal collar cleft.

The thoracic setigerous tubercles are quite prominent and the uncinigerous tori very long, the most anterior ones nearly meeting ventrally and the posterior not much shorter. The abdominal tori are about $\frac{1}{3}$ as long as the anterior thoracic.

The setæ occur in strong tufts, but all are broken short off at the body surface. A few fragments of the terminal parts indicate that they are short and stout, with broad blades distinctly denticulated on the margins. Both thoracic and abdominal somites bear rather large uncini, all of one kind and arranged in a single series. A torus on somite V contains 112, all of one size; on the abdominal somites they are about $\frac{2}{3}$ as large, and 41 were counted on somite XI.

They have the form (fig. 44) represented by Malmgren for the type of the genus and quite unlike that figured by Marenzeller for his *Laonome japonica*. The base is abruptly truncated posteriorly, nearly continuing the direction of the posterior line of the neck, but is produced anteriorly into a remarkably prominent breast that reaches beyond the tip of the beak. A short, thick, erect neck is surmounted by a scarcely enlarged head with a prominent, acute, slightly recurved beak nearly parallel with the opposite border of the breast, from which it is separated by a sinus much narrower than the diameter of the neck; the elevated crest is composed of 3 or rarely of 4 very distinct, acute, solid teeth of diminishing size.

Suruga Bay, 3,707, type only, without tube.

Euchone alicaudata n. sp. (Pl. XI, figs. 14–16; Pl. XII, fig. 43.)

The single example was taken from a tube and is regularly rounded and of equal diameter, with the somites very indistinctly indicated, except at the caudal end, where the body is flattened and tapers abruptly. The total length is 38 mm., the thorax 6.5 mm., and the branchia 13 mm. There are eight setigerous thoracic and twenty-five abdominal somites. The thoracic and most of the abdominal somites are obscurely equally biannulate. Ventral plates are confined to the thoracic segments and are divided into two equal parts by the transverse interannular furrows. The last eight abdominal somites are more distinctly differentiated, and decrease rapidly in diameter to the short rounded pygidium. From them the broad caudal membrane arises just ventrad of the setæ, continuing anteriorly around the ventral surface nearly to the middle line, but posteriorly spreading widely as a horizontal plate with a median emargination in which the pygidium lies. The basal part of the membrane exhibits distinct metameric thickenings which disappear toward the margins.

The anus is situated slightly ventrad in a small slit, from which the very faint fæcal groove passes forward between the ventral cleft of the caudal membrane to the posterior margin of somite IX, where it turns to the left, passes obliquely across the side of this somite and disappears in front of the setigerous area, but reappears in the dorsal middle line of VIII and continues to the peristomium, where it turns slightly to the left and disappears finally on the collar.

The collar is very peculiar. It is thin and rather high, its margin even all around, but, owing to the obliquity of the peristomium due to the prolongation forward of its ventral plate, the height of the collar appears to be about twice as great dorsally as ventrally. The median ventral part is injured so that the character of the ventral lobes cannot be ascertained. Laterally at the level of the sides of the ventral plates is an abrupt thinning, folded in the form of a little niche terminating at the base in a minute pit; but there is no actual incision. Dorsally a somewhat similar condition exists, each half of the collar being adherent to the median line by a very delicate membranous fold, so that no actual cleft is present, The fold of the right side overlaps the left broadly, and thus deflects the end of the fæcal groove toward the latter side. No eyes nor otocysts are visible on either the peristomium or pygidium.

As indicated by the measurements the branchiæ are relatively elongated, contributing about $\frac{1}{3}$ of the total length. The basal lobes are exceedingly short and are entirely concealed within the collar. There are 15 branchial radioles on each side, arranged strictly in one row and of equal length. They show no tendency to coil or twist. The radioles of each half are connected for $\frac{1}{4}$ of their length by a delicate membrane, to which they stand in the relation of the ribs to the cover of an umbrella, and which is continued as a delicate wing, especially wide on the most dorsal and ventral member of each group, along each radiole and expands at their ends into a leaf-like appendage, through which the naked end of the radiole passes like a mid-rib, and beyond which it forms a short mucronate tip. The filaments present the usual paired arrangement and are numerous and exceedingly long, the length of the basal ones being at least $1\frac{1}{2}$ times the diameter of the thoracic segments. Besides the ordinary filaments a number of very much larger ones occur within the radioles, one apparently being attached to the base of each of several of the latter. Though none is perfect, they often equal $\frac{1}{2}$ of the length of the radioles. As they bear slight wings and have distinct cartilaginous axes, they probably represent a second set of naked radioles. The region is so brittle that a thorough study of the specimen is impossible. The tentacles are apparently short ovate-lanceolate in shape. Very small eggs completely fill the body cavity.

The setæ of the first thoracic fascicle and the abdominal somites are apparently all slender, winged capillary, those on the latter with extremely narrow wings. On the other thoracic somites there are two forms, distinguished by the breadth of the wings and not always to be sharply separated. Those in a dorsal group (fig. 14) have slender, longitudinally striated shafts, more or less bent and drawn out to a very fine tip, the winged margin fringed, confined to one side, of varying width and reaching far out toward the end of the shaft. Those of a ventral group (fig. 15) are shorter, stouter, with short, broad, usually asymmetrical, obliquely striated double wings and an acuminate tip. The internal structure is similar to the more slender setæ.

The thoracic uncini (fig. 16), which are arranged in single rows, have long, slender, curved stems with a slight shoulder at the surface of the body and beyond it a neck; the head has a long, rather slender, slightly recurved beak and a crest from which three larger spines are separated on each side below, the rest being finely divided. The abdominal uncini (fig. 43) are truncate behind, somewhat as in *Laonome*, but with a slightly produced process; the breast is both high and prominent with a nearly square anterior margin; the sinus is very small; and the beak acute, surmounted by a crest exhibiting 6 or 7 teeth of diminishing size along the profile.

The somewhat horny, stiff tube is covered with coarse sand grains and minute bits of shell.

Sagami Bay, 3,698, 153 fms., type only.

Protula geniculata sp. nov. (Pl. XI, figs. 17, 18; Pl. XII, fig. 38.)

The two specimens upon which this species is founded were taken from the tubes, and are consequently in a rather poor state of preservation and altered in shape by the constraint. Except for the flattened and tapering caudal end the form is completely terete and the thoracic membrane is wrapped closely about the body. Following are the measurements of the type: Total length, 27 mm.; branchiæ, 5 mm.; thorax, 5.5 mm., and diameter of thorax, 1.2 mm.

Branchiæ remain in the type specimen only, and are so fragile that a complete study is impossible. Their bases are short and simple, concealed by the collar ventrally but exposed dorsally. The radioles number about 18 on each side, arise strictly in one row, although in the retracted condition some of the dorsalmost ones are turned inward and spirally twisted, so that they appear partly in a double row. Most of the radioles are rounded in section, but the dorsalmost one on each side is flattened. There is no basal web. At the base of the radioles the barbs are as long as one-half of the diameter of the thorax, but become gradually shorter toward the tip, where they leave naked a filamentous portion of the radiole about as long as the basal barbs. There is no operculum.

The strictly ventral collar is produced directly forward to a length about equal to an anterior thoracic somite; the margin is smooth and entirely without trace of any folds or incisions and with short rounded lateral lobes. The thoracic membrane is rather prominent and produced anteriorly beyond the collar, but not overlapping its lateral lobes. Dorsally the two sides overlap considerably in the middle line, and are thrown into deep oblique folds at each somite, owing to the stowing of a large surface within the small space of the tube. Posteriorly they reach beyond the last thoracic somite and join in a closely appressed ventral fold covering the first abdominal somite below.

There are seven setigerous thoracic somites and seventy abdominal somites. The bundles of thoracic seta are all at the same level and of similar size; the uncinigerous tori are short, equal and widely separated ventrally on all somites. The sides of the thoracic somites between them are transversely wrinkled. On the abdominal region the anterior tori are nearer the dorsal than the ventral side, but posteriorly they are strictly lateral. At the posterior end the body is beveled toward the dorsal side and is provided with low lateral ridges, but no distinct caudal membrane. Dorsally this flattened region bears a narrow but thick shield plate which tapers to an acute point anteriorly and is partly metameric. It occupies about 26 somites and is white and chalky in appearance. In another specimen this plate is less attenuated anteriorly. The body throughout is much tinged with reddish-orange which was probably the natural color.

All of the thoracic setæ are of the limbate type with rather short narrowly lanceolate ends, especially slender on those of the smaller collar tuft; all are colorless, very slightly curved and of more uniform size than usual. The abdominal, except at the caudal end, bear two geniculate setæ (fig. 38) on each side. They are transparent and colorless, with broad, short, very thin and pointed blades, bent nearly at right angles to the shaft, and which appear to have the margin perfectly smooth. On the caudal somites the setæ occur in tufts of three, but occasionally two; they are long, slender, capillary, tapering and curved, but wingless at the tip.

The uncini are relatively small, very delicate, and much crowded, with about 26 distinct and some smaller obscure teeth, all strongly bent downward and overlapping. The upper part of the tooth-bearing margin with the larger teeth rises prominently above the body of the uncinus. The thoracic uncini (fig. 18) have the body quadrate with the truncate lower margin on a level with the elongated lower tooth, while the abdominal uncini (fig. 17) have nearly triangular bodies with the somewhat angulated margin not nearly reaching to the end of the long tooth. This tooth is really a projection of the body of the uncinus and itself bears a fringe of fine teeth on its basal half.

Two nearly complete tubes are present in the collection. They were evidently attached at the base only, with the greater part upright and straight or slightly sinuous, gradually increasing in diameter, perfectly terete, the walls thick, porcellaneous, with a thin, somewhat rough, chalky surface marked with distinct lines of growth, but without any ridges or other special sculpturing.

Suruga Bay, 3,707, 63–75 fms., 2 specimens.

Vermilia ctenophora n. sp. (Pl. XII, figs. 21–25.)

A complete example has a total length of 27 mm., the operculum 6.5 mm., gills 5.7 mm., and thorax 5 mm. An incomplete specimen is larger.

The branchiæ are considerably contracted and very compactly packed into the tube, without any trace of a spiral twist. The undivided base is relatively prominent, composing about $\frac{1}{3}$ of the total length of the gill. When the branchiæ are retracted the distal margin is decidedly oblique and much longer ventrally. Radioles 20 on each side, in the contracted state folded by the doubling of the base dorsad into an inner and an outer series, the barbs of which face each other. The radioles are thick and short, with a short, thick, finger-like termination lacking barbs, and in one specimen, not enclosed in a tube, are curled inward at the ends. There are no branchial eyes. Except near the end, where they become shorter, the barbs have a length of about $\frac{3}{5}$ the diameter of the thorax and are numerous and crowded. Three or four of the dorsalmost radioles each bear at the base a larger barb, about 3 times as thick as the ordinary ones and somewhat longer. Near the median line and at a somewhat more dorsal level is the pair of tentacles of similar form but somewhat stouter. A membranous fold encircles the base of the gills within and surrounds the mouth. The last three features were clearly made out on the incomplete specimen only, not on the type.

The operculum (figs. 21, 21*a*) is dorsal and dextral. It has a slender, wrinkled, somewhat flattened stalk very slightly broader at the distal end and without wings or membranous margins. The body of the operculum is broadly egg-shaped, the basal $\frac{3}{5}$ with soft non-chitinous walls somewhat longitudinally folded, the distal $\frac{2}{5}$ a smooth, brown and firm chitinous dome with a narrow thickened double ring at the base and the surface with traces of a rough calcareous incrustation. In the type the stalk measures 4 mm. in length, .7 mm. in diameter, and the body is 2.5 mm. long and 2 mm. thick. On the larger specimen these measurements are respectively 4.5, .7, 2.5 and 2 mm.

On the type the collar and thoracic membrane are closely folded about the body from contact with the tube, but evidently fully agree with the following description, based on their expanded state in the larger cotype. The collar is produced directly forward for a distance of 1 mm. from the prostomium for the entire width of the space between the ventral margins of the setigerous tubercles. At the sides short round lobes are produced, but there are no other processes and no clefts. The thoracic membrane extends as a broad undulating fold from the first to the fifth torus inclusive, overlapping its fellow medially, the lateral margin of the collar anteriorly, and the sixth torus caudally.

The first setigerous tubercle is included in the base of the thoracic membrane; the others form, with the uncinigerous tori, freely projecting flaps which increase in size and prominence from the second caudally, the last being especially large, nearly twice its predecessor, and almost reaching the median line ventrally, while dorsally it partly covers and conceals the, in this case, detached setæ tuft. The body is slightly flattened and tapers to the caudal end, where the nearly terminal or slightly ventral anus occupies a notch. A thickened dorsal shield plate, of a pink color and elongated elliptical form, occupies about 26 somites. There are in all 7 setigerous thoracic and about 100 abdominal somites, though the number could not be accurately determined, owing to an injury to the only complete specimen.

The thoracic setæ present the same general features as in *V. pluriannulata*, but are throughout more slender, delicate and acute, and have narrower wings; the number of nearly or quite wingless ones is also greater. Throughout the greater part of the abdominal region but two setæ (fig. 23) occur in each bundle. These are delicate, colorless and of the same type as in *V. pluriannulata*, but have narrower, less angulated and less curved blades, which in the case of one is almost perfectly straight.

The arrangement and form of the thoracic uncini (fig. 24) is also very close in the two species, the chief difference being that in this the teeth are usually 15 in number and exhibit a more exact alignment with the basal plate. Very often a minute tooth occurs on the basal plate just below the large truncate tooth, and the overlapping of the latter by the preceding tooth is often very marked. Abdominal uncini (fig. 25) differ still less, but the number of acute teeth is 11–13. The caudal setæ are all broken short off.

Only a small piece of the tube is present. It is thicker than that of *Vermilia pluriannulata*, measures 3 mm. in diameter at the mouth, which is broken, and 2.5 mm. at the opposite end. The single flange present extends only halfway around the tube on the free side, but is very prominent and flaring. The surface of the tube is marked by rough transverse lines of growth with a slightly spiral turn, and on the flange section only by 5 rough longitudinal ribs.

Suruga Bay, 3,707, 63–75 fms., 2 specimens with fragments of tubes.

Vermilia pluriannulata sp. nov. (Pl. XII, figs. 26–32, 45; Pl. XI, fig. 19.)

The single example from which this species is described measures: Total length, 19 mm.; branchiæ, 4.5 mm.; thorax, 3 mm., and diameter, 2.4 mm. The branchiæ are in bad condition, but show 19 radioles on each side, which are shorter and have relatively longer and more slender naked tips than in *V. ctenophora.*

The operculum is developed from the left dorsal branchial radiole, and the stalk and body each measure 2.5 mm. long. The former is of nearly uniform diameter, very slightly depressed and marked with numerous transverse wrinkles, as though in contraction. The body (figs. 26, 27, 28) is broadly elliptical in face views, but in profile shows a nearly parabolic ventral and a slightly convex dorsal outline. It is divided into two nearly equal halves, the proximal of which is soft and longitudinally wrinkled, with a delicate chitinous enclosing membrane, the distal very firm and chitinous, marked by 6 very narrow dark chitinous annular thickenings which have a slightly excentric arrangement, as a result of which they are much crowded dorsally and more widely separated ventrally, leaving a nearly circular, slightly excentric, convex, pale-colored terminal disk. Probably the entire distal half, with the exception of this disk, was originally covered with a calcareous coat; rough fragments of such an incrustation remain especially on the ventral surface.

The collar is higher and its lateral lobes more prolonged than in *V. ctenophora*, but is otherwise similar. The thoracic membrane is also similar, but much higher, fully equalling the dorsal distance between the setæ tufts. As in *V. ctenophora* its base ends at the fifth seta tuft, but a free lobe projects much beyond this to the seventh.

There are 7 setigerous thoracic and about 110 abdominal somites, the posterior ones very short and much crowded. For most of its length the body is nearly terete, but at the posterior end is slightly depressed and tapering. The extreme caudal end is slightly curved ventrad, so that the anus looks downward and is somewhat covered by the posterior margin of the dorsal plate. The latter is much thickened and of an ovate form, covering about 25 somites with the broad end toward the head.

The thoracic setæ are numerous, except in the collar fascicle, and form conspicuous pale yellow tufts. Those of the first fascicle are mostly wingless or nearly so, the limbate ones being more slender and with the wings narrower than usual in succeeding tufts. On the succeeding thoracic somites the number of wingless setæ is much reduced, and most of them (figs. 29 and 30) are stouter and distinctly limbate on the convex side and, while differing considerably in length, curvature and breadth of wing, they have the wings constantly wider and more delicately striated than in *V. ctenophora*.

With the exception of those near the caudal end each abdominal fascicle bears but three colorless setæ (fig. 31) with slender stems and rather broad but exceedingly thin and delicate blades. The ends are tapering and curved, with a distinct angle at the base of the convex side, which is fringed for $\frac{2}{3}$ of its length. These setæ are always stouter, more angulated and less distinctly fringed than those of *Vermilia ctenophora*, and the 3 exhibit a closer similarity of form and size. A number (about 25) of the segments at the caudal end bear tufts of 4 or 5 long, slender, colorless capillary setæ of a quite different form (fig. 45).

They about equal or exceed the body diameter, are strongly directed ventrad, and for the greater part of their length they are gently, and near the tip more sharply, curved; and here are also flattened and provided with a delicate wing, beyond which they taper to an acute point.

The tori of somite III contain about 90 uncini and more posterior thoracic somites a much greater number. They are rather large trapezoidal plates (fig. 32), coarsely striated transversely. The pectinate margin bears 14 or occasionally 13 acute teeth, of which the 4th, 5th and 6th are the largest, the upper ones becoming shorter and the lower or cephalic ones especially more slender, the former more hooked, and the latter straighter but more imbricated and appressed, and the last 2 or 3 successively wider, flatter and more curved in the transverse plane. The last tooth is much larger, tubular and truncate, and in many cases is more or less closely embraced by the preceding one. The anterior abdominal tori bear about 20, the caudal ones as many as 50 uncini (fig. 19), which are only about $\frac{1}{2}$ as long and much more delicate than the thoracic ones which they resemble closely in form. The apical offset from the plate is more prominent, the number of teeth usually 13 or sometimes 12, and the truncate tooth is more closely embraced by the one next to it than in the thoracic uncini.

Fragments of the tube are 3.5 mm. in diameter at the mouth, 2 mm. in diameter at a distance of 30 mm. from the mouth. Externally they are marked by a series of wide flaring flanges, sometimes completely encircling the tube, sometimes coalescent with it or incomplete on one side. The surface is marked by a varying number of delicate but rough, undulating parallel longitudinal ridges about .7 mm. apart, the number being usually limited to about 6, confined to one, but not always the same, side. On the free flaring portions of the flanges these ridges become broken into flat spines, many of which are arranged transversely.

Suruga Bay, 3,713, 45 fms., type and portions of tube.

Pomatostegus latiscapus Marenzeller.

Two specimens of a *Pomatostegus* agree closely with Marenzeller's description of all parts except perhaps the collar, concerning which it is simply stated that it is produced directly forward and has no lateral incisions. In the *Albatross* specimens the collar has a very irregular and ragged border, with a long median ventral process and somewhat smaller dorso-lateral processes at the level of the setæ; but no actual incisions. The setæ and operculum agree perfectly. In one specimen the operculum bears 4, in the other 7 platforms, and in the latter is completely enveloped in a growth of sponge which forms a spherical mass fitting the lumen of the tube.

Suruga Bay, 3,707, 63–75 fms.; 3,740, 65 fms.

Pomatoceros auritubis sp. nov. (Pl. XII, figs. 33–37; Pl. XI, fig. 20.)

This species is known only from a single specimen without tube which measures 18.5 mm. in total length, of which the gills are 6 mm., the operculum nearly 7 mm., and the very short thorax, without the collar, 2.5 mm. The branchiæ have 26 radioles on each side, and each half is rolled inward in a somewhat scroll-like fashion dorsally and ventrally. The radioles are somewhat thick and are terminated by a short filament free from barbs, the basal ones of which are about $\frac{1}{5}$ the length of the radioles. A tolerably well-developed web connects the basal $\frac{2}{5}$ of the radioles.

The operculum (figs. 33, 34, 35) is developed from the dorsalmost left radiole. Its stalk is broad and flat with prominent lateral wings extending its entire length and increasing in width to the distal end, where they terminate in narrow, pointed processes embracing the sides of the opercular body. The stalk is attached excentrically to the dorsal side of the body of the operculum, which is bent strongly ventrad. The body is hemispherical with somewhat flaring margins, and bears by a short thick stalk on its distal face a membranous circular concave plate with broad, thin, flaring margins, and a low, slightly rounded central eminence. There are no spines, but two slight marks may be the scars of attachment of a pair. The free margins of the disk are chitinoid, but there is but little indication of calcareous infiltration, the body of the operculum having about the consistency of a rather soft cartilage.

The collar is high and prominent, about equalling the length of the first two somites. Laterally it begins at the level of the first setæ tufts in a pair of lobes which are much overlapped by the dorsal membrane. Its margin is much folded and serrated, finely on the dorsal, coarsely on the ventral part, and in the median ventral region is produced forward as a slender lanceolate lobe, but is nowhere deeply incised. The thoracic membrane is low posteriorly, with a very delicate ventral fold, but becomes high anteriorly with the dorso-anterior angle thrown into a tuft of folds and overlapping the lateral collar lobes.

The anterior pair of thoracic setæ tufts are widely separated from the others, embedded in the thoracic membrane and project forward. Succeeding setigerous and uncinigerous tori of the thoracic region are at first placed at a high level, but sink lower and lower until on the last thoracic somite the latter are entirely on the ventral side and much inclined forward and inward. The last two especially have their ventral ends entirely free, and those of the last meet in the middle line. The ventral plates, which are included in the area between the tori, consequently form a nearly equilateral triangle with the apex caudad. All of the abdominal somites are short and crowded, especially posteriorly, and no caudal plate or membrane is developed. The anus is terminal. No pigment remains in the specimen.

Somite I bears a compact slender tuft of pale, glistening, lanceolate, limbate setæ. They differ considerably in length, width of wing and curvature, but all have the margins very distinctly serrated. On the other thoracic somites the setæ are of the same form, but the wings are generally shorter and broader, the bundles less compact and more spreading, and more distinctly arranged in two rows, one of larger, the other of smaller setæ. Abdominal somites generally bear three delicate colorless setæ of the form shown in fig. 36. They are apparently not trumpet-shaped, but spatulate, with one angle of the flattened end prolonged obliquely into a conspicuous spine upon which the delicate teeth are continued. The stems are delicately longitudinally striated. The posterior abdominal setæ are all broken off.

The thoracic uncinigerous lines begin at the seta tufts and are rather long, that of somite II containing a few more than 200 uncini, which decrease in size toward the ventral end. Abdominal tori contain little more than $\frac{1}{4}$ as many. The uncini are delicate pectinate plates. Those of the thoracic somites (fig. 37) have quadrate plates bearing 13–15 strongly decurved, very acute teeth; the lowermost scoop-tooth is broad, opens toward the uncinial plate and projects freely beyond the lower margin of the latter. Abdominal uncini (fig. 20) are about $\frac{1}{2}$ as large and have only 11 or 12 acute teeth besides the scoop-like one, and the plate is triangular, with its lowermost angle produced into a process about $\frac{1}{2}$ as long as the lowermost tooth.

Suruga Bay, 3,713, 45 fms., type only, without tube.

The Spirorbes in the collection were submitted for study to Miss Katharine J. Bush, of the Yale University Museum, who has kindly furnished the following descriptions:

Spirorbis argutus Bush sp. nov.

Tube coiled in a low discoid sinistral form with large central cavity, spreading around the base in a thin layer, the whorls radially enlarging and ornamented by one large median keel which renders the surface on each side slightly concave, all crossed by distinct transverse lines. Smaller specimen about 1 mm. in diameter; larger, about 1.5 mm.

Branchiæ too much matted to determine their number. Operculum (fig. *a*) a thin transparent elongated membranous bulb, flat on top and protected by a thin calcareous disk slightly thickened in the center, borne on a long, very slender peduncle.

Fig. *a*. *S. argutus*, operculum mounted in glycerine.

Thorax with three fascicles of setæ and two rows of uncini on each side. All the setæ simple tapered blades (fig. *b*), so small and delicate as not to be clearly seen under a 7 objective, showing no serrations on the edge of the blade even under $\frac{1}{10}$ oil immersion. Uncini very narrow, linear, the teeth appearing as but slight roughnesses on the surface, even under the highest power. Abdominal uncini in the first series or segment not appreciably smaller than those on the thorax; setæ not found.

Two specimens on one of the red algæ with the following (*S. foraminosus*), at Station 3,730, in 34 fathoms, May 16, 1900.

Spirorbis foraminosus Bush sp. nov.

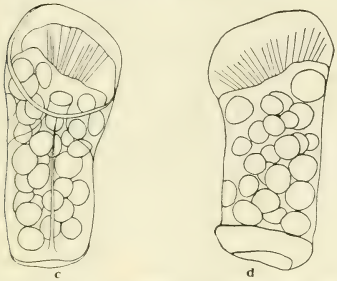
Tube coiled in a similar manner to that of *S. argutus*, but in the opposite direction, and larger, with the surface ornamented with three distinct carinæ, the middle one the most prominent, the surface on each side, or the interspaces, slightly concave and punctured by minute holes or foramina, apparently caused by the erosion of the thin epidermal layer; the immature forms probably having the entire surface crossed by numerous prominent transverse lines.

Fig. *b*. *S. argutus*, seta from 3d thoracic somite.

Branchiæ, the number of which is not determined, are long and folded about, partially covering or protecting the large operculum (figs. *c* and *d*), which is in the form of an elongated (apparently stiffened by a very thin deposit of lime) cylinder-like broodpouch filled with eggs; the end protected by a calcareous disk with flaring edge and an inner enlarged basal portion, showing the length of the ventral area attached posteriorly to the secondary calcareous disk on the end of the operculum proper, which is formed of many longitudinal muscles spreading from a short peduncle, which is apparently differentiated from the longitudinal ventral muscular layer of the body-wall and separated from the branchial lobes.

Thoracic setæ simple tapered blades with but little color in three fascicles on each side with two series of uncini. Those on the collar (fig. *e*) somewhat broader and less regularly tapered than the others; no odd ones found in the second or third bundles. Uncini distinctly yellow or delicate horn-color with numerous fine teeth, clearly seen under a 7 objective, those on the abdomen much shorter and associated with a single similarly colored seta.

Two specimens on one of the red algæ with *S. argutus*, at Station 3,730, in 34 fathoms, May 16, 1900.



Figs. *c* and *d*. *S. foraminosus*, front and rear views of operculum, filled with eggs.

Fig. *e*. *S. foraminosus*, seta from collar fascicle.

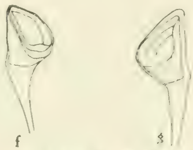
Spirorbis bellulus Bush sp. nov.

Tube small, regularly coiled, dextral, with small central cavity, the rounded whorls ornamented with three, sometimes four, unequal, rounded threads, the one on the summit being more prominent than the others.

Specimens from 1 to 1.5 mm. in diameter.

Branchiæ peculiarly developed, probably abnormal, broad, thin, flattened, with few pinnæ. Operculum (figs. *f* and *g*) on a very long peduncle, with somewhat squarish calcareous plate with deep erect thickened rim.

Setæ (fig. *h*) long and slender simple blades, similar in all the fascicles which are three on each side of the thorax with two series of uncini, those on the collar showing a few comparatively



Figs. *f* and *g*. *S. bellulus*, operculum, front and rear views.

coarse serrations on edge, seen under a 7 objective. Uncini very narrow, the teeth too fine to determine. Abdominal setæ and uncini not seen.

Fig. *h*. *S. bellulus*, seta from collar fascicle.

Steamer *Albatross*, May 8, 1900, at Station 3,707, off the coast of Japan, in 63–75 fathoms. Five specimens on fragments of mollusks and pebbles.

Spirorbis dorsatus Bush sp. nov.

Tube small, regularly coiled, dextral, differing from the preceding (*S. bellulus*) in having but one very prominent keel on the middle of the whorls, rendering the tube three-sided. A small nematode worm and sand filled the tube, but no animal was found.

Three specimens were found with the preceding, at Station 3,707, in 63–75 fathoms.

As no animals were found, it is impossible to determine whether or not these tubes may not be the young of *S. foraminosus*.

Explanation of Plates XI and XII.

Plate XI, Fig. 1.—*Sabella japonica*. Slender lanceolate seta from ventral part of the fascicle of V, × 480.

Fig. 2.—*Sabella japonica*. Small uncinus from the dorsal part of the torus of V, × 480.

Figs. 3–6.—*Potamilla acuminata*.

Fig. 3.—Slender seta from dorsal part of VI, × 335.

Fig. 4.—Face view of a slender seta from XL, × 335.

Fig. 5.—Two views of a spatulate and mucronate seta from ventral part of VI, × 335.

Fig. 6.—A pick-shaped uncinus from VI, showing a slender tip of about the average length, × 600.

Figs. 7–13.—*Hypsicomus lyra*.

Fig. 7.—Limbate seta from the ventral series of the collar fascicle, × 480.

Fig. 8.—Hooded seta from the dorsal series of the same, × 480.

Fig. 9.—Limbate seta from the dorsal part of V, × 335.

Fig. 10.—Plain paddle-shaped seta from the ventral part of V, × 335.

Fig. 11.—Mucronate paddle-shaped seta from the same, × 335.

Fig. 12.—Bilimbate pointed seta from a posterior abdominal somite, × 335.

Fig. 13.—Pick-shaped uncinus from VI, × 480.

Figs. 14, 15, 16.—*Euchone alicaudata*.

Fig. 14.—Outline of slender seta from the dorsal part of V, × 480.

Fig. 15.—One of the more symmetrical broadly bilimbate setæ from the ventral part of V, × 480.

Fig. 16.—A crochet from VI, × 480.

Fig. 17–18.—*Protula geniculata*. Abdominal and thoracic uncini respectively, × 800.

Fig. 19.—*Vermilia pluriannulata.* An abdominal uncinus, × 600.
Fig. 20.—*Pomatoceros auritubis.* An uncinus from the middle abdominal region, showing also the outlines of the front and back faces of the large gouge-shaped tooth, × 600.

Plate XII, Figs. 21 to 25.—*Vermilia ctenophora.*
Figs. 21, 21*a*.—Dorsal and lateral views respectively of operculum, × 8.
Fig. 22.—An average limbate seta from VI, × 250.
Fig. 23.—The smallest and most curved seta from an abdominal pair, × 440.
Fig. 24.—Uncinus from V, × 440.
Fig. 25.—An uncinus from the middle abdominal region, × 440.
Figs. 26 to 32.—*Vermilia pluriannulata.*
Figs. 26, 27, and 28.—Dorsal, ventral and lateral views respectively of the operculum, × 13.
Figs. 29 and 30.—Long and short slender limbate setæ from VI, × 250.
Fig. 31.—The middle seta of the three on somite XXX, × 440.
Fig. 32.—An uncinus from V, × 440.
Figs. 33 to 37.—*Pomatoceros auritubis.*
Figs. 33, 34, 35.—Dorsal, ventral and lateral views respectively of the operculum, × 8.
Fig. 36.—Middle abdominal seta, × 440.
Fig. 37.—Uncinus from IV, × 440.
Fig. 38.—*Protula geniculata.* Seta from middle abdominal region, × 250.
Fig. 39.—*Sabella japonica.* Uncinus from dorsal part of VI, × 360.
Fig. 40.—*Sabella japonica.* Uncinus from ventral portion of a middle abdominal uncinus, × 250.
Fig. 41.—*Potamella acuminata.* Uncinus from VI, × 360.
Fig. 42.—*Hypsicomus lyra.* Uncinus from VI, × 360.
Fig. 43.—*Euchone alicaudata.* Uncinus from XXI, × 360.
Fig. 44.—*Laonome tridentata.* Uncinus from XVI, × 360.
Fig. 45.—*Vermilia pluriannulata.* End of a capillary caudal seta representing about $\frac{1}{6}$ of the exposed part, × 250.

FEBRUARY 2.

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

Seventy-four persons present.

The death of Karl Zittel, a correspondent, January 5, was announced.

The Publication Committee reported that the following communications had been received:

"On the Germ Cells and the Embryology of Planaria simplissima Curtis," by N. M. Stevens (January 23).

"A Study of the Mammalian Genus Chilonycteris," by James A. G. Rehn (January 30).

MR. H. CLAY BORDEN made a communication on the Moki Indians, their habits and customs, with special reference to their religious dances. (No abstract.)

The following were accepted for publication:

A STUDY OF THE MAMMALIAN GENUS CHILONYCTERIS.

BY JAMES A. G. REHN.

The following paper is the result of a study of an exceedingly interesting series of one hundred and three specimens, of which twenty-four were preserved as skins, the remainder being in alcohol. Of this representation forty-three were from the collection of the United States National Museum, thirty-six from that of the Biological Survey, eighteen from the American Museum of Natural History, and a small but exceedingly important series from the collection of the Academy.

The author wishes to express his indebtedness to Mr. Gerrit S. Miller, Jr., of the United States National Museum, Dr. C. Hart Merriam, of the Biological Survey, and Dr. J. A. Allen of the American Museum of Natural History, for their kindness in securing and permitting the use of specimens from the collections under their charge.

CHILONYCTERIS Gray.

1839. *Chilonycteris* Gray, Ann. Nat. Hist., IV, p. 4. September, 1839. Type—*Chilonycteris MacLeayii* Gray.
1840. *Chilonycteris* Wagner, Suppl. Schreber's Säugthiere, I, p. 448.
1840. *Lobostoma* Gundlach, Archiv für Naturgeschichte, VI, bd. I, p. 357. [Part.]
1843. *Chilonycteris* Wagner, Archiv für Naturgeschichte, IX, bd. I, p. 367. [Part.]
1843. *Chilonycteris* Gray, Proc. Zoöl. Soc. London, 1843, p. 20.
1843. *Phyllodia* Gray, Proc. Zoöl. Soc. London, 1843, p. 50. Type—*Phyllodia parnellii* Gray.
1850. *Chilonycteris* Wagner, Abhandlungen Mathem.-Physik. Cl. Akad. Wissenschaften, München, V, p. 179. [Part.]
1851. *Chilonycteris* Gosse, Naturalist's Sojourn in Jamaica, p 326.
1854. *Chilonycteris* Burmeister, Thiere Brasiliens, I, p. 74. [Part.]
1855. *Chilonycteris* Wagner, Suppl. Schreber's Säugthiere, V, p. 677. [Part.]
1861. *Chilonycteris* Gundlach, Monatsber. K. Preuss. Akad. Wissensch., Berlin, 1861, p. 154.
1861. *Chilonycteris* Tomes, Proc. Zoöl. Soc. London, 1861, p. 65.
1872. *Chilonycteris* Peters, Monatsber. K. Preuss. Akad. Wissensch., Berlin, 1872, p. 359.
1878. *Chilonycteris* Dobson, Catal. Chiropt. Brit. Mus., p. 447. [Part.]
1879. *Chilonycteris* Alston, Biol. Cent.-Amer., Mamm., p. 34. [Part.]
1880. *Chilonycteris* Dobson, Rep. Brit. Asso. Adv. Soc., 1880, p. 195.
1894. *Chilonycteris* J. A. Allen, Bull. Amer. Mus. Nat. Hist., VI, p. 247.
1902. *Chilonycteris* Miller, Proc. Acad. Nat. Sci. Phila., 1902, p. 400.

Generic Characters.—Crown of the head moderately elevated above the face line; ears separate, lateral; rostrum moderately depressed; nostrils superiorly with a more or less distinctly developed cutaneous ridge; lower jaw with two transverse chin-lappets. Skull with the brain-case moderately elevated above the rostrum, and with basicranial axis but slightly raised from the facial axis. Dentition i. $\frac{2-2}{2-2}$, c. $\frac{1-1}{1-1}$, p. $\frac{2-2}{3-3}$, m. $\frac{3-3}{3-3}$.

History.—The genus *Chilonycteris* was founded by Gray in 1839 on the Cuban *C. macleayii*, the describer believing the genus to be intermediate between "the Saccopteri and the genus Mormoops," the latter genus being considered by him a member of the tribe *Noctilionina*. In 1840, Gundlach described the genus *Lobostoma* based on two species, one of which is the Cuban representative of the genus *Mormoops*, the other a synonym of *Chilonycteris macleayii*. The same year Wagner, in the first supplementary volume of the Säugthiere, associated the genus with *Mormoops*, and placed them in the tribe *Brachyura* of the *Gymnorhina*. During the year 1843 this genus received considerable attention from Wagner and Gray, the former of whom described *C. personata*, *C. rubiginosa* and *C. gymnonotus*, all from Natterer's Brazilian material. The last of these three species has since been removed to *Dermonotus* (=*Pteronotus* auct.). Gray's work consisted of the description of the Haitian *C. fuliginosa* and *Phyllodia parnellii* from Jamaica, the rather different character of the latter form having impressed him to such an extent that he created a genus for it. In commenting on *Phyllodia* he says it is "a Noctilionine bat, with an apparent nose-leaf, bearing a much greater resemblance to the Leaf-nosed Bats (Phyllostomina) than even Mormoops, which, when he first described it, Dr. Leach referred to that group." The Jamaican *C. grisea* was the next form described, Gosse also giving us a figure. Burmeister, in 1854, in his system of Brazilian mammals, associated *Chilonycteris* and *Dysopes*, and placed them in the *Gymnura;* while Wagner, in 1855, placed it and *Mormoops* with the Noctilionine bats in the section *Brachyura* of the *Gymnorhina*. The year 1861 witnessed the description of two more species of the genus, *C. boothi* from Cuba by Gundlach, and *C. osburni* by Tomes from Jamaica, the latter being Gray's *Phyllodia parnellii*. Koch in 1862–63[1] used the term *Mormopida* in an indefinite way, apparently for this association of genera; while Gray, in 1866,[2] used the term *Mormopsina* for *Mormoops*, and *Phyllodiana* for *Phyllodia*, *Chilonycteris* and *Pteronotus*. Peters, in his synopsis of the *Mormopes*, published in 1872, associated *Chilonycteris* with *Mormops* in the above group. Gill, in the same year,[3] proposed

[1] *Jahrb. Ver. Naturkunde Nassau*, Wiesbaden, XVII–XVIII, p. 358.
[2] *Ann. and Mag. Nat. Hist.*, XVII, p. 93.
[3] *Arrangement of the Families of Mammals*, p. 16.

the family name *Mormopidæ*. Dobson, in his historic catalogue, considered *Chilonycteris* and *Mormops* to comprise the group *Mormopes*, which is coextensive with his subfamily *Lobostominæ*. The same author also describes the peculiar *C. psilotis* from an unknown locality. In 1892, Harrison Allen[4] raised Dobson's *Lobostominæ* to family rank, the *Lobostomidæ*. In 1902, Miller separated the Mexican type of the *rubiginosa* group as *C. mexicana*, and distinguished a Porto Rican representative of the *boothi* group as *portoricensis*. While treating the genus *Mormoops*, the author, in the same year, considered *Mormoops*, *Chilonycteris* and *Dermonotus* representatives of a subfamily, for which the name *Mormoopinæ* was used.

General Relations.—The general relationship of the genus *Chilonycteris* to the other members of the *Mormoopinæ* has already been considered.[5] Of the species in the genus the *boothi* and *rubiginosa* groups present the greatest superficial resemblance to *Mormoops*, particularly in the broad flattened head and the general form of the chin-lappets; but that these resemblances are not supported by other characters is evident on studying the skulls and structure of the ears and head appendages. On the other hand, the relationship of *C. psilotis* with *Dermonotus* is evident from the structure of the skull, while the *rubiginosa* group is seen to possess a skull having the same general characteristics. The arrangement of species in the following portion of this paper is in accordance with the general characters exhibited by the skull, running from the slender arched type of *C. macleayii* to the heavy short depressed skull of *C. psilotis*. There are several objections to such an arrangement, but there appears to be no good evidence to support any other classification. Dobson's *psilotis* is no doubt the most aberrant member of the genus, and, while in some tooth characters it appears to differ from all the other species, and also from *Dermonotus*, its position in the genus is easily found by the shape of the skull. Wagner's *personata* I have not seen, and probably it is closer to *psilotis* than my treatment would lead one to suppose. This point can, of course, only be settled by the examination of the specimens in the Vienna and Berlin Museums, or by the acquisition of further material.

Remarks.—Probably the most striking fact noticed on examining a large series of specimens of this genus is the presence of two well-marked color phases, one rufous, the other dark brown. This dichromatism is evident in every form of which an extensive series is

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[4] *Proc. U. S. Nat. Mus.*, XV, p. 437.
[5] *Proc. Acad. Nat. Sci. Phila.*, 1902, p. 161.

available. The two extremes are sometimes connected by a series of intermediate individuals possessing to a greater or less degree the dull rather purplish-brown of one type and the rich golden rufous or warm red-brown of the other. This dichromatic coloration is also found in *Mormoops* and *Dermonotus.*

Key to the Forms.

a.—External margin of the ear with a distinct notch at or slightly below the middle.

b.—Internal margin of the ear basally thickened and bearing a distinct angulate notch.

c.—External margin of the ear abruptly convex at the commencement of its lower third forming an acute-angulate notch; forearm 35–44.5 mm.

d.—Forearm less than 43 mm. in length; cutaneous ridge surmounting the superior margin of the nostrils without a deep median emargination.

e.—Length of head, body and tail considerably over 56 mm.; calcaneum not less, usually much more, than 18 mm. in length.

f.—Skull rather elongate and slender; greatest zygomatic width usually less than half the total length of the skull; rostrum and brain-case about equal in length, *macleayii* Gray.[6]

ff.—Skull abbreviate; rostrum inflated; greatest zygomatic width more than half the total length of the skull; rostrum not as long as the brain-case, . . *m. inflata* n. subsp.

ee.—Length of head, body and tail about 56 mm.; calcaneum not over 16 mm. in length, *m. fuliginosa* (Gray).

dd.—Forearm 43 mm. or more in length; cutaneous ridge surmounting the superior margin of the nostrils with a deep median emargination, . . *m. grisea* (Gosse).

cc.—External margin of the ear abruptly convex at the commencement of its lower third, forming a rectangulate notch; forearm 45.7 mm., . . . *personata* Wagner.

bb.—Internal margin of the ear not basally thickened and without a distinct angulate notch.

c.—Nose with a comparatively high erect tubercle; tragus apically obtuse-angulate with a large accessory lobe; skull with the rostrum slender.

d.—First lower premolar in contact with third, the second crowded out of the toothrow on the lingual side; skull with the rostrum high; foot rather slender, *parnellii* (Gray).

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[6] The females of this form closely approach *m. inflata,* but the males are quite distinct.

dd.—First lower premolar not in contact with third, the second in the toothrow though usually displaced toward the lingual side; skull with rostrum of moderate height; foot rather robust.

e.—Size large, total length 83–85 mm.; skull with the rostrum rather slender, brain-case slightly depressed, ... *p. boothii* (Gundlach).

ee.—Size rather small, total length 74–79 mm.; skull with the rostrum somewhat bullate, brain-case evenly arched transversely, *p. portoricensis* (Miller).

cc.—Nose with a low rounded tubercle; skull with the rostrum comparatively short and broad; tragus apically produced, with a slight accessory lobe.

d.—Size very large; forearm not less than 59 mm. in length; head and body not less than 72 mm., *rubiginosa* Wagner.

dd.—Size medium; forearm not more than 59 mm. in length; head and body not more than 63 mm., *r. mexicana* (Miller).

aa.—External margin of the ear without a distinct notch at or slightly below the middle, ... *psilotis* Dobson.

Chilonycteris macleayii Gray.

1839. *Chilonycteris MacLeayii* Gray, Ann. Nat. Hist., IV, p. 5, Pl. 1, fig. 2. September, 1839. [Cuba.]
1840. *Ch[ilonycteris] MacLeayii* Wagner, Suppl. Schreber's Säugthiere, I, p. 448. [Cuba.]
1840. [*Lobostoma*] *quadridens* Gundlach, Archiv für Naturgeschichte, VI, bd. I, p. 357. [Cuba.]
1850. *Ch[ilonycteris] Mac-Leayii* Wagner, Abhandlungen Mathem.-Physik. Cl. Akad. Wissenschaften, München, V, p. 186. [No locality.]
1855. *Ch[ilonycteris] MacLeayii* Wagner, Suppl. Schreber's Säugthiere, V, p. 678. [Cuba.]
1855. *Ch[ilonycteris] quadridens* Wagner, Suppl. Schreber's Säugthiere, V, p. 678. [Cuba.]
1872. *Chilonycteris MacLeayii* Peters, Monatsber. K Preuss. Akad. Wissensch. Berlin. 1872, p. 360. [Part.] [Cuba; Jamaica; Haiti.]
1873. *Chilonycteris Mac-Leayi* Gundlach, Anales Soc. Espan. Hist. Nat., I, cuad. 3, p. 244. [Cuba.]
1878. *Chilonycteris macleayi* Dobson, Catal. Chiropt. Brit. Mus., p. 449. [Part.] [Cuba; Port au Prince, Haiti (type of *fuliginosa* Gray); Jamaica (type of *grisea* Gosse).]
1904. *Chilonycteris macleayii* Miller, Proc. U. S. Nat. Mus., XXVII, p. 342. [Guanajay and Baracoa, Cuba.]

Type Locality.—Cuba.

Distribution.—Cuba, apparently covering the greater part of the island, specimens from such extremes as Baracoa and Guanajay having been examined. Gundlach (*l. c.*), in speaking of this species, says: Very common, they frequent the houses in the country; observed also in caves, where they sleep in clusters.

General Characters.—Size rather small (for the genus); ears elongate.

sublanceolate, internal margin with a distinct submedian shoulder, external margin with a prominent submedian dentiform shoulder; nostrils surmounted by a sinuate ridge bearing a series of small pads, nostrils flanked by a subacute protuberance.

Head.—Moderately elongate; rostrum considerably depressed. Ears elongate, sublanceolate, the lower margin extending considerably forward but failing to reach the angle of the mouth; internal margin of the ear attached to the head anterior to the small eye, internal ridge distinct, arcuate, passing by a moderately rounded shoulder into the internal margin of the ear, distal two-thirds of the internal margin of the ear straight, bearing several distinct spiniform points superior to the shoulder of the internal ridge; external margin and lower margin ample, bearing a distinct acute notch at a point about opposite to the shoulder of the internal ridge, distal portion of the external margin straight, except the extreme apical portion which is gently concave; apex subfalcate, rounded. Tragus subelliptical; external margin with a slight nodular shoulder; internal margin bearing a subapical whorl-like accessory flap, which lies in a plane at right angles to the body of the tragus; apex rather narrowly rounded. Nostrils ovate, bordered by a low ridge, superior margin slightly depressed centrally and bearing six distinct sucker-like tubercles,[7] lateral margins flanked by an erect subdentiform flap. Labial chin-lappet transverse, forming broadly rounded lobes laterally, the median portion of the inferior margin broadly and evenly concave, median portion of the lappet strongly papillose and margined superiorly by a small rounded nonpapillose area. Posterior chin-lappet slight, adpressed, rounded and consisting only of a fold of skin.

Limbs.—Forearm moderately long, rather strongly bowed in the proximal half; third digit rather short. Femora, tibiæ and feet rather slender; calcaneum very long, half again as long as the tibiæ.

Membranes and Fur.—Membranes rather heavy and leathery; transverse nerves very regularly disposed in the endopatagium and mesopatagium; propatagium large, the anterior border totally free; uropatagium very large, extending beyond the enclosed portion of tail a distance about equal to the same. Fur of moderate length, soft and silky; throat and chin with the fur floccose; endopatagium partially and slightly furred above; upper lip and muzzle with the hair bristle-like in character.

Color.[8]—Rufous phase: above mars-brown suffused on the back and

[7] This character is subject to more or less variation, as in some specimens the individual character of each protuberance is lost.

[8] From skins.

scapular region with burnt-umber, a slight silvering of pale hairs scattered irregularly; beneath uniform fawn color. Brown phase: above sepia, around the head and neck paler as there the ecru under color is very apparent; below pale isabella color, the hair seal-brown basally. Membranes ranging from vandyke-brown to almost pure black in color.

Skull.—Rather fragile in character; elongate, zygomata not markedly expanded; brain-case considerably elevated above the moderately depressed rostrum; foramen magnum placed slightly above the basicranial axis. Brain-case subglobose, crests but slightly marked; auditory bullæ considerably inflated, of medium size. Rostrum rather low, of moderate length, evenly expanded; nasal depression considerably excavated and visibly compressed; palate subequal in width, moderately excavated, posterior projection extending but little beyond the major portion, the cleft narrowly rounded; pterygoids rather strongly divergent. Mandible with the ramus rather strong, ascending ramus low and comparatively weak; condyle small; coronoid process very weak and not elevated above the condyle; angle of the mandible strongly developed and directed laterally, forming a pronounced subfalciform process. Skulls of females are considerably smaller, and have the rostral portion much more bullate than in the males, in this respect approaching the race *inflata*, from which they can, however, be separated by the slenderer skull and narrow palate.

Teeth.—Central pair of upper incisors much larger than the lateral pair, broad, cutting edge bilobate; lateral incisors with a single acute posteriorly placed cusp; upper canines conoid, very slightly diverging; first upper premolar subreniform in basal outline, the posterior portion lying against the internal border of the second premolar smaller than the anterior portion; second upper premolar with a large hastate posterior cusp, basal outline subpentagonous; first and second upper molars subquadrate, protocone and hypocone developed as low pointed cusps; third upper molar strongly transverse, protocone developed as a jagged elevation, para-hypoconoid ridge N-shaped. Lower incisors crowded, equal in size, trilobate; canines slender; first lower premolar unicuspidate, the labial face considerably excavated; second lower premolar very minute and crowded between the first and third and displaced toward the lingual face; third lower premolar unicuspidate, slightly more acute than the first premolar; molars equal in size.

Measurements.—Average of series:[9] Total length [5] 61 mm. (59–65);

[9] Numbers in brackets designate the number of specimens examined for that particular measurement. This is necessitated by the condition of material, as some alcoholic specimens are shriveled to such an extent that but few measurements can be taken. Figures in parentheses have their usual significance as extremes.

length of head and body [2] 41.2 (41.5–44); head [3] 16.4 (15.8–17); ear [3] 13.6 (12–16); tragus [3] 4.8 (4.5–5); forearm [10] 39 (37.5–41.5); thumb [3] 6.5 (6–7); third digit [3] 60.6 (60–62); tibia [10] 14.6 (12–16); calcaneum [2] 22.7 (22.5–23); foot [10] 8.8 (8–9.2); tail [3] 19.3 (18–20).

Total length of skull [6] 15.4 mm. (14.1–16.1); greatest zygomatic width [7] 7.7 (7.5–8); interorbital width [7] 3.2 (3–3.5); height at base of second premolar [7] 3.3 (3–3.5); height of brain-case [6] 6.1 (6–6.3); width of palatal constriction [7] 1.4 (1.3–1.5); length of palate [7] 6.5 (6–7); width of palate including teeth [7] 5.7 (5.3–6); greatest length of mandible [7] 11.1 (10–11.6).

Remarks.—This species is not liable to be confused with the other species of the genus, but its three subspecies are all, with the possible exception of *C. m. grisea,* quite closely related. From *macleayii grisea* the true *macleayii* may be separated by its smaller size and the shape of the superior margin of the nostrils; from *m. fuliginosa* the larger size and heavier build will distinguish it; from *m. inflata* the shape of the rostral portion of the skull, as well as the general slenderer character of the palate and zygomata, will serve to differentiate it.

The most striking variation exhibited by this species is the occurrence of two forms, one considerably smaller than the other. This fact was first noticed by Miller (*l. c.*), and, as he states, it appears to be independent of age or sex. The series studied, while a picked lot from the series he examined, do not give the extreme dimensions he cites, but the two forms can very readily be distinguished. Another very striking variation is in the shape of the skull, and is apparently sexual. The skulls of the females examined are shorter and more inflated in the rostral portion than those of the males. In this respect they approach the Porto Rican *m. inflata,* but the skull of that form appears, in both sexes, to be more inflated and robust proportionally than the smaller females of *macleayii.*

Specimens Examined.—Eleven alcoholic specimens and seven skins:

Guanajay, Pinar del Rio, Cuba. (U. S. N. M.) [6.]

Baracoa, Santiago, Cuba. (U. S. N. M.) [4.]

Eight miles east of Baracoa, Santiago, Cuba. (U. S. N. M.) [8.]

Chilonycteris macleayii fuliginosa (Gray).

1843. *Chilonycteris fuliginosa* Gray, Proc. Zoöl. Soc. London, 1843, p. 20. [Haiti.]

1855. *Ch[ilonycteris] fuliginosa* Wagner, Suppl. Schreber's Säugthiere, V, p. 679. [Haiti.]

1872. *Chilonycteris MacLeayii* Peters, Monatsb. K. Preuss. Akad. Wissensch., Berlin, 1872, p. 360. [Part.] [Cuba; Jamaica; Haiti.]

1878. *Chilonycteris macleayi* Dobson, Catal. Chiropt. Brit. Mus., p. 449. [Part.] [Cuba; Port au Prince, Haiti (type of *fuliginosa* Gray); Jamaica (type of *grisea* Gosse).]

Type Locality.—Port au Prince, Haiti.

Distribution.—The island of Haiti and San Domingo. No specimens possessing exact data available.

General Characters.—Allied to the Cuban *macleayii* but the size smallest in the genus, skull smaller than in *macleayii* and comparatively slender, and calcanea shorter.

Head.—As in *C. macleayii.*

Limbs.—Except for the generally smaller size of the forearm and tibia, no difference is noted from the same portions of *macleayii.* The calcaneum is distinctly shorter, not at all or but slightly exceeding the tibia in length.

Membranes and Fur.—As in *macleayii.*

Color.—The available alcoholic specimens have been preserved for quite a long time and the coloration exhibited by them may be somewhat abnormal. General color above cinnamon-rufous; below seal-brown; volar membranes prout's-brown; ears wood-brown. The single skin available is mummified and has been in a liquid preservative at some time; the colors are as follows: above pale mars-brown; below isabelline, becoming ecru-drab on the throat; membranes drab.

Skull.—Similar to *C. macleayii* but smaller, the males with the whole form comparatively more robust than in the same sex of *macleayii.* The singular abbreviate skull of the females of *macleayii* approaches *m. fuliginosa* very much, but the latter has a slenderer rostrum and more compressed zygomata. One specimen (5072, A. N. S. P.) bears a comparatively high sagittal crest.

Teeth.—Essentially as in *C. macleayii* with the following exceptions: first upper premolar simpler in outline, more ovate than reniform; second upper premolar more transverse in outline than pentagonal, the anterior shoulder not as strongly developed as in *macleayii.*

Measurements.—Average of series: Total length [1] 56.2 mm.; length of head and body [3] 40.5 (39.5–41); head [1] 17.1; ear [2] 13.6 (13.2–14); tragus [2] 4.5; forearm [5] 37.7 (35–40); thumb [4] 6.2 (6–7); third digit [5] 62.2 (58.5–68); tibia [5] 15.1 (14.5–16); calcaneum [2] 15 (14–16); foot [5] 8.3 (8.9); tail [5] 18.8 (17–20).

Total length of skull [2] 14.1 (14–14.3); greatest zygomatic width [1] 7.2; interorbital width [3] 3; height at base of second premolar [3] 3; height of brain-case [2] 6; width of palatal constriction [2] 1.4; length of palate [2] 6.1 (6–6.2); width of palate including teeth [3] 5.1 (5–5.2); greatest length of mandible [2] 10.5 (10–11).

Remarks.—This form of *macleayii,* while not at all sharply defined, can be recognized by the unusually small size, short calcaneum and rather different skull. In a number of characters which reach their extremes in *macleayii* and *m. inflata, m. fuliginosa* is intermediate, as might be expected from the distribution of these forms; but that the three types are entitled to recognition will generally be admitted on examining representatives of the several races.

Specimens Examined.—Five, one skin and four alcoholic specimens:

Haiti. (A. M. N. H.) [1.]

San Domingo. (A. N. S. P.) [4.]

Chilonycteris macleayii inflata n. subsp.

1878. *Chilonycteris Mac-Leayi* Gundlach (not of Gray), Anales Soc. Espan. Hist. Nat., VII, cuad. I, p. 140. [Bayamon and Mayaguez, Porto Rico.]

Type.—Adult ♂; Cueva di Fari, near Pueblo Viejo, Porto Rico. No. 6,234, A. N. S. Phila. March 19, 1900. Collected by Drs. C. W. Richmond and L. Stejneger.

Distribution.—Apparently the whole island of Porto Rico, specimens from a cave near Pueblo Viejo and Mayaguez having been examined.

General Characters.—This form is distinguished from true *macleayii* by the short and bullate rostrum of the skull and the rather expanded zygomata.

Head, limbs and *fur* very much as in *macleayii*, but the distal half of the ear is shorter and broader, the apex more blunt, and not so falcate, the external margin being straighter.

Color.—Rufous phase:[10] above rather dark cinnamon; below wood-brown, the fur basally mummy-brown. Brown phase: above bistre, the short hair on the nape and sides of the neck silvery-white, the latter also apparent in the general bistre tint, caused by scattered unicolored hairs and also by the silvery median bands of the darker hairs; below with the hair basally bistre, apically drab, becoming wood-brown on the chin and throat and whitish on the abdomen. Membranes dull blackish. One specimen examined appears to be intermediate between the two phases.

Skull.—Similar to that of *C. macleayii*, but with the rostrum shorter and broader, the brain-case higher and the zygomata more expanded. The rostrum is considerably shorter than the brain-case in length and the lateral margins are rather strongly and evenly arcuate; brain-case strongly inflated and elevated above the rostrum a distance more than equal to the height of the rostrum at the anterior margin of the orbits. Palate considerably broader than in *macleayii*. The skulls of females of *macleayii* are, of course, very similar to the males of *m. inflata* in general appearance, but they lack the extreme characters of the rostrum, and the high brain-case is peculiar to *inflata*. The skull of the female of *inflata*, however, is practically indistinguishable from that of *macleayii*, though the latter is somewhat smaller.

[10] Type in this phase.

Teeth.—Similar to *macleayii* but for the following exceptions: median upper incisors very broad and very distinctly bilobate; first upper premolar small and low, considerably crowded; second lower premolar shorter and broader, the basal outline more rounded and not so oblong as in *macleayii.*

Measurements.—Type: Total length 63 mm.; head and body 45.5; head 17.3; ear 12.5; tragus 4.8; forearm 38.5; thumb 7; third digit 63.5; tibia 16.5; calcaneum 18; foot 8.5; tail 18. Average of series: Total length [3] 64.3 (61.5–68.5); head and body [5] 48.7 (41–52); head [2] 16.9 (16.5–17.3); ear [2] 12.2 (12–12.5); tragus [2] 4.5 (4.3–4.8); forearm [6] 38.7 (38–40); thumb [2] 7; third digit [2] 62.2 (61–63.5); tibia [5] 15.6 (15–16.5); calcaneum [2] 19.7 (18–20.5); foot [6] 8.4 (8–9); tail [4] 19.6 (17–23).

Type skull: Total length 15.3 mm.; interorbital width 3.5; height at base of second premolar 3.5; height of brain-case 6.4; width of palatal constriction 1.5; length of palate 6; width of palate including teeth 5.5; greatest length of mandible 11. Average of series of skulls: Total length [5] 14.8 (14.2–15.3); greatest zygomatic width [3] 8 (7.9–8); interorbital width [5] 3.2 (3–3.5); height at base of second premolar [5] 3.3 (3.1–3.5); height of brain-case [5] 6.4 (6.1–7); width of palatal constriction [5] 1.4 (1.3–1.5); length of palate from anterior foramina [5] 6.1 (6–6.4); width of palate including teeth [5] 5.3 (5.1–5.5); length of mandible [5] 10.8 (10.6–11.1).

Remarks.—The foregoing description presents the differential characters of *inflata* so that no general remarks are necessary. The phyla represented by *m. fuliginosa* and *m. inflata* reaches its extreme type in the latter race, the most apparent diagnostic character of which is the inflated rostrum.

Specimens Examined.—Two alcoholics and four skins:

Cueva di Fari, near Pueblo Viejo, Porto Rico. (A. N. S. P. and U. S. N. M.) [5.]

Mayaguez, Porto Rico. (U. S. N. M.) [1.]

Chilonycteris macleayii grisea (Gosse).

1851. *Chilonycteris grisea* Gosse, A Naturalist's Sojourn in Jamaica, p. 326, Pl. VI, fig. 1. [Phœnix Park, Jamaica.]
1861. *Chilonycteris quadridens* Tomes, Proc. Zool. Soc. London, 1861, p. 65. [Oxford Cave, Jamaica.]
1872. *Chilonycteris MacLeayi* Peters, Monatsb. K. Preuss. Akad. Wissensch., Berlin, 1872, p. 360. (Part.) [Cuba; Jamaica; Haiti.]
1878. *Chilonycteris macleayi* Dobson, Catal. Chiropt. Brit. Mus., p. 449, Pl. XXIII, fig. 1. (Part.) [Cuba; Port au Prince, Haiti (type of *fuliginosa* Gray); Jamaica (type of *grisea* Gosse).]
1880. *Chilonycteris macleayi* Dobson (not of Gray), Rep. Brit. Asso. Adv. Sci., 1880, p. 195. [Environs of Kingston, Jamaica.]

Type Locality.—Phœnix Park, St. Ann Parish, Jamaica.

Distribution.—The island of Jamaica, specimens having been recorded from the type locality, Kingston and Oxford Cave, while other individuals have been examined from Lucea, Hanover Parish, in the extreme northwestern part of the island.

General Characters.—Size quite large, largest of the *macleayii* group; nostrils with the superior margin deeply and squarely emarginate centrally.

Head.—Similar to *C. macleayii* with the following exceptions: Nostrils with the superior margins bearing two low quadrate peg-like projections, between which is a deep emargination completely separating them; process flanking the nostrils elongate, sublanceolate in character. Dobson's figure (*vide supra*) represents these characters very clearly and was no doubt taken from the type specimen presented by Gosse, as that was the only Jamaican specimen studied by him.

Limbs.—Similar in character to *C. macleayii,* but, of course, larger, though the proportions are practically the same.

Membranes and Fur.—As in *macleayii*, but the free margin of the uropatagium very curiously tucked and thickened by short longitudinal thickenings, a character well exhibited in Gosse's original plate of the species.

Color.[11]—Rufous phase: above ferruginous; below chestnut, becoming pale on the chin; ears and cephalic processes vinaceous-cinnamon, the former becoming pale drab apically; volar membranes mummy-brown. Brown phase: above bistre, sprinkled and suffused with silvery-white as in the brown phase of the other races of the *macleayii* group; beneath clove-brown; membranes as in the rufous phase.

Skull.—Elongate, somewhat compressed; rostrum slenderer, comparatively, than in any of the other forms of the *macleayii* group; brain-case moderately inflated.

Teeth.—As in *C. macleayii,* except for the first lower premolar which is broader, with the external margin more rounded than in the typical form.

Measurements.—Average of series: Total length [4] 68.7 (66.5–74); head and body [4] 45.4 (44.5–49); head [2] 18.3 (18.2–18.5); ear [4] 15.2 (14–16.3); tragus [4] 5.6 (5–6.5); forearm [4] 43.8 (43–44.5); thumb [4] 7.5 (7–8); third digit [4] 73.7 (72.5–75); tibia [4] 16.3 (16–17); calcaneum [4] 23 (20–26); foot [4] 9.7 (9.5–10); tail [4] 23.2 (22–25).

Total length of skull [2] 16.9 (16.8–17); greatest zygomatic width [2] 8 (8–8.1); interorbital space [2] 3.5; height of second premolar [2] 3.5 (3.5–3.6); height of brain-case [1] 6.3; width of palatal constriction

[11] From alcohol.

[2] 1.5 (1.5–1.6); length of palate from anterior foramina [2] 7; width of palate including teeth [3] 6; greatest length of mandible [2] 12 (11.9–12.1).

Remarks.—The Jamaican form of the *macleayii* group is so very distinct from the other associated races that no general summary is necessary.

Specimens Examined.—Four alcoholic specimens: Lucea, Jamaica. (A. M. N. H.)

Chilonycteris personata Wagner.

1843. *Chilonycteris personata* Wagner, Archiv für Naturgeschichte, IX, bd. I, p. 367. [Matto Grosso.]
1850. *Chilonycteris personata* Wagner, Abhandlungen Mathem.-Physik. Cl. Akad. Wissenschaften, München, V, p. 185. [St. Vincent, Matto Grosso.]
1854. *Chilonycteris personata* Burmeister, Thiere Brasiliens, I, p. 76. [St. Vincent, Matto Grosso.]
1855. *Ch[ilonycteris] personata* Wagner, Suppl. Schreber's Säugthiere, V, p. 680. [Matto Grosso.]
1872. *Chilonycteris personata* Peters, Monatsber. K. Preuss. Akad. Wissensch., Berlin, 1872, p. 360. [Brazil; Venezuela; Guatemala.]
1878. *Chilonycteris persona'a* Dobson, Catal. Chiropt. Brit. Mus., p. 451. [Guatemala; Venezuela; Matto Grosso, Brazil.]
1879. *Chilonycteris personata* Alston, Biol. Cent.-Amer., Mamm., p. 35. [Guatemala; Venezuela; Brazil.]

Type Locality.—Matto Grosso, Brazil. As Wagner afterward particularly mentioned St. Vincent, Matto Grosso, it is quite probable that it was the exact locality from which the type was obtained.

Distribution.—This species has a very extensive distribution, but as specimens appear to be extremely rare and none are now at hand, the records mentioned above constitute the only information. It will be seen to range from Matto Grosso, Brazil, to Guatemala, and eastward to Venezuela.

Description.—As no specimens have been examined in this connection, Wagner's description and notes in the *München Abhandlungen* (*vide supra*) are here given:

"Die Beschaffenheit der Ohren, der Klappe, der Nase, des Lippenbesatzes und der Schneidezähne ist ganz dieselbe wie bei *Ch. gymnonotus*.[12] Die Sporen sind ebenfalls, aber nur sehr wenig, an den untern Theil des Schienbeins geheftet, und auch die Flügel setzen sich etwas tiefer an. Der Hauptunterschied liegt in der Behaarung, indem der Rücken bei dieser Art eben so behaart ist als der übrige Körper. Die Farbe des Pelzes kann nicht mit Sicherheit angegeben werden, da das einzige Exemplar in Brauntwein aufbewahrt ist. Sie scheint oben schwarz oder dunkelbraun zu seyn, unten lichtbraun, indem hier die Haarspitzen weit heller sind. Mit *Ch. rubiginosa* kann der verschied-

[12] This is *Dermonotus fulvus*.

enen Färbung und der geringeren Grösse wegen keine Verwechslung vor sich gehen.

Körper	2″	1‴	Schwanz	0″	7½‴
Höhe	1	8½	Freier Theil desselben	0	3
Kopf	0	7	Schenkelflughaut	1	1
Ohrlänge	0	6	Vorderarm	1	8
Ohrbreite	0	4	Schienbein	0	7½
Sporen	0	10	Flugweite ohngefähr	10	6

"Das beschriebene Exemplar, ein Männchen, rührt von St. Vincente in der Provinz Mato grosso her. Steht mit *Ch. Mac-Leayii* in naher Verwandtschaft; wenn jedoch, wie es allen Anschein hat, *Gundlach's Lobostoma quadridens* mit der Gray'schen Art identisch ist, so ist von ihren die unserige schon deshalb spezifisch verschieden, weil zwar die untere Hälfte des Vorderrandes des Ohrs ebenfalls erweitert ist (was mit zu den generischen Kennzeichen zu gehören scheint), aber die Erweiterung bildet nicht 4 Zähnchen, sondern ist wie bei voriger Art ganzrandig."

Chilonycteris parnellii (Gray).

1843. *Phyllodia Parnellii* Gray, Proc. Zoöl. Soc. London, 1843, p. 50. [Jamaica.]
1855. *Ch[ilonycteris] Parnellii* Wagner, Suppl. Schreber's Saügthiere V, p. 680. [Jamaica.]
1861. *Chilonycteris osburni* Tomes, Proc. Zoöl. Soc. London, 1861, p. 66, Pl. XIII. [Sportsman's Cave, Jamaica.]
1865. *Chilonycteris* sp. Osborn, Proc. Zoöl. Soc. London, 1865, p. 68. [Sportsman's Hall Cave; Oxford Cave, Manchester, Jamaica.]
1865. *Chilonycteris osburni* Sclater, Proc. Zoöl. Soc. London 1865, p. 68, footnote.
1866. *Phyllodia Parnellii* Peters, Monatsber. K. Preuss. Akad. Wissensch., Berlin, 1866, p. 678. [No locality.]
1872. *Chilonycteris Parnellii* Peters, Monatsber. K. Preuss. Akad. Wissensch., Berlin, 1872, p. 360. (Part.) [Cuba; Jamaica.]
1878. *Chilonycteris parnellii* Dobson, Catal. Chiropt. Brit. Mus., p. 452. [Jamaica.]
1902. *Chilonycteris parnellii* Miller, Proc. Acad. Nat. Sci. Phila., 1902, p. 401.

Type Locality.—Jamaica.

Distribution.—Apparently restricted to the island of Jamaica, the only definite records being from the Sportsman's Hall and Oxford Cave, while a series of specimens examined in this connection are from Lucea, Hanover Parish. Osburn (*l.c.*) has given us an interesting account of the species in captivity.

General Characters.—Size rather large; ears large, subacute; the internal margin arcuate, the external margin with a distinct submedian shoulder; tragus rounded with a distinct accessory lobe; nostrils superiorly margined by a slight cutaneous ridge; nose bearing a distinct high fleshy protuberance.

Head.—Rather elongate, depressed; rostrum rather broad. Ears large, rather broad, the lower flap broad and extending forward almost to the corner of the mouth; internal margin evenly arcuate, attached to the head above the posterior corner of the small eye, internal ridge distinct, the inferior lobe truncate; external margin of the ear basally arcuate, a distinct though slight submedian shoulder, distal half faintly arcuate with a subapical concavity which throws into relief the rather blunt though slightly recurved apex. Tragus rather short, the apex blunt and rounded, the external margin with a slight submedian shoulder; accessory lobe distinct and represented by a curved fold on the internal side parallel with, but distinct from, the main portion of the tragus. Nostrils somewhat inflated, and each surmounted and internally bordered by a low arcuate row of obscure tubercles. Lateral portions of the muzzle thickened and forming a moderately elevated ridge which gradually passes into the lateral portions of the upper lip. Rostrum surrounded by a high rounded excrescence.[13] Labial chin-lappet rather narrow, strongly transverse, the median portion strongly papillose, the superior margin around the semicircular chin-pad bearing the largest papillæ; inferior margin very faintly concave. Posterior chin-lappet a simple flap almost equal to the labial lappet in width, depressed.

Limbs.—Forearm of moderate length, slightly curved in the proximal portion; thumb rather heavy. Tibia rather heavy and stout (for the genus); foot slender, the toes strongly compressed; calcaneum not quite half as long again as the tibia.

Membranes and Fur.—Membranes rather thin but strong, the endopatagium and mesopatagium with the nerve rami longitudinal; uropatagium moderately large and with a great number of transverse lines of hair; propatagium deep proximally, margin entirely free. Fur rather thick and rather woolly in character on the lower surface, the throat sparsely haired, the upper surface of the endopatagium with a considerable proximal area furred. Hair on the chin-lappets and muzzle rather setiform; ears with an irregular covering of white flocculose hairs.

Color.—This species appears to possess two color phases, which are not quite so clearly defined as in some of the other forms of the genus. Brown phase:[14] above between clove- and vandyke-brown; below clove-

[13] This curious outgrowth is exceedingly interesting. It is possibly analogous to the nose-leaf of the Phyllostomatine bats, but this appears to be doubtful, and probably it should be considered as representing a structure similar to that found in some Vespertilionine bats such as *Antrozous* and *Corynorhinus*.

[14] From alcohol.

brown, the hair with a silvery or whitish suffusion; membranes and muzzle mars-brown, the latter portion rather pale and tending toward cinnamon. Rufous phase: above dark mars-brown, the hair pale at base; below with the hair between vandyke-brown and sepia basally, the apical portion light and rather silvery in character; membranes a little paler than in the brown form.

Skull.—Robust and strongly built. Brain-case moderately elevated above the rostrum, somewhat depressed longitudinally, but rather evenly arched transversely; auditory bullæ rather prominent; zygomata little curved, simple, greatest width posterior. Rostrum rather high, appearing somewhat compressed when viewed from the anterior aspect, merging into the brain-case with a very slight angle; nasal depression slight, shallow; palate rather deeply excavated, posterior extension short and with the cleft acute-angulate. Mandible rather slender, symphysis and anterior portion heavy; ascending ramus low; angle bluntly and slightly recurved.

Teeth.—Median upper incisors quadrate in outline, very obscurely bilobate; lateral upper incisor circular in basal outline and touching the anterior margin of the incisor, cusp very low; upper canine conoid, very slightly recurved; first upper premolar reniform in basal outline, cusp rather low; second upper premolar trigonal in basal outline, cusp moderately high, caniniform, internal cingulum rather strongly marked; first and second upper molars with the proto-hypoconoid ridge well marked, the hypocone considerably the lower. Lower median incisors distinctly trilobate, laterals bilobate or obscurely trilobate, all short and rather crowded; lower canines somewhat divergent and slightly recurved; first lower premolar rather oblong in basal outline, cusp rather acute; second lower premolar small, circular and crowded between the first and third premolar and forced to the internal side of the toothrow, which when viewed from the labial aspect exhibits little or no space between the first and third premolar; third lower premolar compressed, elongate when viewed from above, the cusp erect and somewhat recurved with a slight anterior accessory cusp; lower molars similar in character to one another, the first the largest in the series, the posterior molar with the entoconid very low when compared with that cusp of the other teeth.

Measurements.—Average of series of eight alcoholic specimens: Total length 76 (73.5–81) mm.; length of head and body 56.7 (53–60.5); length of head 23.5 (22–25); length of ear 20.6 (19.5–21.5); length of tragus 5.3 (4.5–6); length of forearm 53.5 (52–54); length of thumb 8.2 (7.5–8.5); length of third digit 85.8 (84–87); length of tibia 19 (18–19.5);

length of calcaneum 23 (21–24); length of foot 12.7 (12–13.4); length of tail 20.9 (17–25).

Average of three skulls: Total length 20.6 (20.2–21); greatest zygomatic width 11.1 (11–11.5); interorbital width 4 (4–4.1); height at base of second premolar 4.9 (4.8–5); height of brain-case 7.6 (7.2–8); breadth of brain-case above roots of zygomata 10; width of palatal constriction 1.4 (1.4–1.5); length of palate from anterior foramina 8.6 (8.3–9); width of palate including teeth 7.1 (7.1–7.2); greatest length of mandible 15.5 (15.2–16.)

Remarks.—This species is not liable to be confused with any of the forms of the genus except its own subspecies. From both of these it may be separated by the crowded second premolar, the high rostral portion of the skull and the rather slender foot.

Specimens Examined.—Eight alcoholic specimens: Lucea, Jamaica. (A. M. N. H.)

Chilonycteris parnellii boothi (Gundlach).

1861. *Chilonycteris Boothi* Gundlach, Monatsber. K. Preuss. Akad. Wissensch., Berlin, 1861, p. 154. ["In Fundador, auch in Guines."]
1872. *Chilonycteris Parnellii* Peters, Monatsber. K. Preuss. Akad. Wissensch., Berlin, 1872, p. 360. (Part.) [Cuba; Jamaica.]
1873. *Chilonycteris Boothi* Gundlach, Anales Soc. Espan. Hist. Nat., I, cuad. 3, p. 245. [Cuba.]
1902. *Chilonycteris boothi* Miller, Proc. Acad. Nat. Sci. Phila., 1902, p. 401.
1904. *Chilonycteris boothi* Miller, Proc. U. S. Nat. Mus., XXVII, p. 341. [Baracoa, Santiago, Cuba.]

Type Locality.—Fundador, Matanzas Province, Cuba. Gundlach states that the species was also found at Guines, but Fundador was fixed as the type locality by Miller and Rehn.[15]

Distribution.—The species has been recorded from Guines, Havana Province; Fundador, Matanzas Province, and Baracoa, Santiago Province. From these records it would appear that the species is rather generally distributed through the island. Gundlach, in speaking of the species, says: Observed and not rare in various caves of the departments, also gathering at night in houses in the country.

General Characters.—Similar to *C. parnellii*, but differing in the disposition of the lower premolars, the more depressed rostrum and the more robust form. It is also very closely related to *C. p. portoricensis*, from which, however, it is separated by its larger size, slenderer rostrum and rather depressed brain-case.

Head.—Similar to *C. parnellii*, but with the ear slenderer, longer and with the apical portion decidedly falcate.

Limbs.—Much as in *C. parnellii*, except that the foot appears to be

[15] *Proc. Boston Soc. Nat. Hist.*, XXXI, p. 125.

rather stouter and heavier. As the comparable material of *C. p. boothi* is very limited, this may prove to be incorrect when a larger series is examined and compared.

Membranes and Fur.—As in *C. parnellii.*

Color.—As far as published references and available material goes, no rufous phase is known in this race. This is no doubt due to the limited material available, and further work will probably show the rufous type is also present in the Cuban form. Hair of the upper surface silvery-gray at the base, apically dark walnut-brown, rather pale on the nape and sides of the neck, where the under color shows through and considerably weakens the brown tint; below with the hair of the chest and abdomen bistre at the base, the tips of the hair on these parts and all the hair on the throat and chin ecru-drab, this color appearing stronger on the throat than on the other parts; membranes seal-brown.

Skull.—Similar to *C. parnellii*, but slightly larger, the rostrum slightly slenderer and lower, while the nasal impression is not as marked as *C. parnellii.*

Teeth.—Essentially as in *C. parnellii*, except that the second lower premolar is not as crowded, having a place in the toothrow (*i.e.*, placed so that it is distinctly visible from either the labial or lingual aspect of the tooth series), though still somewhat displaced toward the lingual side.

Measurements.—Average of a series of four specimens: Total length 81.2 (76–88); length of head and body 64.4 (60.5–68); length of head[16] 24.8 (24.2–25.5); length of ear[16] 22 (21.5–22.5); length of tragus[16] 5.6 (5.3–6); length of forearm 52 (51–53.5); length of thumb 8.7 (8–9.1); length of third digit 86.7 (85–90); length of tibia 19.5 (19–20); length of calcaneum 21.8 (21–23); length of foot 11.6 (11–12.5); length of tail[16] 21 (19.5–22.5).

Average of two skulls: Total length 21 (20.8–21.2); greatest zygomatic width 11.2 (11.2–11.3); interorbital width 4.2; height at base of second premolar 4.8; height of brain-case 7.4 (7.3–7.5); breadth of brain-case above roots of zygomata 10; width of palatal constriction 1.4 (1.3–1.6); length of palate from anterior foramina 8.7 (8.6–8.8); width of palate including teeth 7.2 (7.2–7.3); greatest length of mandible 15.7 (15.5–16).

Remarks.—The differential characters of this form have already been given under the key of the species and general characters of the race.

[16] From two specimens.

Specimens Examined.—Four specimens, two skins, two alcoholic individuals: Baracoa, Santiago, Cuba. (U. S. N. M.)

Chilonycteris parnellii portoricensis (Miller).

1902. *Chilonycteris portoricensis* Miller, Proc. Acad. Nat. Sci. Phila., 1902, p. 400. [Cave near Pueblo Viejo, Porto Rico.]

Type Locality.—Cueva di Fari, near Pueblo Viejo, Bayamon district, Porto Rico.

Distribution.—Known only from the type locality, but probably found in suitable localities throughout the island.

General Characters.—Similar to *C. p. boothi*, but the size is less, while the skull is somewhat inflated.

Head.—Essentially as in *C. p. boothi*, except that the ears appear to be slightly smaller with the apical portion blunter and less falcate.

Limbs.—Except for the slight difference in proportions, essentially as in *C. p. boothi*.

Membranes and Fur.—As in *C. p. boothi*.

Color.—Above dark brown, between Ridgway's mars-brown and bistre, pale on the nape where the ecru-drab under portion of the hair is very evident; below dark gray, the base of the hair on the abdomen and chest seal-brown, on the throat and chin pale isabella color; membranes blackish-brown. The remarks made under *C. p. boothi* concerning color phases also apply to this form. One specimen shows a slight approach toward the rufous form.

Skull.—Similar to that of *C. p. boothi*, except that the brain-case is more arched transversely and the rostrum is distinctly broader and heavier. This character is interesting, as it is paralleled by a similar development in the Porto Rican form of the *macleayii* group.

Teeth.—Essentially as in *C. p. boothi*.

Measurements.—Average of series: Total length [5] 77.3 (74–79); length of head and body [5] 57.8 (54–66); length of head [4] 23 (21.5–24.3); length of ear [4] 20.5 (19.7–22); length of tragus [4] 5.3 (5–5.7); length of forearm [5] 50.7 (49.6–51.5); length of thumb [5] 8.2 (8–8.5); length of third digit [5] 81 (79–82); length of tibia [5] 18.4 (18–19); length of calcaneum [4] 22.9 (19–25); length of foot [5] 11.8 (10.5–12.5); length of tail [4] 21 (19.5–23).

Dimensions of one skull: Total length 20.5; greatest zygomatic width 11.1; interorbital space 4; height at base of second premolar 4.8; height of brain-case 7.5; breadth of brain-case above roots of zygomata 9.8; width of palatal constriction 1.4; length of palate from anterior foramina 8.7; width of palate including teeth 7.5; greatest length of mandible 15.6

Remarks.—This race needs special comparison with only one form, *C. parnellii boothi.* From it *portoricensis* can be distinguished by the rather smaller size and the form of the skull. The ears do not seem to be as good a diagnostic character as those given here, but still there is a slight difference in the shape of the same. From *C. parnellii* the same characters that distinguish *C. p. boothi* can be applied to this subspecies.

Specimens Examined.—Five, one skin, four alcoholic specimens: Cueva di Fari, near Pueblo Viejo, Porto Rico. (U. S. N. M.)

Chilonycteris rubiginosa Wagner.

1843. *Chilonycteris rubiginosa* Wagner, Archiv für Naturgeschichte, IX, bd. I, p. 367. [Caiçara, Brazil.]
1850. *Chilonycteris rubiginosa* Wagner, Abhandlungen Mathem.-Physik. Cl. Akad. Wissenschaften, München, V, p. 181, taf. III, figs. 2–6. [Caiçara, Brazil.]
1854. *Chilonycteris rubiginosa* Burmeister, Thiere Brasiliens, I, p. 75. [Caiçara, Brazil.]
1855. *Ch[ilonycteris] rubiginosa* Wagner, Suppl. Schreber's Säugthiere, V, p. 679. [Matto Grosso.]
1872. *Chilonycteris rubiginosa* Peters, Monatsberichte K. Preuss. Akad. Wissensch., Berlin, 1872, p. 360. [Brazil; Guatemala; Costa Rica.]
1878. *Chilonycteris rubiginosa* Dobson, Catal. Chiropt. Brit. Mus., p. 452, Pl. XXIII, fig. 3.
1879. *Chilonycteris rubiginosa* Alston, Biol. Cent.-Amer., Mamm., p. 35. (Part.) [Mirador, Mexico; Dueñas, Ciudad Vieja, Guatemala; Costa Rica; Colombia; Brazil.]
1892. *Chilonycteris rubiginosa* Thomas, Journal Trinidad Field Naturalists' Club, I, p. 162. [Port of Spain, Trinidad.]
1902. *Chilonycteris rubiginosa* Miller Proc. Acad. Nat. Sci. Phila., **1902,** p. 402. [Chontales, Nicaragua; Trinidad.]

Type Locality.—Caiçara, upper Amazon, Brazil.

Distribution.—Upper Amazon region of Brazil, north to Guatemala, east at least to Trinidad. The specimens from the latter island may, when further material has been examined, prove to be a distinct race. This form no doubt intergrades with *C. r. mexicana,* as specimens of the latter race from southern Mexico approach true *rubiginosa* in proportions. The specimen from Guatemala measured by Dobson (*l. c.*) was without doubt true *rubiginosa.*

General Characters.—Size large (largest in the genus); ears with the internal margin entire; tragus apically produced and with a slight accessory lobe; nose with a low rounded tubercle.

Head.—Moderately long, depressed; crown moderately elevated above rostrum. Ears erect, apically acute; internal margin evenly arcuate, the inferior lobe rectangulate; external margin slightly concave in its upper half, median notch rectangulate, rather small, the angle of the inferior shoulder rounded, lower portion of the external margin evenly rounded and carried forward to near the angle of the mouth, at which point it rather abruptly and squarely terminates. Tragus sublanceolate; apex acutely produced; external margin evenly rounded, with a slight emargination and thickening of the proximal portion; internal margin thickened and bearing a slight accessory lobe, which takes the form of a subarcuate longitudinal thickening of the internal margin. Nose, a distance back from the nostrils, with a rather low, rounded, subtransverse excrescence, anterior from which extend three impressed lines, the lateral ones strong, extending down to and flanking the nostrils, median one fainter and dividing the nostrils. Nostrils subovate, each crowned by a very low transverse fleshy ridge, each bearing several very poorly defined flat disk-like structures; median line between the nostrils flanked by a row of several indistinct nodular processes. Labial chin-lappet strongly transverse, arcuate; lateral portions without papillæ; median portion strongly and very distinctly papillose, and margined superiorly by a semicircular unimpressed area. Posterior chin-lappet a simple adpressed fold half the width of the labial chin-lappet.

Limbs.—Forearm moderately long, slightly and evenly bowed; third digit of medium length. Forearm, tibiæ and feet rather robust, the toes occupying about half the length of the foot; calcaneum rather short, exceeding the tibiæ by a fifth the length of the latter.

Membranes and Fur.—Membranes leathery, but not heavy; veins of the endopatagium and mesopatagium regularly longitudinal, those of uropatagium irregularly radiating from the point of exit of the tail; uropatagium large; propatagium deep, free its entire length. Fur uniformly distributed over the body, and extending a moderate distance on the endopatagium, both above and below; hair around the muzzle rather setiform in character.

Color.[17]—Above mars-brown, with a slight hoary frosting posteriorly; below prout's-brown posteriorly suffused with pale ochraceous. Membranes sepia. The red phase is also present in this species, as both Wagner and Dobson mention it.

Wagner possessed two specimens, one in each phase. He describes the red phase as follows: The color of the upper and the under side is a uniform rusty cinnamon-red, that of the upper side of the body by the nape and the breast brighter, on the belly lighter with scattered spots of light brown. On the upper side the hair is unicolor for its entire length; on the belly the greater under part is dark with lighter tips. The flying membranes are brownish, the nails of the hind foot soiled horn-brown. The second example is a dark color.

[17] From one Nicaragua skin.

Skull.—Rather strongly built; moderately elongate, zygomata but little expanded; brain-case moderately elevated above the short and broad rostrum. Brain-case subglobose, somewhat depressed, crests faint. Rostrum of medium height, comparatively short and distinctly expanded, considerably less than the brain-case in length; nasal depression distinctly though shallowly excavated; palate subequal in width, moderately excavated, posterior projection extending but little beyond the major portion, the cleft narrowly rounded; pterygoids considerably divergent. Mandible with the ascending rami low and quite weak, the angle being considerably elevated and moderately produced laterally.

Teeth.—Median upper incisors moderately large, shallowly bilobate, the external lobe considerably smaller than the internal; external upper incisors over half the size of the median pair in basal outline, the cusp very low and weak, no space present between the incisors and canines; upper canines very slightly divergent and moderately recurved; first upper premolar reniform in basal outline, the greatest length of the tooth oblique, cusp low and simple; second upper premolar crudely triangular in basal outline, the apex anterior, cusp caniniform; first and second upper molars with the protocone and hypocone distinct and acute. Lower median incisors trilobate; lower lateral incisors bilobate, not half the size of the median pair and crowded between them and the canines; lower canines considerably divergent, slightly recurved; first lower premolar subquadrate in basal outline, cusp moderately elevated, compressed; second lower premolar low, circular and strongly crowded between the first and third premolar; third lower premolar oblong in basal outline, the single cusp acute; third lower molar smaller than the two preceding teeth and the entoconid and hypoconid somewhat weaker when compared with the para-proto-metaconid group.

Measurements.—Averages of series: Length of head and body [3] 67.5 mm. (62.5–72); total length [4] 89 (80–95); length of head [3] 25.3 (24–26.1); ear [3] 21.5 (21–22); tragus [3] 5.7 (5.5–6); forearm [4] 60.6 (59–63); thumb [3] 10.7 (10.3–11.5); third digit [3] 96.6 (92–101); tibia [4] 22.1 (22–22.5); foot [3] 14.5 (14–15); tail [3] 24.9 (23–26).

Total length of skull [averages from two skulls] 22.7 mm. (22.5–23); greatest zygomatic width 12.9 (12.5–13.3); breadth of brain-case above roots of zygomata 11.2 (11–11.5); interorbital width 5; height at base of second premolar 5.4 (5.3–5.5); height of brain-case 8.5; width of palatal constriction 1.8 (1.7–2); length of palate from anterior foramina 9.7 (9.6–9.8); width of palate including teeth 8; greatest length of mandible 17.8.

Remarks.—This species is unlikely to be confused with any form of the genus except the race *mexicana*, which can readily be separated by the size and the intensity of the coloration in the brown phase. From the *boothi* group it can readily be separated by the characters given in the key of species.

Specimens Examined.—Four, one skin and three alcoholic individuals:

Port of Spain, Trinidad. (U. S. N. M.) [2.]

Costa Rica. (U. S. N. M.) [1.]

Chontales, Nicaragua. (U. S. N. M.) [1.]

Chilonycteris rubiginosa mexicana (Miller).

1879. *Chilonycteris rubiginosa* Alston, Biol. Cent.-Amer., Mamm., p. 35. (Part.) [Mirador, Mexico; Dueñas, Ciudad Vieja, Guatemala; Costa Rica; Colombia; Brazil.]

1894. *Chilonycteris rubiginosus* J. A. Allen. Bull. Amer. Mus. Nat. Hist., VI, p. 247. (Not of Wagner.) [South shore of Lake Chapala, Michoacan, Mexico.]

1902. *Chilonycteris mexicana* Miller, Proc. Acad. Nat. Sci. Phila., 1902, p. 401. [San Blas, Tepic; Hacienda Magdalena, near city of Colima, Colima; Chacala, Durango; Ameca, Bolaños, Jalisco: near Ometepec, Guerrero; Morelos; Huiltepec, Oaxaca; Mexico.]

Type Locality.—San Blas, Tepic, Mexico.

Distribution.—Specimens have been examined from localities reaching from Tehuantepec and Huiltepec, Oaxaca to Chacala, Durango, while individuals from Mirador, Vera Cruz, are perfectly typical. To the south, no doubt, this form grades into true *rubiginosa*, as the specimens from southern Mexico average larger than those from around the type locality.

Miller says of this form: "At San Blas *Chilonycteris mexicana* was very common in a small narrow cave which extended like a deep crevice into the base of the cliff on the hillside facing the town."

General Characters.—Similar to *C. rubiginosa* but smaller, and the brown phase of coloration lighter.

Limbs.—As in *rubiginosa*, but for the smaller size.

Membranes and Fur.—As in *rubiginosa*.

Color.—Brown phase: above prout's-brown, rather pale on the nape; below with the hair seal-brown basally with broccoli-brown tips, the color weak on the throat due to the thinner character of the pelage. Ears and membranes clove-brown.

Rufous phase: entire body and head rich tawny-ochraceous, the hairs of the under surface brown at base (varying from cinnamon on the throat to mummy-brown on the abdomen). Ears and membranes clove-brown.

The two color phases appear to run together as several specimens examined are almost intermediate, for while the upper surface will incline toward the brown phase, the lower surface strongly resembles the rufous form. The type, described by Miller, apparently does not represent the extreme of the brown phase. From the specimens examined the brown phase may be said to be commoner than the rufous form.

Skull and Teeth.—Except for the difference in size, the skull and teeth are as in *Ch. rubiginosa.*

Measurements.—Average of representative series of fourteen specimens: Total length 78.8 (77–85); length of head and body 58.8 (56.5–63.5); length of head 23.6 (22.5–24.5); length of ear 20.5 (18.5–22.1); length of tragus 5.8 (5–6.4); length of forearm 56.5 (54–59); length of thumb 9.8 (9.1–11); length of third digit 93 (87–97); length of tibia 20.2 (19–22); length of foot 12.9 (12.5–13.5); length of tail 21.2 (19.4–23.5).

Average of eleven skulls: Greatest length 21.2 (20.9–22); greatest zygomatic width 11.8 (11–12.5); interorbital width 4.4 (4.2–4.8); breadth of brain-case above roots of zygomata 10.3 (10.1–10.5); height at base of second premolar 4.8 (4.6–5.1); height of brain-case 8 (7.8–8.2); width of palatal constriction 1.6 (1.4–1.8); length of palate from anterior foramina 8.5 (8.3–9.2); width of palate including teeth 7.4 (7–7.9); greatest length of mandible 15.8 (15.4–16.5).

Remarks.—This race can easily be distinguished from true *rubiginosa* by the difference in size.

Specimens Examined.—Forty-six specimens; eight skins, thirty-six alcoholic individuals, one odd skull:

Near Tehuantepec, Oaxaca, Mexico. (Biological Survey.) [1.]
Huiltepec, Oaxaca, Mexico. (Biological Survey.) [1.]
Ometepec, Guerrero, Mexico. (Biological Survey.) [3.]
Morelos, Mexico. (U. S. N. M.) [4.]
Mirador, Vera Cruz, Mexico. (U. S. N. M.) [1.]
Colima City, Colima, Mexico. (Biological Survey.) [2.]
Hacienda Magdalena, Colima, Mexico. (Biological Survey.) [5.]
Ameca, Jalisco, Mexico. (Biological Survey.) [5.]
Bolaños, Jalisco, Mexico. (Biological Survey.) [4.]
South shore of Lake Chapala, Michoacan, Mexico. (A. M. N. H.) [4.]
San Blas, Tepic, Mexico. (Biological Survey.) [11.]
Chacala, Durango, Mexico. (Biological Survey.) [5.]

Chilonycteris psilotis Dobson.

1878. *Chilonycteris psilotis* Dobson, Catal. Chiropt. Brit. Mus., p. 451. Pl. XXIII, fig. 2.
1902. *Chilonycteris psilotis* Miller, Proc. Biol. Soc. Wash., XV, p. 249. December 16, 1902. [Isthmus of Tehuantepec, Mexico.]

Type Locality and Distribution.—Dobson's types (♂ and ♀) came from an unknown locality, and until the recent record of the species by Miller (*vide supra*) nothing was known regarding its habitat. The Isthmus of Tehuantepec is accordingly the only locality from which the species is known.

General Characters.—Size medium; ear without distinct notch on the external margin; toes distinctly longer than the remainder of the foot.

Head.—Rather short and broad; rostrum moderately depressed, bearing on its superior aspect a distance back of the nosa a transverse, arcuate fleshy ridge, equal in width to the nose-pad itself. Ears moderately elongate, rather broad (for the genus), apically sublanceolate, the lower margins extended considerably forward, but failing to reach the angle of the mouth; internal margin of the ear attached to the head superior to the eye, internal ridge distinct, thickened, slightly arcuate, evenly rounded inferiorly and passing by a well-marked shoulder into the internal margin of the ear, distal two-thirds of the internal margin arcuate, slightly sinuate toward the apex and furnished about half-way between the apex and the shoulder of the internal ridge with a series of four small tooth-like projections; external margin basally convex, apically concave, without any distinct notch; apex rather slender, subfalciform, narrowly rounded. Tragus oblong, apex rather acute, accessory flap small and rounded. Nostrils transversely ovate, superior margin with a rather low ridge which is divided into about six parts by shallow incisions, lateral margins flanked by low rounded fleshy folds. Labial chin-lappet strongly transverse, bearing a raised margin laterally; inferior margin very broadly and slightly concave, median portion of the lappet with rather obscure papillæ; superior margin with a deep median emargination, which lodges the simple lip-pad. Posterior chin-lappet slight, a simple fold equal in width to the labial fold, against which it is closely set.

Limbs.—Forearm moderately long, considerably bowed in the proximal half. Femora and tibiæ moderately robust (for the genus); foot elongate, somewhat compressed, considerably more than half the length of the foot occupied by the toes; calcanea but slightly longer than the tibiæ and provided with a free apex.

Membranes and Fur.—Membranes thin and rather papery in character; transverse nerves of the endopatagium and mesopatagium very regularly disposed; propatagium much as in *macleayii*, but the distal portion is rather narrower; uropatagium rather large, extending beyond the enclosed portion of the tail a distance equal to the same. Fur of moderate length and extending evenly a short distance out on the dorsal surface of the endopatagium; both surfaces of the endopatagium and uropatagium with scattered inconspicuous hairs; muzzle with a number of long setiform hairs.

Color.—As the only available specimen is an old alcoholic individual, the colors are possibly not what might be seen in fresh specimens. Above vandyke-brown, rather pale on the loins; beneath drab, with a clouding of pale whitish. Muzzle, naked spots on head and ears wood-brown, the latter rather darker than the other portions. Membranes mummy-brown, paler on the propatagium, proximal portions of the endopatagium and uropatagium than on the remaining sections. Dobson describes the color as follows: "Fur orange above and beneath with orange-brown extremities; darker above, paler beneath."

Skull.—Comparatively short and robust, the rostral portion moderately inflated and the nasal depression rather broadly and deeply excavated. Brain considerably inflated and moderately elevated above the rostrum, into which it evenly descends, crests hardly visible; zygomata moderately expanded; interorbital constriction not strongly marked. Palate subequal in width (not including teeth), moderately arched, posterior projection of little extent, the cleft obtuse-angulate; pterygoids strongly divergent. Mandible very similar to that of *C. macleayii*, but the length is less, the build heavier and the angle distinctly falcate.

Teeth.—Upper median incisors broad, rather faintly bilobate; lateral upper incisors small and closely pressed to the median pair and separated from the canines by a considerable space; upper canines moderately long, very slightly curved; first upper premolar oblong in basal outline, longitudinal disposed and bearing a single low cusp; second upper premolar subpentagonal in basal outline, the single cusp acute and subcaniniform; first and second upper molars with the hypoconid region developed into a rather projecting rounded lobe which is very apparent. Lower incisors small, trifid; lower canines straight; first lower premolar subrotundate in basal outline with the cusp rather blunt; second lower premolar minute and displaced to the inner side of the toothrow; third lower premolar subquadrate in basal outline; lower molars very much as in *C. macleayii*.

Measurements.[18]—Total length 62 mm.; head and body 46; ear (from meatus) 15.8; tragus 5; forearm 44; thumb 8; third digit 71; tibia 17; calcaneum 19; foot 9 (8); tail 16.

Total length of skull 15 mm.; greatest zygomatic width 8.2; interorbital width 3.7; height at base of second premolar 4; height of braincase 6.5; width of palatal constriction 1.2; length of palate 6; width of palate including teeth 5.5; greatest length of mandible 10.5.

Remarks.—This species hardly requires comparison with any in the genus, being smaller and differing in general aspect from the *boothi* and *rubiginosa* group, while the *macleayii* type may easily be separated by the form of the ear. The skull closely resembles that of *Dermonotus*, but it is slenderer with a narrower interorbital region and different shaped premolars. As the species seems to approach *Dermonotus* in some characters, I have placed it at the end of the genus, all the other forms appearing to be more homogeneous, a fact rather strongly demonstrated by the form of the skull.

Specimens Examined.—One alcoholic; Isthmus of Tehuantepec, Mexico. (U. S. N. M.)

[18] As some measurements of the only available specimen have already been published by Miller (*l. c.*), I have used his information, only filling out the proportions required to make the measurements uniform with those of the remainder of this paper.

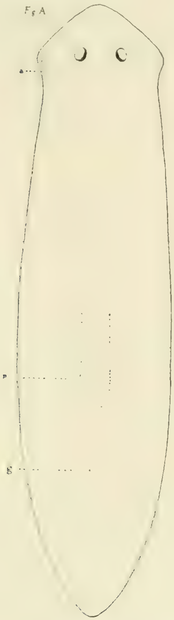
ON THE GERM CELLS AND THE EMBRYOLOGY OF PLANARIA SIMPLISSIMA.

BY N. M. STEVENS.

This planarian, which is found in small streams about Bryn Mawr, was identified provisionally in 1900 by Woodworth as *Planaria lugubris*, and has since figured under that name in several of Prof. T. H. Morgan's papers on regeneration; also in my "Notes on Regeneration in *Planaria lugubris*" (Stevens, '01).

On looking up the European species (*P. lugubris*) as described and figured by Schmidt ('59, Pl. III, figs. 5 and 6), and by Kennel ('79, Pl. VII, fig. 8), I felt sure that Woodworth must have been mistaken as to the species; but I was unable to find any correct description or figures, either of the external characters of the animal or of its reproductive organs, and I was inclined to call it a new species. In September, 1903, after this paper was written, I came across an article by Curtis ('00) on the reproductive organs of *Planaria simplissima* n. sp. The reproductive organs of this species were so strikingly like those of the form on which I had been working that, although there was considerable difference in form, size and color, I was convinced that the two worms must be closely related, if not local varieties of the same species.

In answer to my inquiries about *Planaria simplissima*, Prof. Curtis has recently written me that after studying specimens sent to him by Prof. Morgan from Bryn Mawr, and sectioning others of the same species found near Baltimore in 1900 and 1901, he concluded that the Williamstown form, *P. simplissima* (fig. B), and the Bryn Mawr form *P.* (*lugubris*), (fig. A) belonged to the same species. Prof. Curtis desires me to state that his description of the external characters of *P. simplissima* was made from fixed material, living specimens not being accessible when he discovered that he was dealing with a new species. Later observations on living specimens from Williamstown made it apparent that his description was at fault, especially with regard to the lateral cephalic appendages which are more marked than was evident in fixed material. A careful sketch, made at this time from the living animal and sent to me with his letter, is a good representation of a young specimen of the Bryn Mawr form (figs. A and B)



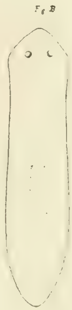


Fig. A. Outline sketch of a large mature specimen of *Planaria simplissima*, a=gray sensory area on the lateral auricular appendage. p=pharynx. g=genital opening.

Fig. B. Outline drawing from Curtis's sketch of a small specimen from Williamstown.

and, I think, leaves no doubt that we have the same species, which may be described as follows:

Planaria simplissima Curtis.

Length of mature specimens 7–15 mm.; breadth 2–4 mm. Color a nearly uniform seal-brown (occasionally grayish) with an inconspicuous gray area on each cephalic appendage. Eyes gray with a crescent of black pigment on the median side. Both anterior and posterior ends blunt. Lateral cephalic appendages blunt and inconspicuous as compared with *P. maculata.* Body thick as compared with *P. maculata.* Pharynx just posterior to the middle point of the longitudinal axis of the worm. Ovaries two, ventral, somewhat lobed, and situated about half-way from the anterior end of the animal to the pharynx.

Testes four or five on each side, unpaired, dorsal, and irregularly distributed from the region of the ovaries to the posterior end of the pharynx (figs. C and D). Penis long and slender, not filling the

Fig. C. Median longitudinal section of *Planaria simplissima* showing reproductive organs. Parts out of the plane of the section are shown in dotted lines. *a*=antrum. *b*=brain. *o*=ovary. *od*=oviduct. *p*=penis. *t*=testis. *u*=uterus. *vd*=vas deferens of one side. *x*=ciliated tube opening into uterus. *v*=vagina.

Fig. D. Reconstruction from several cross-sections showing ovaries (*o*), oviducts (*od*), nerve cords (*n*) and testes (*t*).

antrum. Uterus consisting of a chamber lined with glandular epithelium, dorsal to the antrum, and with an anterior prolongation in the form of a narrow ciliated tube with no enlargement at its anterior end. Vasa deferentia two, opening separately into the anterior enlargement of the lumen of the penis. Oviducts two, ventral and parallel with the nerve-cords, uniting before entering the uterus (figs. C and D). Vitellaria extending from the region of the ovaries to the posterior extremity of the animal.

Found on the under side of stones and leaves along the margin of small streams.

The original object of this paper was a discussion of the reproductive organs, ovogenesis, spermatogenesis and embryological development of *Planaria* (*lugubris*). The discovery that it is not *P. lugubris* but *P. simplissima* Curtis renders further discussion of the reproductive organs unnecessary, and I shall therefore confine my attention to a study of the germ-cells and the embryology of this species, which presents some peculiarities not fully described by Ijima ('84) and Hallez ('79).

Fertilization.—Copulation has not been observed in this species, but there is every reason for supposing that it occurs, for spermatozoa are found only in the vasa deferentia, the lumen of the penis, the uterus and the oviduct. In nearly every specimen the anterior end of the oviduct is crowded with spermatozoa (Pl. XIII, fig. 1, *od*), while only occasionally one is found in the posterior part of the duct or in the uterus. The spermatozoa are never found among the oöcytes in the ovary, and it is probable that each egg is fertilized as it enters the oviduct, for the spermatozoon is always found in the eggs of a forming capsule, and no spermatozoa are found among the eggs and yolk.

I should therefore agree with Ijima in regarding the uterus as a gland for forming the cocoon shell, and not as the place where fertilization occurs (Hallez), or as a receptaculum seminis (Kennel).

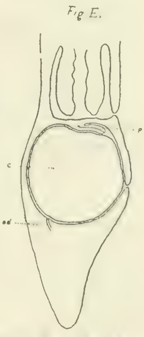


Fig. E. Median longitudinal section through an individual containing an egg-capsule (*c*). *od*= oviduct. *p*= penis

When an egg-capsule is forming, the antrum, uterus and the tube x (fig. C) are all thrown into one chamber, which is filled with eggs and yolk-cells, the penis being pushed back against the anterior wall of the antrum (fig. E) and the antrum being separated from the pharynx-chamber by so thin a layer of tissue that it is often broken through in fixed specimens, and yolk-cells are found in the pharynx-chamber.

Ovogenesis.—The early stages in the development of the oöcytes evidently should be studied in the summer after laying-time, for the ovaries are practically unchanged in appearance from October to laying-time in April. Figure 1, drawn from a section cut in November, shows nearly all of the oöcytes in the same condition as in sections containing the first maturation-spindle (cut in April and May). The cytoplasm of the oöcytes stains deeply with hæmatoxylin and contains here and there a yolk-granule in a vacuole (fig. 2*a*, *y*). The nucleus is very large and shows but little stainable chromatin, and that in the form of fine granules on threads of linin. The large nucleolus, which stains deeply with orange, contains one or more vacuoles. As in my previous work on the histology of planarians (Stevens, '02), the best results were obtained by fixing the material with sublimate-acetic and staining with Delafield's hæmatoxylin and orange.

The first maturation-spindle is found in the ovary about twenty-four hours before laying. In an equatorial stage the spindle is near the centre of the egg. The asters are very large, but there is no evidence of centrosome or sphere. The chromosomes are V-shaped, and split longitudinally, giving V-shaped daughter chromosomes, as in figs. 3*a* and 3*b*. Only four specimens in this stage were obtained out of a large number sectioned; and of these, three had either 3 chromosomes in an equatorial plate (figs. 2*a* and 2*b*) or 6 daughter chromosomes (figs. 3*a* and 3*b*), and one had 4 in the equatorial plate (fig. 4). Time and material were lacking to trace the egg from the ovary to the uterus, after it was ascertained that an interval of about twenty-four hours occurred between the formation of the first and second polar bodies.

By removing the capsule before the shell is formed and staining with Schneider's aceto-carmine, the second maturation-division can be more advantageously studied than in sections. Figs. 8–11 were made from such preparations; figs. 5*a*, 5*b* and 6, from sections. In only two cases was the first polar body observed (figs. 6 and 8), and it seems probable that it is usually lost as the egg passes down the oviduct. The number of egg-chromosomes is 3 in most cases. In two eggs from the same capsule the number was 6 (figs. 9 and 10), and in a few others 4 and 5 were observed, indicating that, as in *Ascaris megalocephala* and *Echinus microtuberculatus*, there may be two forms which occasionally interbreed, one having twice as many chromosomes as the other.

Thus an egg having 6 chromosomes fertilized by a spermatozoon having 3 would give an individual having 9 somatic chromosomes and probably 5 chromosomes in germ-cells after reduction. Union of germ-cells having 3 and 5 chromosomes respectively would result in an individual having 8 chromosomes in somatic cells, and 4 in oöcytes and spermatozoa.

Figure 8 shows an egg in which there was no doubt about the number 3 in the first polar body (p^1), and at the poles of the second maturation-spindle (p^2 and e). Figure 7 is a somatic cell containing 6 chromosomes. Six have also been counted several times in the first segmentation-division. That the second maturation-division of the chromosomes is longitudinal like the first one is evident from the form of the chromosomes and from the pairs seen at a and b in fig. 10. Figure 11 shows the second polar body separating from the egg.

Spermatogenesis.—As in the case of the ovaries, the testes should be studied in summer after laying-time, in order to follow the development of the spermatogonia, but occasional divisions of spermatogonia and both spermatocyte-divisions may be observed in material preserved at any time during the autumn and winter. My best material was fixed about the first of December. Pl. XV, fig. 15, shows a part of the section of a testis which contained dividing spermatogonia (a), both maturation-divisions (e and f), spermatids in all stages (g, h, i, k, l), and ripe spermatozoa. In this animal the number of chromosomes in the maturation-divisions was 4, in the spermatogonia 8. In several others only 3 were found in the spermatocytes (figs. 20 and 22). Various phases of the first maturation-division are shown in figs. 16–21 and of the second in figs. 22 and 23. The form of the chromosomes in all phases of both divisions is the same, a Y-shape, easily distinguishable from the V-shaped and U-shaped chromosomes of the spermatogonia and somatic cells. There is no evidence of a transverse, or reducing, division. In an anaphase (figs. 20 and 22), each daughter chromosome appears to be drawn toward the pole of the spindle by a single fiber attached to the stem of the Y. The spindle is composed of very few fibers, and neither centrosomes nor asters have been demonstrated. The spermatocytes before division appear as in fig. 15, d, and nothing corresponding to the synapsis stage described by various authors has been found. The spermatogonia in both resting and division-stages closely resemble the so-called embryonic or parenchyma cells which are scattered through the planarian body and play a conspicuous rôle in regeneration (fig. 15, a).

Figs. 24–32 show various stages in the development of the spermatozoön. The nucleus of the spermatid contracts, forming a small ball of nuclear material which stains deeply and uniformly (figs. 24–27, a). This concentrated nucleus gradually elongates (figs. 27, b–29), and finally leaves the cytoplasm tail first (figs. 15 and 29). Many empty spermatid cells are shown in fig. 15, n. The spermatozoön appears to be formed wholly from the nucleus of the spermatid, and stains like chromatin throughout. The spermatozoa in the oviduct near the ovary have a knob-like appendage near the anterior end (fig. 32)

This appears to be a late development, as it is not found on the spermatozoön in the testes, vasa deferentia, or lumen of the penis.

Embryological Development.—As stated above, the first maturation-division of the egg occurs in the ovary; fertilization probably takes place in the oviduct; and the second maturation-division is found in the forming capsules. The eggs of capsules just laid always show the two pronuclei with very large nucleoli, as in Pl. XIII, fig. 12, and a few hours later the pronuclei are fused as in fig. 13, but the two nucleoli are distinct. The development of the eggs during the first day can be best studied in aceto-carmine. Sections of these and of older capsules may be obtained by piercing the shell with a needle and fixing in sublimate-acetic. The shell must be removed before embedding. The rate of development varies greatly in different capsules, and even among the eggs of the same capsule. Laying occurs in the morning from daylight to ten o'clock. In one case the first cleavage-spindle was found at 10.30 A.M. in one egg of a capsule, in which all the others showed the pronuclei not fused. In other capsules eggs containing the pronuclei were found as late as 5 P.M. Two, four and eight-celled stages were also occasionally found late in the afternoon. Figure 14, *a*, was from an egg stained with aceto-carmine at 4.30 P.M. There were 6 chromosomes at each pole, as shown in fig. 14, *b*, obtained by focussing down on one end of the spindle. As in the maturation-divisions, neither centrosome nor sphere could be demonstrated.

The peculiar positions taken by the blastomeres in 2, 4 and 8-celled stages is shown in Pl. XIII, figs. 33–36. Fig. 35 is a reconstruction from five successive sections. Fig. 36 is a section of a 32-celled stage in which the yolk-cells near the group of blastomeres have begun to break down in the region *x*............*x*. The next stage (Pl. XV, fig. 37) shows a section of an embryo, consisting of a syncitial yolk-mass (y^1), distinct from the surrounding yolk-cells and disintegrated yolk-material. The group of blastomeres is always irregular in orm and eccentrically situated, coming to the surface on one side of the yolk-mass. Some of the blastomeres soon begin to wander through the syncitium, and may be found dividing at any point. A section of a capsule at this stage frequently shows sections of three or four such embryos. The embryonic yolk-mass gradually increases in size, as may be seen by comparing figs. 37–40, all drawn with the same magnification. The embryo is partly or wholly surrounded by a region of disintegrated yolk-cells (fig. 37, *a*), from which material for the embryonic syncitium is evidently drawn. In some cases whole yolk-cells appear to be taken into the syncitium in amœboid fashion.

In fig. 38, p^1, the first cells of the embryonic pharynx are distinguished from the surrounding blastomeres by their different staining qualities. Figs. 39–41 show the characteristic structure of such a pharynx which is well developed, but not yet functional. Fig. 40 is a median vertical-section through the pharynx, fig. 39 a median cross-section through the central cells (b), and fig. 41 a cross-section through the four inner cells (d). The cells which surround the lumen of the pharynx are twelve in number—four somewhat flattened surface cells (a), four cylindrical central cells (b), and four nearly spherical inner cells (d). Metschnikoff ('83) suggests that the latter group of four cells, supposed by some to represent the primary endoderm, may serve as a valve to prevent the escape of yolk-cells. The central cells are surrounded by a considerable number of smaller cells radially arranged and supposed to be muscle-cells serving to open the pharynx. Figs. 39 and 40 also show wandering blastomeres in all parts of the syncitial yolk-material of the embryo. A few of these are flattened to form a partial epithelium. Fig. 42 is a section through a functional pharynx taking in yolk-cells (y^2). The central cells (b) are much flattened to form the lining of the lumen, and the muscle-cells are lengthened radially. The two inner cells shown in dotted outline belong to the next section.

Up to the time when the embryonic pharynx becomes functional, the embryo is a solid ball of yolk in the form of a syncitium containing scattered blastomeres, with the developing pharynx at one side, in the region where segmentation began. Here and there over the surface are flattened blastomeres forming an incomplete epithelium (figs. 39–40). As the yolk is sucked in, the embryo becomes a hollow ball filled with yolk-cells (figs. 43–47). [In these and the following figures the space occupied by the yolk cells sucked in by the embryonic pharynx—the secondary yolk (y^2)—is not filled in.] Fig. 43 is a section of a nearly spherical embryo from a capsule in which some yolk still remained around the embryos. Fig. 44 is a cross-section of a flattened embryo of full size, all the yolk outside of the embryos having disappeared. In these sections the blastomeres (b) are scattered in the primary yolk-material (y^1) of the embryonic surface layer of the embryo, and still possess the characteristics of the earlier blastomeres, deeply-staining cytoplasm and large nucleus containing a conspicuous nucleolus. Figs. 45 and 46 show parts of sections from somewhat older embryos, where the embryonic pharynx (p^1) is degenerating and the blastomeres have multiplied so as to nearly fill the embryonic layer, very little yolk remaining among them. The embryonic pharynx disappears completely before the adult pharynx begins to form, but its relation to that pharynx appears to be the same as in *P. maculata,* as recently described by Curtis ('02). In fig. 45 the ventral side of the embryonic layer is easily distinguishable from the dorsal side by its greater thickness, and the degenerating pharynx (p^1) is on the dorsal side, as in Curtis's fig. 51, Pl. 17. The embryonic pharynx disappears so early, when many of the embryos are quite irregular in form, that it is impossible to tell whether it has a fixed position relative to the permanent pharynx or not, but my impression is that its position is variable. There is no evidence whatever that the embryonic pharynx serves as a tube leading to the anlage of the permanent pharynx, as described by Metschnikoff ('83) for *Planaria polychroa.*

Fig. 47 is from a 4-day embryo in which the pharynx-chamber appears as a split in the thickened ventral region of the embryo. In this stage pigment and rhabdites have begun to appear in the surface epithelium-cells, and rhabdite-cells are found among the embryonic cells, which are no longer like the early blastomeres, but closely resemble the embryonic cells of newly regenerated regions of adult planarians. Figs. 48 and 49 are sections of an older embryo (5–6 days), showing the permanent ectoderm well developed and full of pigment and rhabdite-cells. So far as I am able to determine, the ectoderm is formed from the outer embryonic cells and not by division of the earlier scattered epithelium-cells. There is considerable evidence that rhabdite-cells migrate from the interior to the surface and become a part of the ectoderm. In this embryo (figs. 48–51) the pharynx (p^2) is quite large and has a lumen connected with the central yolk-area (fig. 50). The yolk-area is being gradually divided up by strands of cells extending inward from the surface layer of embryonic cells to form the boundaries of the axial gut and its principal branches. Fig. 52 is from an older embryo (7 or 8 days), in which the development of the digestive tract is quite far advanced. In fig. 49 there is a section of a very young eye (e), the pigmented cup consisting of only 5 or 6 cells. No brain is yet distinguishable, but the lateral nerve-cords are represented by a few strands of nerve-fibers (n). In fig. 52 the eye is much further advanced and the nerve-cords are larger. The eyes in all embryos of this age are situated much deeper in the tissue than in the adult. There is as yet no definite endoderm, but here and there are cells with nuclei like those of adult endoderm-cells, and processes extend out from them among the yolk-cells as seen in fig. 51, e.

Fig. 53 is a cross-section of an embryo just before hatching (12th day). The lumen of the digestive tract is still full of yolk-cells and the endoderm-cells also contain masses of yolk (y^2). Figs. 55 and 56, endoderm-cells containing large masses of yolk, were taken from the same embryo as Fig. 53. Fig. 57 shows a similar endoderm-cell from a young planarian one day old. This cell contains one of the large vacuoles (v) characteristic of adult endoderm-cells, and the yolk is much disintegrated.

Thus it is perfectly plain, in this form at least, that the yolk-cells do not serve as a "vicarious endoderm" (Metschnikoff); but endoderm-cells, developed from the embryonic cells of the one germ layer, consume the yolk-cells in the same manner as they do other food material later on.

Fig. 54 is a section from the head region of the same embryo as fig. 53, showing brain (b) and eyes (e). By the fourth day after birth the yolk has all disappeared from the lumen of the gut, but masses of it are still to be seen in the endoderm-cells. The late embryos and young planarians contain a very large proportion of embryonic cells and few muscle- and gland-cells compared with mature animals. The tissue of the whole body resembles that of recently regenerated parts of adult planarians. It is interesting to note that the interval between egg-laying and the development of the permanent pharynx, eyes and nervous system in the embryo is about the same as between merotomy and regeneration of the same organs in pieces of adult planarians.

The reproductive organs develop late, and as yet have been studied in only two specimens. In one young planarian, 8 weeks old, one ovary was found, but no other reproductive or genital organs. In another, 10 weeks old, there was a small antrum with the penis just forming, but no genital pore; one ovary and three testes were found. The oöcytes in these young ovaries were small and only just distinguishable from the cells of the yoke glands, which were quite well developed. In the testes there were already mature spermatozoa.

Summary.

The points that seem to need especial emphasis are:

1. In *Planaria simplissima* division of the chromosomes in both maturation-divisions is longitudinl.

2. The number of chromosomes in the maturation-divisions of the germ-cells varies frrom 3 to 6, but is usually 3.

3. In the embryological development there is nothing corresponding to the typical blastula and gastrula. After several segmentation divisions the blastomeres form an irregular group embedded in a syncitial yolk-mass which forms a part of the embryo. Some of the blasto-

meres form the embryonic pharynx; others wander through the syncitium.

4. The embryonic layer which covers the secondary yolk (y^2) taken in by the embryonic pharynx, in no way corresponds to the ordinary gastrula-stage. The solid embryo has, by sucking in yolk through its pharynx, become a hollow ball filled with secondary yoke-cells (y^2). The embryo now consists of a single layer of syncitial yolk-material, containing scattered blastomeres which feed on the primary yolk-material and multiply until they occupy the whole space previously filled by the primary yolk (figs. 43–46). Then the inner embryonic cells begin to serve as endoderm-cells to absorb the secondary yolk.

5. The axial gut and its principal branches are formed by ingrowths from the embryonic layer, dividing up the central space which is filled with secondary yolk (y^2).

6. Ectoderm, endoderm, permanent pharynx, eyes, nervous system, reproductive organs, gland- and muscle-cells are all formed by direct differentiation of the embryonic cells of the *one* embryonic or germ-layer. There is no formation of two or three distinct germ layers, nor are any of the organs formed by folding as in most other forms.

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Description of Plates XIII, XIV, XV and XVI.

Plate XIII, Fig. 1.—Ovary showing large oöcytes and oviduct full of spermatozoa (*od*). Bausch and Lamb, obj. ½ in., oc. C, camera.

Fig. 2, *a* and *b*.—Ovarian egg showing first maturation-spindle with 3 chromosomes. $y =$ yolk granule. B. and L. ⅕–C.

Fig. 3, *a* and *b*.—Same as above with 6 daughter chromosomes.

Fig. 4.—Same with 4 chromosomes (a part of one chromosome in next section).

Fig. 5, *a* and *b*.—Egg from section of a capsule before laying, showing second maturation-spindle and 3 chromosomes. $s =$ sperm.

Fig. 6.—Same as above, showing first polar body and 3 chromosomes.

Fig. 7.—Somatic cell from a regenerating piece of *Planaria lugubris,* showing 6 chromosomes. B. and L. $\frac{1}{12}$–C.

Fig. 8. Egg from a capsule before laying, stained with Schneider's acetocarmine. $p^1 =$ 1st polar body. $p^2 =$ chromosomes of 2d polar body. $s =$ sperm. $e =$ egg-chromosomes. B. and L. $\frac{1}{5}$–C.

Fig. 9.—Similar egg with 6 egg-chromosomes (e) and 6 chromosomes for the 2d polar body (p^2).

Fig. 10.—Egg from same capsule as 9, showing longitudinal division at a and b.

Fig. 11.—Similar egg showing 2d polar body (p^2), sperm (s) and egg-chromosomes (e).

Fig. 12.—Egg from capsule just laid showing pronuclei.

Fig. 13.—Egg from capsule 3–4 hours after laying, showing pronuclei fused but nucleoli distinct.

Fig. 14*a*.—Egg from a capsule 8–10 hours after laying, showing first segmentation-spindle with 6 chromosomes at each pole.

Fig. 14*b*.—Optical cross-section of polar plate, showing two cross-sections of each of the 6 chromosomes.

Figs. 33–35.—2-celled, 4-celled and 8-celled stages from sections of capsules, showing the peculiar relative positions of the blastomeres. Fig. 35 is a reconstruction from five sections. B. and L. $\frac{1}{5}$–C.

Fig. 36.—Section of a 32(?)-celled stage, yolk-cells breaking down at x, x. B. and L. $\frac{1}{2}$–C.

Plate XIV, Fig. 15.—One-half of a cross-section of an unusually large testis. $a =$ dividing spermatogonium. $b =$ small spermatagonium after division. $c =$ resting spermatgonium. $d =$ resting spermatocyte of the first order. $e =$ first maturation division. $f =$ second maturation division. $g =$ young spermatids. $h, i, k =$ spermatids in later stages. $l =$ spermatid apparently twice the usual size. $m =$ spermatozoa. $n =$ empty spermatid cells. B. and L. $\frac{1}{5}$–C.

Figs. 16–21.—Various phases of first maturation divisions, showing 3 and 4 chromosomes. B. and L. $\frac{1}{12}$–C.

Figs. 22 and 23.—Second maturation division.

Figs. 24–29.—Spermatids in various stages.

Figs. 30–31.—Spermatozoa from the testis.

Fig. 32.—Spermatozoon from the oviduct near the ovary. B. and L. $\frac{1}{12}$–C.

Plate XV, Fig. 37.—Section of a slightly later stage (64-celled)(?), showing an irregular mass of blastomeres (b), a definite embryonic yolk-area (y^1) and a region of disintegrating yolk-cells (a). B. and L. $\frac{1}{2}$–C.

Fig. 38.—Section of a still later stage, showing larger embryonic area containing yolk-nuclei (y^1), yolk-cells (y^2), wandering blastomeres (b), and the beginning of the embryonic pharynx (p^1). Same magnif.

Fig. 39.—Cross-section through the central cells (b) of an embryonic pharynx (p^1), well-developed, but not yet functional. $c =$ muscle-cells. $y^1 =$ yolk-nucleus. $bl. =$ blastomeres scattered in the yolk of the embryonic area. $e =$ flattened blastomere on the surface of embryo.

Fig. 40.—Longitudinal-section through an embryonic pharynx of the same age as 39. $a =$ two of the 4 large surface cells bounding the lumen. $b =$ two of 4 central cells. $c =$ muscle-cells. $d =$ two of the 4 inner lumen-cells. $e =$ a blastomere partly on the surface of the embryo. $y^1 =$ yolk-nucleus. B. and L. $\frac{1}{2}$–C.

Fig. 41.—Cross-section of the 4 inner lumen-cells of the embryo shown in Fig. 39.

Fig. 42.—Functional pharynx, lumen open and yolk-cells entering. Same magnif.

Fig. 43—Section of embryo which has sucked in a large amount of yolk (y^2) but is still surrounded by yolk. p^1 = functional pharynx closed. b = a blastomere in embryonic layer. y^1 = yolk-nucleus of embryonic layer. B. and L. 1–C.

Fig. 44.—Section of embryo from a capsule where all the yolk has been absorbed, embryo somewhat flattened. y^2 = yolk taken in by pharynx.

Fig. 45.—Part of a section of an older embryo showing blastomeres filling the embryonic layer, slightly thicker ventral side, and degenerating embryonic pharynx (p^1).

Fig. 46.—Small part of section from same embryo showing dividing blastomeres or embryonic cells, very little yolk and few yolk-nuclei (y^1) among the embryonic cells. B. and L. $\frac{1}{5}$–C.

Fig. 47.—Later embryo (4th day) showing a very early stage in the formation of the permanent pharynx (p^2). e = ectoderm-cell containing pigment and rhabdites. r = rhabdite-cell. B. and L. 1–C.

Fig. 48.—Sections from an older embryo (6th day) showing later stage of the pharynx (p^2), well-developed ectoderm, and stands of embryonic cells beginning to divide off the central yolk-region into axial gut and its branches. a = endoderm-cells beginning to take in yolk-cells. e = very young eye, optic cup of about 5 pigmented cells. n = first appearance of nerve-cord.

Plate XVI, Fig. 49.—The same as fig. 48.

Fig. 50.—Another section of pharynx (p^2) from same embryo.

Fig. 51.—Section from same embryo, showing endoderm-cells (e) sending out processes among the yolk-cells (y^2). B. and L. $\frac{1}{5}$–C.

Fig. 52.—Section from an older embryo (7–8 days) showing older eye (e), larger nerve-cord (n) and formation of gut more advanced.

Fig. 53.—Cross-section of 12th day embryo ready to hatch, showing well-developed pharynx (p^2) and gut still filled with yolk-cells (y^2). B. and L. 1–C.

Fig. 54.—Another section from same embryo showing well-developed eyes and brain (b).

Figs. 55–56.—Endoderm-cells containing large masses of yolk (y^2), from same embryo as Fig. 53. B. and L. $\frac{1}{12}$–C.

Fig. 57.—Similar endoderm-cell from a young planarian one day old, yolk considerably disintegrated.

Fig. 58.—Longitudinal section of young planarian, one day old, tail-region shorter than in adult. (e = eye. b = brain. g = gut. p^2 = pharynx B. and L. 1–a.

FEBRUARY 16.

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

Seventy-eight persons present.

The Publication Committee reported that the following communications had been received:

"The Fossil Land Shells of Bermuda," by Addison Gulick (February 3).

"New, Little Known and Typical Berycoid Fishes," by Henry W. Fowler (February 8).

"Description of a new Race of Notropis chalybæus from New Jersey," by Henry W. Fowler (February 8).

"The Larval Eye of Chiton," by Harold Heath (February 10).

PROF. ARTHUR W. GOODSPEED made a communication on radium and the relation of its phenomena to general physical laws, especially those of radiant matter. (No abstract.)

The following were accepted for publication:

NEW, LITTLE KNOWN AND TYPICAL BERYCOID FISHES.

BY HENRY W. FOWLER.

The specimens used in the preparation of this paper are all contained in the collection of the Academy except when otherwise stated.

HOLOCENTHRIDÆ.

Myripristis jacobus Cuvier.

Hist. Nat. Poiss., III, 1829, p. 121. Martinique. (M. Achard.) Brésil. (M. Delalande.) Havane. (M. Desmarest.)
Rhinoberyx chryseus Cope, Trans. Amer. Philos. Soc. Phila., XIV, 1871, p 464, fig. St. Croix. (Thos. Davidson.)

Two examples, types of *Rhinoberyx chryseus* Cope.

Myripristis berndti Jordan and Evermann.

Bull. U. S. Fish Comm., 1902 (1903), p. 170. Honolulu. (U. S. Fish Comm.)
Myripristis murdjan Fowler, Proc. Acad. Nat. Sci. Phila., 1900, p. 501. Sandwich Islands. (Dr. Benjamin Sharp.) (Not of Forskål.)

A co-type of *Myripristis berndti* Jordan and Evermann agrees with the example collected by Dr. Sharp. Two examples from Cocos Island, Galapagos Islands, collected by Messrs. Heller and Snodgrass, also appear to be the same species.

Myripristis murdjan (Forskål).

Sciæna murdjan Forskål, Descript. Animal., 1775, p. 48. Djiddæ.

Head $2\frac{5}{6}$; depth $2\frac{1}{4}$; D. X, I, I, 12; A. IV, I, 11; P. I, 14; V. I, 5; scales 29 in lateral line to base of caudal, and 3 more continued on latter; about 9 scales before spinous dorsal, 3 between latter's origin and lateral line, and 6 between latter and origin of anal; width of head $1\frac{1}{2}$ in its length; mandible $1\frac{7}{10}$; first dorsal spine $3\frac{5}{8}$; second $2\frac{1}{3}$; third 2; eleventh $3\frac{2}{3}$; first developed dorsal ray $1\frac{2}{5}$; third anal spine $2\frac{2}{3}$; second developed anal ray $1\frac{3}{5}$; upper caudal lobe $1\frac{1}{4}$; pectoral $1\frac{1}{2}$; ventral $1\frac{1}{3}$; ventral spine 2; least depth of caudal peduncle $3\frac{5}{6}$; snout $4\frac{2}{3}$ in head measured from its tip; eye $2\frac{1}{3}$; maxillary $1\frac{3}{4}$; interorbital space $5\frac{1}{4}$.

Body deep, compressed, and greatest depth near tip of ventral spine. Upper profile from tip of snout to middle of dorsal evenly convex. Greatest width of body not equal to that of head. Caudal peduncle small, compressed, and its depth about equal to its length.

Head large, obtuse in front, its depth greater than its length. Snout steep, broad, obtuse, incised in front, and with a similar shaped upper jaw projecting. Eye large, high, and almost impinging on upper profile. Mouth superior, oblique, and gape reaching about opposite nostril. Maxillary large, broadly expanded distally till $1\frac{3}{5}$ in eye, and reaching a little beyond its center. Jaws strong, and heavy mandible protruding when mouth is closed. Only lower lip developed, laterally thick and fleshy. Teeth in jaws fine, in broad bands, those in outer series short, enlarged, and truncate. At symphyseal knob of mandible conspicuous patches of such teeth, those on dental surface well separated, and others also on lower surface of each ramus. Tongue broad, pointed, and free. Suborbital rim narrow. Nostril large, vertical, close to front of and midway in height of orbit. Interorbital space rather narrow, slightly convex, and with two broad flattened longitudinal ridges. Opercle with a strong spine. Margins of bones of head serrate.

Gill-opening deep, extending forward below front margin of eye. Rakers long, slender, compressed, longest longer than filaments or about $2\frac{1}{2}$ in orbit. Pseudobranchiæ longer than filaments, nearly equal to diameter of pupil. Branchiostegal rays large, broad at bases. Isthmus short, and membrane with narrow fold across.

Scales large, strongly ctenoid, and rather narrowly imbricated on side. Scales along bases of dorsal and anal spinescent, but not extending on fins. Caudal covered with small scales, except margins. Base of pectoral with small scales. Ventral without scales except pointed axillary scale. No flap between bases of these fins. Opercles and cheek scaly, in 4 rows on latter, and rest of head naked. Lateral line concurrent with margin of basal scales of dorsal, then obliquely down across upper side of caudal peduncle to middle of base of caudal.

Origin of spinous dorsal beginning a little behind that of pectoral, heteracanthous, and graduated down from fifth to penultimate, which is shortest. Soft dorsal inserted a little in advance of origin of soft anal, its first developed ray longest, and margin of fin straight from this to last which is shortest, or about $\frac{1}{3}$ its length. Third anal spine larger, though shorter than fourth. Soft anal like soft dorsal, second developed ray longest, and last about $2\frac{2}{5}$ in its length. Caudal deeply forked, with pointed lobes. Pectoral small, and inserted over ventral. Ventral large, spine straight and reaching about half way, and rest of fin reaching about $\frac{3}{4}$ of distance to origin of anal.

Color when fresh in arrack rosy-red, deeper above. Base of spinous dorsal pale rosy-red, and upper margin broadly pale orange-yellow.

Base of soft dorsal pale rosy-red, also same of anal and caudal. First and second rays of soft dorsal and anal, also outer caudal rays, pale gray or dull white. Tips of anterior dorsal and anal rays just behind pale edge, also tips of caudal lobes, blackish. Other fins more or less pale orange. Pectoral and ventral pale rosy, latter with a whitish margin. Axil of pectoral deep brown. Upper edge of opercle deep blackish-brown. Iris with a broad deep brown vertical band continuous below. Peritoneum black.

Length $8\frac{5}{8}$ inches.

A single example from Padang, Sumatra. Coll. A. C. Harrison, Jr., and Dr. H. M. Hiller.

According to Rüppell[1] and Day[2] the iris is marked with a rather large broad black vertical bar. Bleeker has described a form which he identified with *M. murdjan*,[3] but no mention is made of this ocular bar, or is it shown on his figure. Dr. Günther has indicated a dark blotch on the upper part of the iris in his.[4]

Myripristis chryseres Jordan and Evermann.

L. c., p. 171. Hilo, Honolulu. (U. S. Fish Comm.)

Co-type of *Myripristis chryseres* Jordan and Evermann with a rather large dark blotch on iris above pupil. Dr. Günther's figure of *M. murdjan*[5] is probably this species, though it differs in the dark spot above pectoral axil. It also shows about 35 scales in lateral line to base of caudal.

Myripristis argyromus Jordan and Evermann.

L. c., p. 172. Hilo, Honolulu. (U. S. Fish Comm.)

Myripristis murdjan Fowler, *l. c.*, p. 501. Sandwich Islands. (Dr. J. K. Townsend.) (Not of Forskål.)

The example in Dr. Townsend's collection appears to belong to this species.

HOLOTRACHYS Günther.

Journ. Mus. Godef. (Fische der Südsee), III, 1874, p. 93 (*lima*).

Holotrachys lima (Valenciennes).

Myripristis lima Valenciennes, Hist. Nat. Poiss., VII, 1831, p. 371. Isle-de-France. (M. Dussumier.)

One from Hawaiian Islands. Dr. J. K. Townsend.

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[1] *Atlas zu der Reise im nördlichen Afrika, Fisch.*, 1828, p. 86, Pl. 23, fig. 2.
[2] *Fishes of India*, II, 1876, p. 170, Pl. 41, fig. 2.
[3] *Nat. Tijds. Ned. Ind.*, IV, 1853, p. 109. Amboina.——*Ned. Tijds. Dierk.*, IV, 1874, p. 188. Java; Cocos; Batu; Celebes; Amboina; Ceram; Goram.
[4] *Journ. Mus. Godef.* (Fische der Südsee), IV, 1875, Pl. 61.
[5] *L. c.*

HOLOCENTHRUS Scopoli.

The original orthography, though erroneous, cannot altogether be considered an unintentional misprint, as its occurrence is but twice in the entire work and in each case it is spelled exactly as above.

Subgenus HOLOCENTHRUS Scopoli.

Margin of opercle finely serrated.

Holocenthrus adscensionis (Osbeck).

Perca adscensionis Osbeck, Reis. Ostind. Chin., 1765, p. 388. Ascensionsinsul.

An adult example from Rio Janeiro, Brazil, agrees with others from the Bahamas. In former preopercular spine reaches a trifle beyond gill-opening, and its upper free margin is about equal to half of orbit. Pectoral $1\frac{4}{5}$ in head, from tip of snout to tip of opercular spine. Third anal spine, from scales, $2\frac{1}{10}$. Soft dorsal $1\frac{1}{2}$. Ventrals falling well short of vent. Length $11\frac{1}{2}$ inches.

Three smaller examples from San Domingo differ in a larger eye, longer pointed fins, and long opercular spine reaching base of pectoral. They also have a more slender caudal peduncle. Prof. W. M. Gabb collection.

The form called *rufus* by Drs. Jordan and Evermann is evidently the same.

Mr. W. J. Fox has called attention[6] to the original spelling of the specific name of this species which has been ignored by writers.

Holocenthrus xantherythrus (Jordan and Evermann).

Holocentrus xantherythrus Jordan and Evermann, Bull. U. S. Fish Comm., 1902 (1903), p. 175. Honolulu. Kailua.

Co-type of *Holocentrus xantherythrus* Jordan and Evermann.

Holocenthrus gladispinis sp. nov. Fig. 1.

Holocentrus diploxiphus Fowler, Proc. Acad. Nat. Sci. Phila., 1900, p. 520. Tahiti. (Dr. J. K. Townsend.) (Not of Günther.)

Head 3; depth 3; D. XI, 13; A. IV, 9; P. I, 14; V. I, 7; scales 44 in lateral line to base of caudal, and 4 more on latter; $3\frac{1}{3}$ scales obliquely back from origin of spinous dorsal to lateral line, and 3 in vertical series between last dorsal spine and lateral line; 7 scales obliquely back from lateral line to middle of belly; width of head 2 in its length; depth of head at posterior margin of orbit $1\frac{1}{3}$; snout $4\frac{2}{5}$; orbit $2\frac{9}{10}$; maxillary $2\frac{9}{10}$; mandible $2\frac{1}{15}$; interorbital space $3\frac{1}{4}$; first dorsal spine $3\frac{1}{2}$; third 2; second dorsal ray 2; third anal spine $1\frac{3}{5}$; second anal ray 2; least depth of caudal peduncle $3\frac{2}{3}$; upper caudal lobe $1\frac{1}{3}$; pectoral $1\frac{1}{3}$; ventral $1\frac{3}{5}$.

[6] *Science*, 1900, p. 717.

Body moderately elongate, compressed, greatest depth about middle of depressed ventral, and upper profile a little more convex than lower. Caudal peduncle compressed, and its least depth $1\frac{7}{8}$ of length.

Head somewhat large, compressed, and upper profile steep, more convex than lower. Snout short, broad, convex, upper jaw projecting a little. Eye large, impinging on upper profile, anterior, and circular. Mouth rather small, jaws about even, projecting, and gape reaching about opposite front of posterior nostril. Maxillary small, slipping below narrow preorbital, beyond front rim of pupil or about first third of orbit, and its distal expansion a little less than diameter of pupil. Teeth minute, pointed, numerous, in bands in jaws, and on palatines.

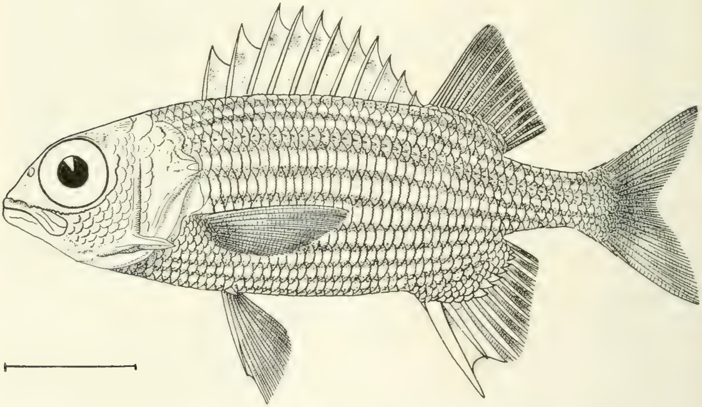

Fig. 1. *Holocenthrus gladispinis* Fowler.

A small patch also on vomer. Tongue attenuate, long, free and smooth. Nostrils adjoining, and close to front rim of orbit, anterior inconspicuous and posterior a large cavity. Interorbital space broad, slightly concave medianly, and with a low obsolete ridge laterally. Head with many fine denticles along edge of cranial bones. Preorbital denticulate, with a large blunt spine in front. Opercle ending in two small spines of equal size. Preopercle armed below at its angle with a broad dagger-like spine equal to $\frac{1}{2}$ of orbit, along its upper margin, and reaching beyond gill-opening.

Gill-opening extending forward opposite middle of orbit. Rakers v 2 + 9 iii, longest shorter than filaments which equal diameter of pupil. Pseudobranchiæ large. Isthmus not trenchant, branchiostegal membrane forming a short free fold across.

Scales moderately small, finely spinescent, and those on side just below lateral line largest and imbricated somewhat narrowly. Scales at base of spinous dorsal forming a sheath and each one ending in a backwardly directed spine. Scales along base of soft dorsal not enlarged, rather low. Median scales at base of soft anal elongate and pointed. Bases of caudal and pectoral with small scales. A scaly flap between bases of ventrals and each fin with a broad pointed axillary scale. A series of five scales between orbit and base of preopercular spine. A few scales on opercle, and with exception of occiput head otherwise naked. Lateral line concurrent with dorsal profile till near caudal peduncle, along side of which it extends a little high at first till middle of base of caudal, though not extending on scales of that fin.

Spinous dorsal inserted over origin of pectoral, third spine longest, also next two nearly subequal. First spine a little longer than ninth, but eleventh shortest and joined to first dorsal ray by a low membrane. Margin of fin deeply notched. Soft dorsal posterior, inserted nearer base of caudal than origin of pectoral, elevated anteriorly, margin above straight, and first developed ray longest. Spinous anal inserted a trifle before origin of soft dorsal, first spine minute, third long, enlarged, reaching tip of rayed fin, and fourth shorter but next in size. Soft anal similar to rayed dorsal. Caudal forked and lobes pointed. Pectoral rather long, slender, and upper rays longest. Ventral inserted a little posterior, altogether behind base of pectoral, and reaching about two-thirds of distance to anal. Ventral spine slender, a little over two-thirds length of fin. Anus close in front of anal.

Color in alcohol faded brassy-brown with many silvery reflections. Above lateral line three longitudinal pale whitish bands along each series of scales. Below seven similar bands, those just below lateral line broadest. Fins plain-colored like general body-color. Spinous dorsal just above middle with a small white blotch behind each spine. Iris straw-colored. Peritoneum silvery.

Length $5\frac{5}{8}$ inches.

Type No. 14,140, A. N. S. P. Tahiti. Dr. J. K. Townsend.

A single example. This species is closely related to *Holocenthrus diploxiphus* (Günther). Dr. Günther's figure[7] shows about 3 scales between origin of spinous dorsal and lateral line, obliquely back, apparently about 43 in lateral line to base of caudal, ventral shorter,

[7] *Proc. Zoöl. Soc. London*, 1871, p. 660, Pl. 60 (upper figure). Samoa Islands. (Coll. Godeffroy.)

third anal spine longer, a dusky blotch below base of soft dorsal, upper caudal lobe longer, and no longitudinal alternate dark and pale bands on side.

(*Gladius*, knife; *spina*, spine.)

Holocenthrus gracilispinis sp. nov. Fig. 2.

Holocentrus diploxiphus Fowler, Proc. Acad. Nat. Sci. Phila., 1900, p. 501. Sandwich Islands. (Dr. J. K. Townsend.) (Not of Günther.)

Head 3; depth 3; D. XI, 13; A. IV, 9; P. I, 14; V. I, 7; scales 47 in lateral line to base of caudal, also several more continued on latter; $3\frac{1}{2}$ scales obliquely back from origin of spinous dorsal to lateral line; about 8 scales obliquely forward from origin of spinous anal to lateral line;

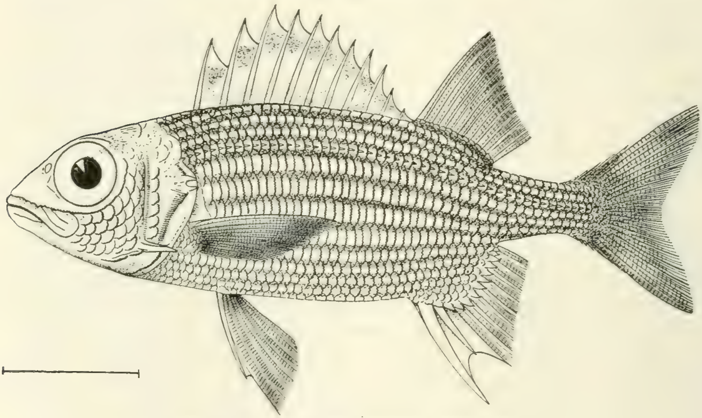

Fig. 2. *Holocenthrus gracilispinis* Fowler.

3 scales between middle of spinous dorsal basally and lateral line; width of head $1\frac{5}{6}$ in its length; depth of head $1\frac{2}{7}$, over posterior margin of eye; snout 4; eye $2\frac{7}{8}$; maxillary $2\frac{3}{5}$; mandible $2\frac{1}{8}$; interorbital space $3\frac{1}{2}$; third dorsal spine $1\frac{2}{3}$; first $2\frac{1}{2}$; second dorsal ray $1\frac{3}{5}$; third anal spine $1\frac{3}{7}$; first anal ray $1\frac{3}{5}$; least depth of caudal peduncle $3\frac{5}{6}$; pectoral $1\frac{1}{4}$; ventral $1\frac{2}{5}$.

Unless otherwise stated, all of the characters noted under *H. gladispinis* apply equally to this species.

Profiles of body apparently more evenly convex anteriorly. Caudal peduncle compressed, and its least depth about half of its length. Upper profile of head more like lower than in *H. gladispinis*. Snout a little large. Interorbital space a trifle narrow. Posterior nostril rather large. Obsolete lateral ridge along each side of interorbital space. A rather narrow dagger-like preopercular spine equal to about $\frac{3}{5}$ of orbit, along its upper margin. Rakers III 2+8 III, longest nearly equal to diameter of pupil. Scales small. Third and fourth dorsal spines longest, subequal, fifth a little shorter. Caudal lobes damaged, their length about equal.

Length $5\frac{1}{2}$ inches.

Type No. 27,271, A. N. S. P. Honolulu, Hawaiian Islands. U. S. Fish Commission (No. 14,233).

Three examples. This is the northern representative of *Holocenthrus diploxiphus* (Günther), apparently differing in the slender preopercular spine, even caudal lobes, larger ventral and comparatively shorter third anal spine.

(*Gracilis*, slender; *spina*, spine.)

Holocenthrus polynesiæ sp. nov. Fig. 3.

Holocentrus pœcilopterus Fowler, Proc. Acad. Nat. Sci. Phila., 1899, p. 485. Thornton Island, South Pacific (wrongly ascribed to Caroline Islands). (C. D. Voy.)

Head $2\frac{3}{4}$; depth 3; scales 49 in lateral line to base of caudal; 4 scales

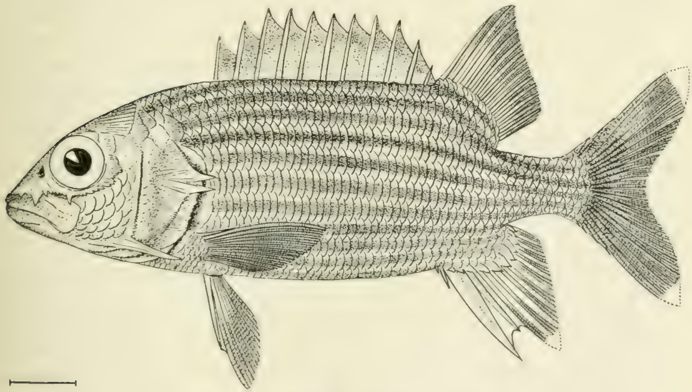

Fig. 3. *Holocenthrus polynesiæ* Fowler.

obliquely back from origin of spinous dorsal to lateral line; 3 scales between middle of spinous dorsal and lateral line; about 6? series of scales vertically between lateral line and middle of belly; width of head about $2\frac{1}{4}$ in its length; depth of head about $1\frac{2}{5}$; snout about $3\frac{4}{5}$; eye about 4; maxillary (from tip of premaxillary) about $2\frac{3}{4}$; mandible $2\frac{1}{8}$; interorbital space about $5\frac{2}{5}$; first dorsal spine about 5; third about 3; third dorsal ray about $2\frac{1}{5}$; third anal spine about $1\frac{9}{10}$; second anal ray about 2; least depth of caudal peduncle about $3\frac{4}{5}$; pectoral about $1\frac{2}{3}$; ventral about $1\frac{3}{4}$.

Body moderately elongate, compressed, and apparently of somewhat ovoid form with profiles more or less similarly convex. Greatest depth apparently near middle of spinous dorsal. Caudal peduncle compressed, and its least depth about $\frac{3}{5}$ its length.

Head large, upper profile more or less straight, and more inclined than lower. Snout rather short, a little broad, convex above, and upper jaw a little protruded. Eye rather small, high, impinging on upper profile, circular, and anterior. Mouth small, jaws apparently even when closed, projecting, and gape falling a little short of posterior nostril. Maxillary rather small, apparently reaching middle of pupil, and distal expanded extremity about $\frac{4}{7}$ of orbit. Teeth minute, in rather broad villose bands in jaws and on palatines. A small triangular patch also on vomer. Nostrils adjoining, close in front of eye a little above, anterior obsolete, and posterior a large cavity. Interorbital space rather narrow, nearly level, only slightly concave, and with a low obsolete ridge laterally. Head with many small denticles along edges of bones. A double-pronged nasal spine in front of snout. Preorbital denticulate, with a large broad spine in front, immediately followed by a smaller curved one. A curved backwardly directed spine on narrow infraorbital. Postorbital rim also denticulate, and a little broader. Opercle ending in two rather small spines, upper a little longer. Preopercle armed below with a long and rather narrow spine, slightly curved at its extremity, and equal to $\frac{9}{10}$ of orbit, along its upper edge. It also reaches a little beyond gill-opening. Serræ along margin of preopercle becoming a little enlarged below.

Gill-opening apparently extending forward till opposite middle of orbit.

Scales small, and narrowly imbricated, those forming along base of spinous dorsal not spinescent. Rather small scales along base of soft dorsal. Greater basal region of caudal covered with small scales. Base of pectoral also with small scales. A rather short broad scaly flap between bases of ventrals, and each axilla of same fins with a short scale. Five series of scales on cheek. A row of rather broad scales along margin of preopercle on opercle. Except occiput, and otherwise stated, head naked. Lateral line at first more or less concurrent with dorsal profile, and posteriorly running a little high along side of caudal peduncle to base of caudal, but not extending on base of fin.

Spinous dorsal inserted nearly opposite origin of pectoral, fin rather low, margin notched, first and tenth spines about equal, last shortest, and third to fifth subequal and longest. Membrane connecting dorsals distinct. Soft dorsal inserted nearer base of caudal than origin of pectoral, and elevated in front. Spinous anal apparently inserted a little behind origin of soft dorsal, third spine longest, broad, and not extending as far as tip of second anal ray. Fourth anal spine slender. Second anal ray apparently longest, first but little shorter. Caudal forked, damaged. Pectoral somewhat small, upper rays longest. Ventral apparently inserted behind pectoral, rather broad. Spine about $1\frac{3}{5}$ in fin.

Color of dried skin straw-brown. About 3 olivaceous longitudinal bands parallel with and above lateral line. Six others of same color longitudinally below lateral line. They are all rather broad, spaces between but little narrower than their own width. Fins and iris dull brown like general body-color.

Length 11 inches.

Type No. 23,277, A. N. S. P. Thornton Island, Polynesia. C. D. Voy. Presented by Prof. E. D. Cope.

Three examples. This species apparently approaches *Holocenthrus poecilopterus* (Bleeker), but differs in color, as there are no traces of spots on spinous dorsal.

(*Πολὺς*, many; *νῆσος*, island; Polynesia.)

Holocenthrus thorntonensis sp. nov. Fig. 4.

Holocentrus microstomus Fowler, Proc. Acad. Nat. Sci. Phila., 1901, p. 325. Thornton Island. South Pacific. (C D. Voy.) (Not of Günther.)

Head $2\frac{3}{4}$; depth 3; D. XI, 12?; A. IV, 7; scales 37 in lateral line to base of caudal; $3\frac{1}{2}$ scales between origin of spinous dorsal and lateral line; 3 scales between middle of spinous dorsal and lateral line; 7 scales below lateral line to middle of belly in a vertical series; snout $4\frac{1}{3}$ in head; eye $2\frac{2}{3}$; maxillary $2\frac{1}{5}$; interorbital space 3; third dorsal spine $2\frac{1}{10}$; third anal spine 2; least depth of caudal peduncle 4; pectoral $2\frac{1}{6}$; ventral $1\frac{3}{4}$.

Body elongate, rather ellipsoid, profiles about evenly convex and greatest depth near front of spinous dorsal. Caudal peduncle compressed, its least depth about $\frac{3}{7}$ its length.

Head deep, compressed, upper profile a little more convex than lower. Snout short, broad, forming a sharp protruding point in front. Eye large, circular. Mouth small, well inferior. Maxillary small, oblique, reaching near middle of pupil. Preorbital rim narrow, with coarse serrations. Margin of preopercle coarsely serrated. Opercle with a strong spine above, the one just below but little shorter. Preopercle with a strong spine reaching beyond gill-opening, but not quite opposite base of pectoral. Nostrils small, without spines. Interorbital space broad, flattened, the supraocular ridge formed on each side sharp.

Gill-opening large, extending forward about opposite front margin of pupil.

Scales large, spinescent, those on middle of side rather narrowly im-

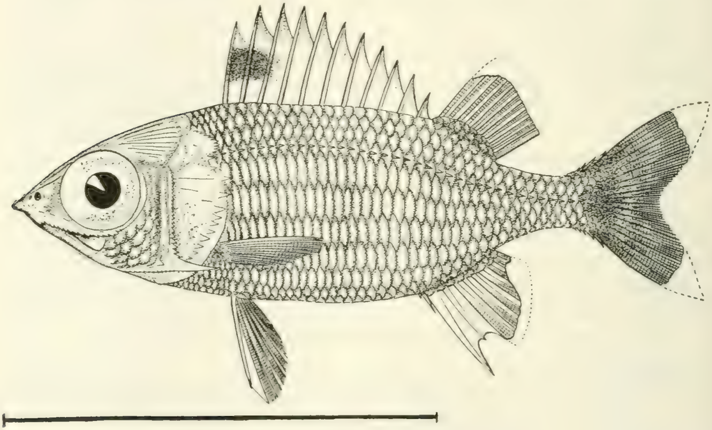

Fig. 4. *Holocenthrus thorntonensis* Fowler.

bricated. Four or five rows of scales on cheek extending up on post-ocular region, head otherwise naked. Bases of soft dorsal and anal scaly, line of demarcation distinct on fins. Base of caudal scaly, scales extending well out and becoming smaller. Lateral line forming an even convex curve, more or less parallel with dorsal profile. Tubes simple. Base of ventral with small scaly flap.

Spinous dorsal inserted about opposite origin of ventral, third spine longest, first and fifth of about equal length, and others all graduated down, last very small. Soft dorsal inserted behind origin of spinous anal, small. Third anal spine longest, rayed fin small. Caudal forked. Pectoral small, low, inserted a little before spinous dorsal. Ventral reaching $\frac{4}{7}$ of space to spinous anal, spine about $\frac{4}{5}$ length of fin. Anus close to origin of anal fin.

Color in alcohol brassy-silvery, brownish above lateral line and on upper surface of head. Pale longitudinal lines on trunk about ten, three above lateral line. Fins all pale, upper marginal portion of spinous dorsal between first and fourth spines dusky-brown.

Length $1\frac{9}{16}$ inches.

Type No. 23,769, A. N. S. P. Thornton Island, South Pacific. C. D. Voy. Presented by Prof. E. D. Cope.

A single example, described above. It is in the *Rhynchichthys* stage and does not seem to be the young of any known species. It appears closely related to *Holocenthrus binotatus* (Quoy and Gaimard), but differs in the more slender body, fewer anal rays, dark blotch on the upper anterior portion of spinous dorsal, and more scales in the lateral line. It is also different from *Holocenthrus brachyrhynchus* (Bleeker).

(Named for Thornton Island, formerly Caroline Island, Lat. 10° 0′ 01″ S., Long. 150° 14′ 30″ W., in Polynesia.)

Holocenthrus siccifer (Cope). Fig. 5.

Holocentrum sicciferum Cope, Trans. Am. Philos. Soc. Phila., XIV, 1871, p. 465. New Providence, Bahamas. (Dr. H. C. Wood.)

D. XI, 14; P. I, 14; V. I, 7; $3\frac{1}{2}$ scales between origin of spinous dorsal and lateral line; 3 scales between middle of spinous dorsal and lateral line; 7 scales between lateral line and anus; snout 5 in head, from its own tip to end of opercular spine; interorbital space $3\frac{1}{6}$; maxillary 3; fourth dorsal spine $2\frac{1}{15}$; fourth dorsal ray 2; third anal ray $1\frac{2}{3}$; least depth of caudal peduncle 4; pectoral $1\frac{2}{5}$; ventral $1\frac{1}{2}$; width of head $1\frac{9}{10}$; depth of head over posterior margin of eye $1\frac{1}{3}$.

Body rather ellipsoid, profiles similar, and greatest depth about midway in length of trunk. Caudal peduncle compressed, its least depth $1\frac{3}{4}$ in its length.

Head robust, rather deep, and compressed. Upper jaw protruding a little beyond broad and convexly rounded snout. Eye large, impinging on upper profile, circular. Mouth small, a little oblique, when closed mandible a trifle inferior. Rather broad bands of minute villiform teeth in jaws. Tongue slender, pointed, and free. Nostrils without spines, close to upper front margin of orbit. Interorbital space broad, flattened. Margin of preopercle finely serrate, upper free edge of spine about $\frac{3}{4}$ of pupil.

Gill-opening extending opposite front margin of pupil. Rakers moderate, shorter than filaments. Pseudobranchiæ large.

Scales large, those along middle of side narrowly imbricated. Five rows of scales on cheek. Small scales crowded at bases of soft dorsal and caudal. Scales along base of spinous dorsal each with a small spine directed back. A pointed scale at base of ventral. Lateral line more or less concurrent with dorsal profile, extending a little high on caudal peduncle to middle of base of caudal.

Spinous dorsal inserted a little in advance of origin of pectoral, fourth spine longest, first and ninth of about equal length. Margin of fin notched. Soft dorsal inserted a little behind origin of spinous anal. Third anal spine longest, enlarged. Pectoral low. Ventral

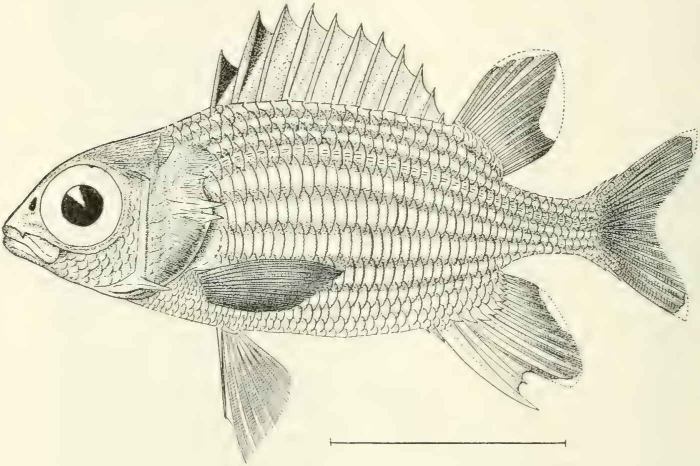

Fig. 5. *Holocenthrus siccifer* (Cope).

pointed, inserted a little behind pectoral, and spine about $\frac{2}{3}$ length of fin. Caudal forked.

Color in alcohol pale brownish with silvery reflections. After brownish blotch on spinous dorsal a white submarginal spot on each membrane between spines. Pale or dusky oblique shades extending up from below on each membrane between spines. Other fins all pale like general body-color. Iris brownish.

Length $3\frac{1}{4}$ inches.

No. 14,138, A. N. S. P. Type of *Holocentrum sicciferum* Cope. New Providence, Bahamas. Dr. H. C. Wood.

Holocenthrus albo-ruber (Lacépède).

Holocentrus albo-ruber Lacépède, Hist. Nat. Poiss., IV, 1803, pp. 333, 372. Les eaux de la Chine.

Two examples, one in the Museum of Stanford University. Padang, Sumatra. Coll. A. C. Harrison, Jr., and Dr. H. M. Hiller. After comparison with the example described by Dr. Jordan and myself, taken at Okinawa, Riukiu,[8] I am unable to find any specific differences. They agree in every respect, and the dark bands are still well preserved. Bleeker's figure[9] does not exactly agree, as but one large distinct opercular spine is shown, and the outer half of the ventral is lavender-color. Dorsal also differently colored, as these examples are all with more or less blackish. Depth $2\frac{3}{5}$. Scales on cheek in 4 series. Third anal spine a little shorter than anterior anal rays. Soft dorsal without a spine. Larger example 6 inches.

Rüppell's figure of *Holocentrus ruber*[10] is certainly different. It shows the third anal spine longer than the rest of the fin, and a median narrow gray longitudinal bar on spinous dorsal for its entire length.

Holocenthrus ensifer (Jordan and Evermann).

Holocentrus ensifer Jordan and Evermann, Bull. U. S. Fish Comm., 1902 (1903), p. 176. Honolulu. Kailua. (U. S. Fish Comm.)

Co-type of *Holocentrus ensifer* Jordan and Evermann. Two small spines on border of anterior nostril, therein differing from other species mentioned in this paper.

SARGOCENTRON subgen. nov.

Type *Holocentrum leo* Cuvier.

Margin of preopercle coarsely serrated. Size large.

(*Σάργος*, an old name of *Diplodus*, one of the *Sparidæ*; *κέντρον*, spine.)

Holocenthrus leo (Cuvier).

Holocentrum leo Cuvier, Hist. Nat. Poiss., III, 1829, p. 152. Borabora. (MM. Lesson et Garnot.)

Holocentrus spinifer Fowler, Proc. Acad. Nat. Sci. Phila., 1899, p. 483. Thornton Island, South Pacific (wrongly ascribed to Caroline Islands). (C. D. Voy.)——*L. c.*, 1900, p. 526. Samoa. (Dr. H. C. Caldwell.) (Not of Forskål.)

Head $2\frac{3}{5}$; depth $2\frac{3}{5}$; scales 43 in lateral line to base of caudal; 4 scales between origin of spinous dorsal and lateral line obliquely back; $3\frac{1}{2}$ scales between middle of spinous dorsal and lateral line; 8 scales obliquely forward from origin of spinous anal to lateral line; depth of head at beginning of scales on occiput $1\frac{1}{6}$ in its length; width of

[8] *Proc. U. S. Nat. Mus.*, XXVI, 1902, p. 15.
[9] *Atlas Ichth.*, VIII, 1878, Pl. (3) 357.
[10] *Atlas zu der Reise im nördlichen Afrika, Fisch.*, 1828, Pl. 22, fig 1.

head $2\frac{1}{2}$; snout $3\frac{1}{6}$; eye $3\frac{5}{6}$; maxillary $2\frac{2}{3}$; mandible 2; first dorsal spine $3\frac{1}{6}$; third 2; third dorsal ray $1\frac{9}{10}$; third anal spine 2; second anal ray about 2; upper caudal lobe about $1\frac{1}{2}$; least depth of caudal peduncle $3\frac{4}{5}$; pectoral $1\frac{3}{7}$; ventral $1\frac{2}{3}$; interorbital space 2 in orbit.

Least depth of caudal peduncle about $\frac{2}{3}$ of its length. Snout rather long, compressed a little, and upper jaw projecting. Eye touching upper profile. Jaws projecting a little, when open lower protrudes a little. Distal expanded end of maxillary about $\frac{4}{7}$ of orbit. Bands of minute teeth in jaws, on vomer and palatines. Nostrils together, anterior obscure, and posterior a deep cavity, its vertical diameter nearly equal to pupil. Interorbital space nearly level, with two distinct ridges. Preopercular spine reaches beyond gill-opening till nearly opposite origin of pectoral, and a little curved. Two nasal prongs. Gill-opening extending forward about opposite middle of eye. Scales well imbricated. Scales along basal sheath of spinous dorsal hardly denticulate posteriorly. Five series of scales on cheek, a series of broad ones along posterior margin of preopercle, and with exception of occiput, head otherwise naked. Small scales on bases of pectoral and caudal, extending well out on lobes of latter. Lateral line not extending on base of caudal. Margin of spinous dorsal hardly notched. Soft dorsal inserted a little nearer base of caudal than middle of pectoral. Third anal spine shorter than rayed fin. Pectoral and ventral not "of equal size," former a little longer.

Color of dried skin plain straw-brown, fins and iris unmarked. About four narrow pale olivaceous longitudinal bands, narrower than spaces between, extending along each series of scales above lateral line. Below lateral line about six or seven faded or paler ones, but a little broader.

One example. Thornton Island, Polynesia. C. D. Voy. Presented by Prof. E. D. Cope.

Another example from Samoa.

FLAMMEO Jordan and Evermann.

Bull. U. S. Nat. Mus. (Fish N. Mid. Amer.), No. 47, III, 1898, p. 2,871 (*marianus*).
Farer Forskål, Descript. Animal., 1775, p. 44 (*sammara*). [Uncertain.]

Flammeo achromopterus sp. nov. Fig. 6.

Holocentrus sammara Fowler, Proc. Acad. Nat. Sci. Phila., 1900, p 526. Samoa. (Dr. H. C. Caldwell.) (Not of Forskål.)

Head $2\frac{4}{5}$; depth $3\frac{1}{3}$; D. XI, 12; A. IV, 8; scales 41 in lateral line, last 3 on base of caudal; $3\frac{1}{2}$ scales obliquely back from origin of spinous dorsal to lateral line; 3 scales between middle of spinous dorsal and lateral line; 7 scales obliquely forward from origin of spinous anal to lateral line; width of head $2\frac{1}{10}$ in its length; depth of head $1\frac{1}{2}$, over posterior margin of eye; mandible $1\frac{7}{8}$; first dorsal spine $2\frac{1}{2}$; third $1\frac{5}{6}$; third anal spine $1\frac{3}{7}$; first anal ray $1\frac{3}{4}$; least depth of caudal peduncle $4\frac{1}{5}$; pectoral $1\frac{3}{4}$; ventral $1\frac{2}{3}$; snout $4\frac{2}{5}$, measured from tip of upper jaw; eye 2; maxillary $2\frac{1}{3}$; interorbital space $4\frac{1}{3}$.

Body rather elongate, compressed, greatest depth near middle of depressed ventral, and upper profile a little more bent and convex than lower. Caudal peduncle compressed, least depth about half its length.

Head a little large, elongate, well compressed, upper profile obtusely

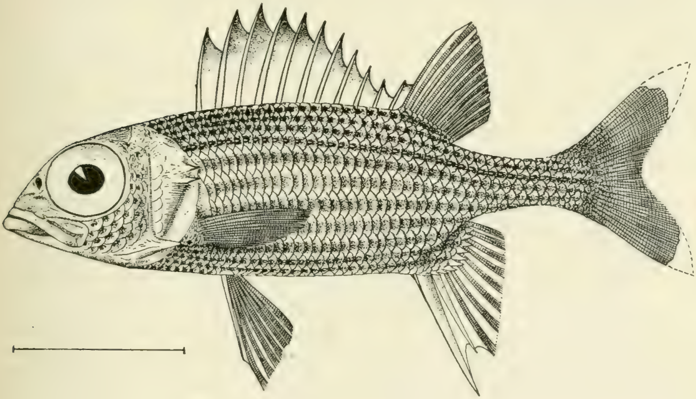

Fig. 6. *Flammeo achromopterus* Fowler.

convex, and lower but little convex. Snout short, convex, broad, upper jaw projecting a little, profile well inclined and straight. Eye rather large, nearly circular, anterior, and impinging on upper profile. Mouth rather small, mandible well protruding beyond upper jaw and gape reaching about front of posterior nostril. Maxillary rather large, slipping below narrow preorbital, and reaching below middle of orbit. Expanded end of maxillary equal to $\frac{3}{4}$ of horizontal diameter of pupil. Supplemental maxillary large. Teeth very small, in bands in jaws and on palatines, also a small triangular patch on vomer. Tongue long, slender, pointed and free. Nostrils adjoining, close in front and opposite middle of orbit, posterior a large pit. Interorbital space broad, and slightly concave. Bones of head mostly with finely denticulate margins. Two opercular spines, upper a trifle larger and longer. A short broad preopercular spine equal to $\frac{2}{3}$ horizontal diameter of pupil. No spines in nostril or at end of nasal bone. Margin of preorbital well serrated.

Gill-opening extending forward till nearly opposite middle of orbit. Rakers IV 2+7 II, longest a trifle over half of horizontal diameter of pupil. Pseudobranchiæ a little less than horizontal diameter of pupil, also a little longer than filaments.

Scales a little large, well imbricated, and finely denticulated, those on middle of side largest. Scales at base of spinous dorsal with small spines directed backward. Small scales crowded at base of soft dorsal. Base of anal scaly, and at middle rays well elongated and pointed. Small scales also on bases of pectoral and caudal. An enlarged scaly flap between bases of ventrals, also an enlarged axillary scale to each ventral. Four rows of scales on cheek, some on postocular region and occiput, and a single series of broad ones along posterior margin of preopercle. Lateral line with simple tubes, concurrent with dorsal profile at first, then extending a little high along side of caudal peduncle to middle of base of caudal.

Spinous dorsal inserted a trifle behind origin of pectoral, graduated to third spine which is longest, first and sixth of about equal size, and last much shorter than first, but also longer than penultimate. Margin of fin notched. Origin of soft dorsal nearly midway between middle of pectoral and base of caudal, and base of fin about $\frac{2}{3}$ its height. Anal inserted a trifle in advance, third spine enlarged, straight, longest, and reaching beyond longest anal ray to base of caudal if not a little beyond. Anterior anal rays longest, like those of soft dorsal. Caudal rather small, forked. Pectoral small, low, and not reaching as far as tip of ventral. Ventral inserted just behind base of pectoral, reaching about $\frac{2}{3}$ of distance to anal fin, first ray pointed, and spine equal to $\frac{5}{7}$ of fin.

Color in alcohol pale straw-brown. Four longitudinal series of narrow dark spots, one at base of each scale, above lateral line. Traces of about seven obscure pale longitudinal bands below lateral line. Fins with exception of marginal portion of spinous dorsal, which is pale dusky, plain pale brown like general body-color. Iris dull brassy-brown with a dusky blotch above.

Length $4\frac{1}{8}$ inches.

Type No. 14,141, A. N. S. P. Samoa. Dr. H. C. Caldwell.

This species is related to *Flammeo sammara* (Forskål), from which it differs, however, in the plain or immaculate fins.

(*Ἀ*, without; *χρόα*, color; *πτερὸν*, wing or fin.)

DESCRIPTION OF A NEW RACE OF NOTROPIS CHALYBÆUS FROM NEW JERSEY.

BY HENRY W. FOWLER.

Notropis chalybæus abbotti subsp. nov. Plate XVII (upper figure).

Cliola chalybæa Cope, Proc. Acad. Nat. Sci. Phila., 1883 (1884), p. 132. A broken dam on the Batsto river, New Jersey.

Head $3\frac{3}{4}$; depth $4\frac{2}{5}$; D. II, 7; A. II, 7; P. I, 13?; V. I, 7; scales 33 in lateral line to base of caudal; 17 scales before dorsal; 7 scales obliquely back from origin of dorsal to lateral line; 4 scales obliquely forward from origin of anal to lateral line; width of head $1\frac{7}{8}$ in its length; depth of head $1\frac{2}{7}$; snout $3\frac{1}{3}$; eye 3; maxillary $3\frac{1}{3}$; interorbital space $2\frac{3}{7}$; length of depressed dorsal 1; anal $1\frac{1}{5}$; pectoral $1\frac{2}{5}$; ventral $1\frac{1}{2}$; least depth of caudal peduncle $2\frac{4}{5}$; length of caudal peduncle, measured from base of last anal ray $1\frac{1}{6}$; caudal $3\frac{2}{5}$ in head and trunk.

Body robust, elongate, and compressed, greatest depth about tip of pectoral. Lower profile a little more convex than upper. Caudal peduncle rather stout, compressed, and its least depth about $\frac{2}{5}$ of its length.

Head rather large, robust, compressed, and somewhat conic in front. Profiles similar. Snout broad, conic, convex, and about even with jaws. Eye circular, close to upper profile, and anterior in head. Mouth small, a little oblique, and jaws about even. Lips rather fleshy. Maxillary small, barely reaching beyond posterior nostril or to front rim of orbit, and more or less concealed. Pharyngeal teeth 2, 4–4, 2, and larger ones a little hooked. Nostrils large, adjoining, near upper front of orbit, and frenum between forming a small flap over front of posterior which is a little larger.

Gill-opening extending forward within a short distance of posterior margin of orbit. Rakers few, weak, and small. Filaments well developed, also pseudobranchiæ.

Scales large, not with exposed edges narrowly imbricated, those in front of dorsal smaller and somewhat crowded in appearance. A few scales on base of caudal, fins and head otherwise naked. Lateral line decurved a little at first, and then continued more or less medianly after base of anal to base of caudal. Tubes simple.

Origin of dorsal a little nearer base of caudal than tip of snout, second simple ray longest, and together with first and second developed rays reaching beyond others or about opposite base of last anal ray. Anal inserted well behind last dorsal ray in vertical, similar to dorsal, and reaching $\frac{3}{5}$ of space to base of dorsal. Caudal rather long, forked, and lobes pointed. Pectoral low, not reaching ventral or only about $\frac{3}{4}$ of space. Ventral placed well before dorsal, and not reaching anal.

Color in alcohol with ground-color pale brown, back and upper surface more or less dusky, becoming deeper on median line of back and each scale with a blackish-dusky edge. A broad black longitudinal band, about as wide as orbit on costal region otherwise a trifle narrower, extends from snout including front of mandible to base of caudal where it forms a spot. Above this band on side of trunk and along its upper edge ground-color is lighter like lower surface. Along base of anal a bar of dusky which fades out on lower surface of caudal peduncle. Dorsal, caudal and upper edge of pectoral pale dusky, fins otherwise whitish. Black band over opercle reflected in same color inside of gill-opening. Iris deep slaty. Peritoneum pale brownish thickly sprinkled with minute dusky dots.

Length $2\frac{5}{16}$ inches.

Type No. 19,860, A. N. S. P. A broken dam on the Batsto river, New Jersey. E. D. Cope.

Also 18 co-types, Nos. 19,861–78, A. N. S. P. Same data.

This form differs from *Notropis chalybæus* (Cope) of the Delaware in its more dusky and deeper coloration. The lateral longitudinal band is also broader throughout its course, the pectoral more dusky, and the dusky dots which are collected along the base of the anal extend along the lower surface of the caudal peduncle to the caudal. This is true of all the Batsto minnows. All of those from the Delaware comprise a large series which I collected in late spring and early summer, during 1899, in a small stream flowing into the upper end of the mill-pond at Bristol, Bucks County, Pennsylvania. These have the lateral band distinctly narrower. As yet I have not taken *Notropis chalybæus* in any other part of the Delaware basin.

(Named for Dr. Charles C. Abbott, an earnest student of the fishes of New Jersey.)

Explanation of Plate XVII.

Notropis chalybæus abbotti Fowler.

Type No. 19,860 A. N. S. P. Batsto river, New Jersey. (Upper figure.)

Notropis chalybæus (Cope).

No. 23,983, A. N. S. P. Delaware river at Bristol, Pennsylvania. (Lower figure.)

March 1.

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

Forty-seven persons present.

The Publication Committee reported that papers under the following titles had been received:

"A Study of the Bats of the Genus Dermototus (Pteronotus auct.)," by James A. G. Rehn (February 26, 1904).

"Notes on Fishes from Arkansas, Indian Territory and Texas," by Henry W. Fowler (February 29, 1904).

"Descriptions of North American Araneæ of the Families Lycosidæ and Pisauridæ," by Thomas H. Montgomery, Jr. (March 1, 1904).

Mr. E. F. Phillips made a communication on recent studies on the habits of the honey bee. The subject was discussed by Dr. Conklin, Mr. A. E. Brown and the President. (No abstract.)

The following were ordered to be printed:

NOTES ON FISHES FROM ARKANSAS, INDIAN TERRITORY AND TEXAS.

BY HENRY W. FOWLER.

Dr. Henry A. Pilsbry, while in the above-named localities during April of 1903, formed a small collection of fishes now in the Academy of Natural Sciences of Philadelphia.

The more precise localities are:

1. *Arkansas:*
   Rogers, White river basin.
   Hartford, Arkansas river basin.
2. *Indian Territory:*
   Wister, Arkansas river basin.
   Limestone Gap, Red river basin.
3. *Texas:*
   Hondo, Neuces river basin.
   Del Rio, Rio Grande basin.
   Devil's river, Rio Grande basin.

One form appears to be new, and the color-notes of others are especially interesting on account of the season.

SILURIDÆ.

Ictalurus punctatus (Rafinesque).

Del Rio, Texas.

Ameiurus nebulosus (Le Sueur).

Hondo, Texas.

CATOSTOMIDÆ.

Carpiodes grayi Cope.

Proc. Amer. Philos. Soc., XI, 1870, p. 482. Probably one of the Western States.

Head $4\frac{1}{3}$; depth $3\frac{1}{4}$; D. III, 23; A. II, 7; P. I, 17; V. I, 10; scales 35 in lateral line to base of caudal; 7 scales obliquely from origin of dorsal to lateral line, and 6 from latter to origin of ventral; 17 scales before dorsal; width of head $1\frac{1}{2}$ in its length; depth of head $1\frac{1}{4}$; snout 3; eye $5\frac{1}{6}$; width of mouth $5\frac{2}{3}$; interorbital space $2\frac{2}{5}$; first developed dorsal ray $1\frac{1}{5}$; anal ray $1\frac{1}{2}$; pectoral $1\frac{1}{3}$; ventral $1\frac{1}{3}$; least depth of caudal peduncle $1\frac{7}{8}$. Opercle with radiating parallel striæ. Gill-rakers fine, slender, numerous, shorter than filaments. Color when fresh in alcohol dull olivaceous-brown on upper surface, pale on sides, and dilute or whitish on lower surface. Everywhere with more or less dull brassy reflections. Longitudinal lines following courses of scales pale. Opercle bright brassy. Fins dilute olive-yellow, unpaired darker and slightly dusky marginally. Cheek silvery. Iris dull golden, dusky above. Peritoneum black. Length $12\frac{1}{4}$ inches. Del Rio, Texas.

Also three others with same data showing following:—Head $4\frac{1}{5}$ to $4\frac{1}{4}$; depth $2\frac{5}{6}$ to $3\frac{1}{8}$; D. III, 22 to 25; scales to base of caudal 35 to 36; total length $7\frac{7}{8}$ to $8\frac{5}{8}$ inches.

These all appear to me to agree best with Cope's description. He gives the orbit as 4 in head, but this is probably due to a different method of measuring. If the figure of *Ictiobus tumidus*[1] is correct it may represent a distinct form. The pectoral is said to almost reach the ventral, and the radii are more numerous. Girard's figure of *Carpiodes damalis*[2] shows a smooth opercle, large subopercle, and the ventral inserted well posterior to the tip of pectoral. In my examples of *C. grayi* the first developed dorsal ray extends back about $\frac{3}{5}$ of the entire length of the depressed fin.

Catostomus nigricans (Le Sueur).

Color when fresh in alcohol dull olive, inclining to whitish below, and everywhere with more or less silvery reflections. Back with five rather indistinctly defined large saddle-like blotches composed of dusky points. Lower surface of head silvery. Dusky dots on side of snout, maxillary and upper opercle. Dorsal and caudal dull scarlet, margins more or less dusky, especially that of former. Anal, pectoral and ventral whitish. Hartford, Arkansas.

Minytrema melanops (Rafinesque).

Del Rio, Texas.

Moxostoma congestum (Baird and Girard).

Head $4\frac{1}{3}$; depth $4\frac{1}{3}$; D. II, 11; A. II, 7; P. I, 17; V. I, 9; scales 44 in lateral line to base of caudal, and 2 or 3 more on latter; 7 scales obliquely from origin of dorsal to lateral line, and 5 between latter and origin of ventral; 16 scales before dorsal; width of head $1\frac{3}{7}$ in its length; depth of head $1\frac{2}{5}$; snout $2\frac{1}{10}$; eye $5\frac{4}{5}$; width of mouth $3\frac{7}{8}$; interorbital space $2\frac{1}{5}$; first developed dorsal ray $1\frac{1}{3}$; base of dorsal $1\frac{4}{5}$;

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[1] *U. S. Mex. Bound. Surv., Ichth.*, 1859, p. 34, Pl. 19, figs. 1–4.
[2] Ex. Doc. No. 78, *Rep. Expl. Surv. R. R. Miss. Pac.*, X. Fish., 1858, p. 218, Pl. 48, figs. 1–4.

third developed anal ray $1\frac{1}{10}$; base of anal $2\frac{4}{5}$; caudal 1; least depth of caudal peduncle $2\frac{1}{3}$; pectoral $1\frac{1}{20}$; ventral $1\frac{1}{3}$. Color when fresh in alcohol dull or pale brown. Lower surface dull milky-white. Back with more or less silvery reflections, and slightly darker even longitudinal lines follow courses of scales. Dorsal and caudal dilute dusky-olive. Anal, pectoral and ventral pale salmon. Iris pale yellowish with grayish. Peritoneum silvery. Length $11\frac{1}{8}$ inches. Del Rio, Texas.

CYPRINIDÆ.

Campostoma anomalum (Rafinesque).

Adult male when fresh in alcohol dark brown above, and on upper side, lower side and under surface of body and fins white. Lower side of trunk posterior to dorsal brick-red with sporadic clusters of pale dusky above. Dorsal and caudal dilute dull olive-dusky, former with a black transverse streak across its middle adjoining a brick-red streak below. Caudal a little dusky medianly at base. Anal slightly ruddy with a deep brown transverse streak adjoining a brick-red one above. Pectoral grayish above at its base. Ventral with more or less ruddy. Other examples are tinged with dull chrome-yellow, and streaks on fins absent. Rogers and Hartford, Arkansas.

Chrosomus erythrogaster (Rafinesque).

Rogers, Arkansas. Most examples with bright red bellies.

Pimephales notatus (Rafinesque).

Color when fresh in alcohol dull olivaceous, becoming pale on side and whitish below. Body with more or less silvery reflections. A narrow well-defined dusky or blackish band about equal to pupil in width extends from eye to base of caudal, where it forms a spot, and also distinct on upper opercle. Scales on back all with more or less olive-dusky dots and well-defined edges. A small pale dusky spot on front of dorsal. Dorsal, caudal and pectoral dull grayish, tinged with dilute red. Anal and ventral pale, slightly tinged with red. Iris grayish. Hartford, Arkansas. Limestone Gap, Indian Territory.

Notropis blennius (Girard).

Color when fresh in alcohol pale olive-buff, whitish below, and everywhere more or less silvery. Scales on back without distinct dark edges. An indistinctly defined and rather broad lateral band of gray from head to base of caudal, and anteriorly including a number of dusky or dark-brown dots. Fins pale or dilute brownish, lower ones whitish. Del Rio, Texas.

Notropis shumardi (Girard).

Color when fresh in alcohol pale olive-green, whitish below, and scales above lateral line with slightly darker edges. Body more or less washed with silvery. Dorsal and pectoral dilute reddish with dusky edges above. Caudal pale dusky-gray. Ventral and anal whitish. Snout dusky-brown. Side with a rather broad indistinctly defined silver-gray band from head to caudal, and scales in lateral line after dorsal with blackish dots becoming most distinct on caudal peduncle. No spot at base of caudal. Blackish spots extending from posterior rim of eye backward, but soon becoming indistinct above pectoral. Iris grayish. Limestone Gap, Indian Territory.

Notropis lutrensis (Baird and Girard).

Dark nuchal band conspicuous. Small tubercles on upper surface of head and along lower side of body above anal very numerous. Devil's river and Del Rio, Texas.

Notropis proserpina (Girard).

Dusky dots at base of dorsal. Caudal bright yellow. Del Rio, Texas.

PARANOTROPIS subg. nov.

Type *Photogenis luciodus* Cope

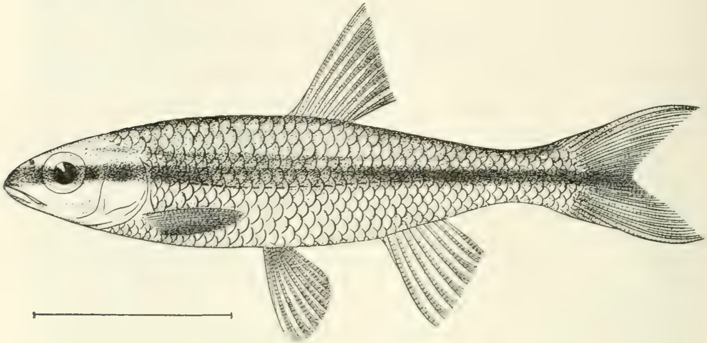
The species of this group closely resemble those of the subgenus *Notropis* Rafinesque, which is typified by *atherinoides*. They differ chiefly in the fewer developed anal rays, mostly 7 to 9. They are also distinguished from the *Luxilus* and *Hydrophlox* groups by the absence of grinding surfaces on the teeth and the broad scales which are not narrowly imbricated. From *Orcella*, with which they agree in these respects, they differ in the top of the head which is not especially elevated, so that the eye is nearer the upper than the lower profile. *Episema* Jordan, based on *scabriceps*, is preoccupied.

(*Παρὰ*, near; *νῶτος*, back, and *τροπὶς*, keel, hence *Notropis*.)

Notropis pilsbryi sp. nov.

Head 4; depth $4\frac{1}{4}$; D. II, 8; A. II, 8; P. I, 15; V. I, 8; scales 40 in lateral line to base of caudal, and 3 more on latter; 15 scales before dorsal; 5 scales between origin of dorsal and lateral line; 4 scales between latter and origin of ventral; width of head $1\frac{9}{10}$ in its length; depth of head $1\frac{4}{7}$; snout $3\frac{1}{6}$; eye $3\frac{1}{6}$; maxillary 3; interorbital space $3\frac{1}{6}$; length of depressed dorsal 1; depressed anal $1\frac{1}{4}$; pectoral $1\frac{1}{3}$; ventral $1\frac{3}{7}$; caudal 1; least depth of caudal peduncle $2\frac{2}{3}$.

Body elongate, compressed, rather slender, more or less fusiform, and greatest depth at origin of dorsal. Caudal peduncle long, compressed, and its least depth $2\frac{2}{5}$ in its length, measured from base of last anal ray.



Head elongate, compressed, and upper profile more or less straight from above nostrils. Snout convex, rather broad, and also with a convex profile. Eye rather large, a little above middle of depth of head, and well anterior in its length. Mouth slightly curved, inclined, and jaws subequal, lower hardly if any projecting. Maxillary reaching about opposite front rim of orbit. Mandible rather broad, and rami but little elevated, edges of jaws rounded. Tongue rather broad, fleshy, and adnate to floor of mouth. Lips thin and narrow. Nostrils adjoining near upper edge of eye, and internasal space much less than interorbital. Anterior nostril circular, and posterior larger, concealed in front by flap of anterior. Both interorbital and internasal spaces a little elevated, though flattened medianly. Subopercle of moderate size.

Gill-opening extending forward below posterior rim of orbit. Rakers small, weak, and very short. Filaments about $\frac{3}{5}$ of orbit. Pseudobranchiæ well developed. Pharyngeal teeth 2, 4–4, 2, compressed, and hooked. Isthmus rather broad.

Scales cycloid, moderately large, and exposed portions but little deeper than broad. Except base of caudal, fins and head naked. Lateral line slightly decurved at first, running rather low and straight to base of caudal. Tubes simple.

Dorsal inserted about midway between tip of snout and base of caudal, second rudimentary ray rather long closely joined with first articulated which is longest. Anal inserted behind base of dorsal, first articulated ray longest. Caudal forked, lobes pointed. Pectoral broad, falling a little short of ventral. Ventral inserted before origin of dorsal and reaching anus which is close in front of anal.

Color when fresh in alcohol dull olive-brown above, below dull white, and side with a broad diffuse grayish band. A band a little wider than pupil composed of dusky dots extends from snout through eye, along side to middle of base of caudal, where it is intensified. It is also continued out to margin of caudal, as median rays are grayish-dusky. Top of head brownish, and a median brownish-dusky streak on back enclosing dorsal fin and continued to caudal. Body everywhere with more or less silvery. Fins red, deepest basally. Dorsal, caudal and pectoral with dilute olivaceous-gray on outer portions. Mandible reddish. Iris silvery, except horizontal median dark cross-bar. Peritoneum dusky-gray

Length 3½ inches.

Type No. 24,514, A. N. S. P. Rogers, White river basin, Arkansas. Collection Dr. H. A. Pilsbry. Also six co-types with same data. After being in alcohol some time the colors have faded. The longitudinal dusky band is, however, still present.

This species is very closely related to *Notropis luciodus* (Cope), differing apparently in coloration and slightly more slender body.

(Named for my friend Dr. Henry A. Pilsbry, well known among leading conchologists.)

Subgenus NOTROPIS Rafinesque.

Notropis socius (Girard).

Del Rio, Texas.

Notropis notemigonoides Evermann.

Hartford, Arkansas.

Phenacobius scopifer (Cope).

Color when fresh in alcohol olivaceous above, whitish below. Scales on back edged with dusky-olive. Lower surface with silvery reflections. Side of head somewhat brassy with pale dusky dots. A broad dusky-slate bar extends from eye to middle of base of caudal, dividing upper and lower colors of body. Top of head dark brownish-olive with a median streak extending to dorsal and continued behind it to caudal. A black spot at base of caudal. Fins and lower surface of head with dilute red, dorsal, caudal and pectoral deepest. Limestone Gap, Indian Territory.

CHARACINIDÆ.

Tetragonopterus argentatus (Baird and Girard).

Color when fresh in alcohol pale olive on upper surface, sides and lower surface silvery-white. Upper boundary of silvery-white of sides shows a pale diffuse leaden band, becoming distinct and dark along middle of side of caudal peduncle to base of caudal. It is also continued on caudal as several of median rays are same color. Dorsal and caudal dilute pale olivaceous, latter with a pale ruddy wash. Anal with marginal portion slightly dusky and basally with a pale ruddy tinge. Pectoral and ventral also with a dilute ruddy tinge. A dull slaty blotch behind opercle above. Iris pale yellowish. Del Rio and Devil's river, Texas.

PŒCILIIDÆ.

Zygonectes notatus (Rafinesque).

Hartford, Arkansas. Wister, Indian Territory.

Gambusia affinis (Baird and Girard).

Devil's river, Texas.

ATHERINIDÆ.

Labidesthes sicculus (Cope).

Hartford, Arkansas.

CENTRARCHIDÆ.

Apomotis cyanellus (Rafinesque).

Hartford, Arkansas. Devil's river, Texas.

Lepomis megalotis (Rafinesque).

Hartford, Arkansas. Devil's river and Del Rio, Texas.

PERCIDÆ.

Etheostoma whipplii (Girard).

Color when fresh in alcohol olivaceous-brown, paler or whitish below. Back and side with marblings or mottlings of deep olivaceous-brown, though on latter about 13 diffuse spots are formed along course of lateral line. Posteriorly, and on caudal peduncle, they become vertically elongate. An enlarged black humeral scale. Head dusky above, and a blackish streak from eye to upper corner of gill-opening. A dusky streak from below eye. Fins mostly orange-red with more or less dusky basally. Spinous dorsal with a median longitudinal orange-red band edged above and below with whitish. A bright orange-red bar on caudal next to rather dusky margin. Pectoral and ventral grayish, latter dark. Limestone Gap, Indian Territory.

Considerable variation is noticed. Some examples have few brown mottlings on side, others have them very distinct and wavy. All are more or less orange-red on fins and show greater portion of caudal dusky.

An example from Hartford, Arkansas, according to Dr. Pilsbry's notes, had the fins vividly colored in life. The spinous dorsal and ventrals were with green spines and rays, the rayed dorsal and caudal with a scarlet border, and the anal scarlet with a green edge.

CICHLIDÆ.

Heros cyanoguttatus (Baird and Girard).

Del Rio and Devil's river, Texas.

A STUDY OF THE BATS OF THE GENUS DERMONOTUS (PTERONOTUS Auct.).

BY JAMES A. G. REHN.

During the preparation of this paper a series of thirty-six specimens of the genus have been examined, all being from the collections of the United States National Museum, the Biological Survey of the United States Department of Agriculture and the American Museum of Natural History. The author wishes to express his indebtedness to the gentlemen in charge of the collections of the above institutions for permitting the examination of the specimens.

DERMONOTUS Gill.

1838. *Pteronotus* Gray, Mag. Zool. and Botany, II, p. 500. Type, *Pteronotus davyi* Gray. (Not of Rafinesque, 1815.)
1843. *Chilonycteris* Wagner, Archiv für Naturgeschichte, IX, bd. I, p. 367. (Part.)
1844. *Pteronotus* Gray, Voyage of the Sulphur, I, Mammalia, p. 24.
1850. *Chilonycteris* Wagner, Abhandlungen Mathem.-Physik Cl. Akad. Wissenschaften, München. V, p. 179. (Part.)
1854. *Chilonycteris* Burmeister, Thiere Brasiliens, I, p. 74. (Part.)
1855. *Chilonycteris* Wagner, Suppl. Schreber's Säugthiere, V, p. 677. (Part.)
1855. *Pteronotus* Wagner, Suppl. Schreber's Säugthiere, V, p. 700.
1872. *Pteronotus* Peters, Monatsber. K. Preuss. Akad. Wissensch., Berlin, p. 361.
1878. *Chilonycteris* Dobson, Catal. Chiropt. Brit. Mus., p. 447. (Part.)
1879. *Chilonycteris* Alston, Biol. Cent.-Amer., Mamm., p. 34. (Part.)
1890. *Pteronotus* J. A. Allen, Bull. Amer. Mus. Nat. Hist., III, p. 178.
1892. *Chilonycteris* Thomas, Ann. and Mag. Nat. Hist., 6th ser., X, p. 410. (Not of Gray.)
1894. *Pteronotus* J. A. Allen, Bull. Amer. Mus. Nat. Hist., VI, p. 248.
1901. *Dermonotus* Gill, Proc. Biol. Soc. Washington, XIV, p. 177. (To replace *Pteronotus* Gray.)
1902. *Dermonotus* Miller, Proc. Biol. Soc. Washington, XV, p. 155.

Generic Characters.—Naked volar membranes extending over the back attached only along the median line and across the shoulders, anterior to which section the dorsal surface is normally furred. Skull with the brain-case moderately elevated and rostrum distinctly inflated. Dentition i. $\frac{2-2}{2-2}$, c. $\frac{1-1}{1-1}$, p. $\frac{2-2}{3-3}$, m. $\frac{3-3}{3-3}$.

History.—The genus *Dermonotus* (*Pteronotus* Gray) is so closely related to *Chilonycteris* and *Mormoops* that its history is in great part a repetition of that witnessed in these two genera. As considerable space has already been given to the taxonomic history of *Mormoops*[1] and *Chilonycteris*,[2] only such points as differ will be noticed. The genus was originally based on a specimen from Trinidad, and associated by Gray with the following genera: *Cheiromeles, Nyctinomus, Molossus, Thyroptera, Myopteris* and *Diclidurus*. Wagner, in 1843, described a specimen of this genus, taken by Natterer at Cuyaba, Brazil, as *Chilonycteris gymnonotus*, unaware that Gray had created a genus for this type of bat. Later, in 1855, he apparently did not recognize his species as a close relative of Gray's *Pteronotus davyi*, as he associated the latter, which he, of course, had never seen, with *Cheiromeles* and *Dysopes* in the section Macrura. The question as to the tenability of the genus as distinct from *Chilonycteris* later caused a great amount of shifting, the individual opinions of Peters, Dobson, Alston, and Thomas differing as to the recognition of the genus. In 1892 Thomas described a race of *davyi* from Jalisco, Mexico, basing it on the brilliant fulvous coloration of the Mexican specimens, and their slightly smaller size. Gill, in 1901, discovered the fact that Gray's *Pteronotus* was preoccupied by *Pteronotus* Rafinesque, a synonym of *Pteropus*, and to meet the deficiency he proposed the name *Dermonotus*.

General Relations.—The genus *Dermonotus* is closely associated with *Mormoops* and *Chilonycteris*, which constitute the subfamily *Mormoopinæ*. The characters of the genus are such that recent workers have all accorded it full generic rank, and as Gill has stated (*l.c.*), modern systematic standards would fully allow the maintenance of the genus as distinct from *Chilonycteris*. An interesting character noted in this genus, as in the two allied genera, is the occurrence of dichromatism. The two phases are quite marked, one being dull chocolate-brown, the other rich fulvous.

Key to the Forms.

a.—First upper premolar longitudinal, not crowded; forearm averaging 46.2 mm., ... *davyi* (Gray).

aa.—First upper premolar nearly transverse, strongly crowded between the canine and second upper premolar; forearm averaging 44.1 mm., ... *davyi fulvus* (Thomas).

Dermonotus davyi (Gray).

1838. *Pteronotus Davyi* Gray, Mag. Zool. and Botany, II, p. 500. [Trinidad.]

1843. *Chilonycteris gymnonotus* Wagner, Archiv für Naturgeschichte, IX, bd. I, p. 367. [Cuyaba.]

[1] *Proc. Acad. Nat. Sci. Phila.*, 1902, pp. 160–172.

[2] *Ibid.*, 1904.

1844. *Pt[eronotus] Davyi* Gray, Voyage of the Sulphur, I, Mammalia, p. 24. [Trinidad.]
1850. *Chilonycteris gymnonotus* Wagner, Abhandlungen Mathem.-Physik Cl. Akad. Wissenschaften, München, V, p. 179. [Cuyaba, Matto Grosso.]
1854. *Chilonycteris gymnonotus* Burmeister, Thiere Brasiliens, I, p. 75. [Cuyaba, Matto Grosso.]
1855. *Ch[ilonycteris] gymnonotus* Wagner, Suppl. Schreber's Säugthiere, V, p. 680, Pl. 48. [Matto Grosso.]
1855. *Pt[eronotus] Davyi* Wagner, Suppl. Schreber's Säugthiere, V, p. 700. [Trinidad.]
1872. *Pteronotus Davyi* Peters, Monatsb. K. Akad. Wissensch., Berlin, p. 361. [Brazil; Mexico.] (Part.)
1878. *Chilonycteris davyi* Dobson, Catal. Chiropt. Brit. Mus., p. 453, Pl. XXIII. [Puerto Cabello; Venezuela.]
1879. *Chilonycteris davyi* Alston, Biol. Cent.-Amer., Mamm., p. 36. [Mexico; Venezuela; Trinidad; Brazil.] (Part.)
1892. *C[hilonycteris] Davyi* Thomas, Ann. and Mag. Nat. Hist., 6th ser., X, p. 410. [Trinidad; Dominica; Venezuela.]
1892. *Chilonycteris davyi* Thomas, Journal Trinidad Field Naturalists' Club, I, p. 162. [Trinidad.]
1902. *D[ermonotus] davyi* Miller, Proc. Biol. Soc. Washington, XV, p. 155. [Dominica; Trinidad.]

Type Locality.—Trinidad.

Distribution.—Brazil; Puerto Cabello, Venezuela, and Trinidad and Dominica in the West Indies.

General Characters.—Size medium; character of the volar membranes as described under the genus.

Head.—Occiput dome-shaped and evenly rounded; rostrum rather depressed, broad. Ear rather elongate, acuminate; internal margin with the internal ridge very distinctly developed and forming a rounded lobe inferiorly, superiorly with a blunt but distinct shoulder, beyond which infra-median point the internal margin is evenly arcuate, curving back to the recurved and very bluntly falcate apex; external margin carried forward inferiorly to the angle of the mouth, external shoulder rounded and median in position, superior portion of the external margin straight except for a marked concavity caused by the recurved apex. Tragus subrectangulate, apical portion narrower than the basal half; external margin sinuate; apex rounded; accessory lobe rather small, subhorizontal, rounded, forming a distinct shoulder or ledge; internal margin inferior to the accessory lobe, sinuate and with a distinct marginal thickening. Nostrils surrounded by a very slight raised margin, and surmounted by a fleshy ridge, which is considerably excavated in the area superior to the nasal division; lateral portions of muzzle with a raised fleshy ridge, which is separated from the nose-pad by a rather deep incision. Superior portion of the muzzle with a median rounded swelling situated a short distance back from the nostrils. Labial chin-lappet strongly transverse, the lateral portions rather inconspicuous and merging into the lip proper, median portion distinctly papillose, the papillæ bordering the arched incision separating the smooth incisive pad larger than the others; posterior chin-lappet almost equal to the labial in width, thin, closely adpressed.

Limbs.—Forearm of medium length, very distinctly arcuate though the distal portion is considerably straighter than the proximal; third finger slightly more than one and one-half times the length of the forearm. Femora, tibiæ and feet rather slender; calcanea about a fourth as long again as the tibiæ.

Membranes and Fur.—Membranes rather thin, but very tough and leathery; propatagium deep, extending free to the thumb; endopatagium and mesopatagium with the longitudinal nerves very regularly and completely distributed, endopatagium attached along the median line of the body by a thin membrane, otherwise free except that anteriorly it is squarely attached across the shoulders and posteriorly it is tightly attached from the middle of the femur to its margin slightly below the middle of the tibia; uropatagium large, the calcanea bound down to the tibiæ to a point opposite the attachment of the endopatagium, tail with the enclosed portion slightly exceeding the free apical section. Fur woolly, evenly distributed over the visible and concealed sections of the dorsal surface and also the entire venter; membranes almost entirely covered with extremely fine short hair; muzzle and lips with groups of distinctly setiform hairs.

Color.[3]—General color vandyke-brown, membranes and ears with a slight touch of blackish. It is quite probable that typical *davyi* will be found to possess a rufous form, as two phases of coloration have been found in almost all the other species and races of the Mormoopinæ. The distinct color phases of *D. davyi fulvus* are very marked, but possibly the more southern type possesses but one color form, or one strongly predominating phase, a case of which is probably found in *Chilonycteris rubiginosa* and *rubiginosa mexicana.*

Skull.—Rather fragile; rostrum considerably inflated and somewhat depressed. Brain-case evenly arched transversely and with a slight longitudinal depression, dipping suddenly toward the rostrum; zygomata widest posteriorly and without any distinct arcuation. Rostrum very distinctly inflated, the greatest width over the posterior molars; nasal depression broad, smoothly excavated. Mandible rather long, the ascending ramus very low and weak; coronoid and condylar processes low, inconspicuous and equal in development; angle strongly curved laterally and with a recurved tip.

[3] From alcoholic specimens.

Teeth.—Central pair of upper incisors broad with a straight, slightly bilobate cutting edge; lateral upper incisor low, in basal outline equal to the median tooth; upper canine slightly recurved; first upper premolar subovate in basal outline, the greatest length of the tooth sublongitudinal; second upper premolar subpentagonal in outline, transverse, cusp distinct and caniniform, internal cingulum developed as a distinct rim to a slightly excavated area; first and second upper molars subquadrate, with the para-metaconoid ridges distinct and high, the paracone developed as a distinct shoulder, protocone and hypocone distinct, the former higher than the latter; third upper molar transverse, para-metaconoid ridge deflected internally, protocone quite distinct. Lower incisors obscurely tridentate, the median teeth in size considerably exceeding the laterals which are crowded against the canines; lower canines erect, slightly curved and slightly tapering; first lower premolar subquadrate in basal outline, cusp longitudinal, acute-angulate; second lower premolar very small, circular in basal outline, crowded between the first and third premolars and deflected toward the lingual side of the tooth-row; third lower premolar rather elongate-quadrate, cusp rather high, acute; molars with the interspaces deeply excavated, the paraconid and hypoconid lower than the other cusps.

Measurements.—Average of five Dominican specimens: Total length 70.8 (70–75) mm.; head and body 52.2 (51.3–53); head 18.9 (18.1–19.5); ear 16 (15.5–17); tragus 4.8 (4.5–5.5); forearm 46.2 (45–48); thumb 8.5 (8.1–9.1); third digit 77.4 (75–79); tibia 17.5 (17–18.1); calcaneum 21.6 (19–24); foot 11.1 (10.8–11.5); tail 20.6 (18–22).

Average of two Dominican skulls: Total length 16.7 (16.5–17); greatest zygomatic breadth 9.1 (9–9.3); interorbital width 4; height at base of the second premolar 3.9 (3.8–4); height of brain-case 6.7 (6.4–7); width of palatal constriction 1.3; length of palate from anterior foramina 7.1 (7–7.3); width of palate including teeth 6.2 (6.1–6.3); greatest length of mandible 11.9 (11.6–12.3); breadth of brain-case above roots of zygomata 8.3 (8.2–8.5).

Remarks.—This form is apparently uniform in size through its range, as Wagner's measurements of the type of *gymnonotus* (*l.c.*) are not materially different from those of the Dominican series examined. The typical form can readily be distinguished from *davyi fulvus* by the larger size and the position and less crowded character of the first upper premolar.

Specimens Examined.—Five alcoholic specimens. Dominica. [U.S. N. M.]

Dermonotus davyi fulvus (Thomas).

1872. *Pteronotus Davyi* Peters, Monatsber. K. Preuss. Akad. Wissensch., Berlin, p. 361. [Brazil; Mexico.] (Part.)
1879. *Chilonycteris davyi* Alston, Biol. Cent.-Amer., Mamm., p. 36. [Mexico; Venezuela; Trinidad; Brazil.] (Part.)
1890. *Pteronotus davyi* J. A. Allen, Bull. Amer. Mus. Nat. Hist., III, p. 178. [Plains of Colima, Mexico.]
1892. *Ch[ilonycteris] Davyi fulvus* Thomas, Ann. and Mag. Nat. Hist., 6th ser., X, p. 410. [Las Peñas, Jalisco, Mexico.]
1894. *Pteronotus davyi* J. A. Allen, Bull. Amer. Mus. Nat. Hist., VI, p. 248. [South shore of Lake Chapala, Michoacan, Mexico.] (Not of Gray.)
1902. *D[ermonotus] fulvus* Miller, Proc. Biol. Soc. Washington, XV, p. 155.

Type Locality.—Las Peñas, Jalisco, Mexico.

Distribution.—Specimens have been examined or recorded from localities from Tehuantepec to the type locality in Jalisco on the west coast, and from Apazote, Campeche, to Mirador, Vera Cruz, on the Atlantic side.

General Characters.—Similar to *D. fulvus*, but the size is less and the first upper premolar is more crowded and with the greatest length transverse.

Head, membranes and other external characters as in *Dermonotus davyi.*

Skull and Teeth.—Essentially as in *D. davyi*, except for the smaller size and the crowded character of the first upper premolar. This tooth is strongly crowded between the canine and second premolar, and in consequence is twisted so that the greatest length is almost transverse.

Color.—Brown phase: Fur above vandyke-brown; below ecru-drab, the hair seal-brown basally. Membranes and ears clove-brown. Rufous phase: Fur above rich tawny, below golden ochraceous, hair cinnamon basally. Membranes and fur as in the rufous phase. From the series examined it would appear that the individuals are equally divided between the two phases.

Measurements.—Average of series: Total length [20][4] 63.3 (59.7–73.5) mm.; head and body [21] 47.2 (41.5–60.5); head [20] 17.1 (16–18.5); ear [20] 14.9 (12.5–16); tragus [20] 4.7 (4.2–5); forearm [30] 44.1 (42.5–46); thumb [30] 7.3 (7–9); third digit [20] 74.7 (71–78); tibia [30] 17.1 (16–19); calcaneum [18] 20 (18–23); foot [30] 9.9 (8.5–10.8); tail [23] 20.5 (18–24.3).

Average of series of skulls: Total length [10] 15.5 (15–16); greatest zygomatic width [9] 8.7 (8.2–9.3); interorbital width [10] 3.6 (3.5–3.9); height at base of second premolar [11] 3.4 (3–3.9); height of brain-case [8] 6.3 (6–6.8); width of palatal constriction [9] 1.3 (1.2–1.5); length of palate from anterior foramina [9] 6.2 (6–6.5); width of palate in-

[4] Number of individuals in brackets.

cluding teeth [11] 5.9 (5.8–6); greatest length of mandible [10] 11.7 (11.3–12.3); breadth of brain-case above roots of zygomata [9] 7.8 (7.4–8).

Remarks.—The slightly smaller general size and the character of the first upper premolar will be found to separate this race from typical *davyi.* The characters are, however, such that merely subspecific rank should be accorded it. The range of variation in size in *davyi fulvus* is very considerable, and does not appear to depend on sex or locality.

Specimens Examined.—Thirty-one, eleven skins, twenty alcoholic individuals:

Tehuantepec, Mexico. [U. S. N. M.] [6.]

Santa Efigenia, Tehuantepec, Mexico. [U. S. N. M.] [2.]

Apazote, Campeche, Mexico. [Biological Surv.] [1.]

San Andres Tuxtla, Vera Cruz, Mexico. [Biolog. Surv.] [11.]

Mirador, Vera Cruz, Mexico. [U. S. N. M.] [7.]

Acapulco, Guerrero, Mexico. [Biolog. Surv.] [2.]

Hacienda Magdalena, Colima, Mexico. [Biolog. Surv.] [1.]

Plains of Colima, Mexico. [A. M. N. H.] [1.]

THE LARVAL EYE OF CHITONS.

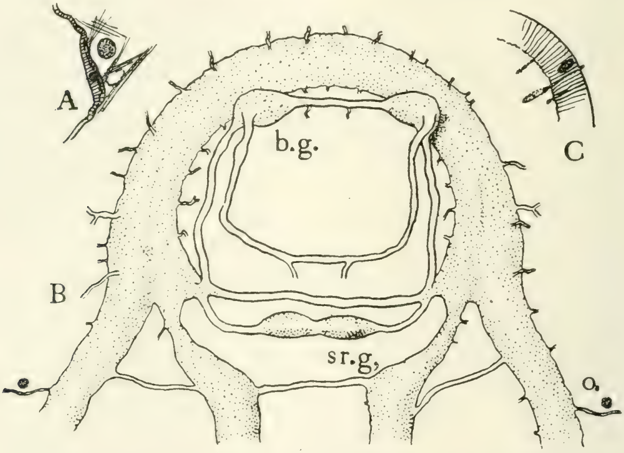
BY HAROLD HEATH.

In *Chiton polii*, according to Kowalevski, and in *Ischnochiton magdalenensis*, *Trachydermon raymondi* and *Nuttallina thomasi* the eyes of the larvæ become clearly defined about the time of the first appearance of the shell. They are situated immediately behind the velum, half-way up the sides of the body. Concerning their structure Kowalevski writes,[1] "They are characterized by the pigment deposited about a central clear body, and are placed almost entirely upon the lateral or branchial nerves." As the figures of this author show, each ocellus at this time consists of a single cell imbedded in the epithelium covering the body. In later stages this condition of affairs in the young of *Chiton polii* becomes more complex. According to Kowalevski, the pigmented body, with its clear included vesicle, retains its early characters, but migrates "under the skin and upon the branchial nerve. The ectodermic epithelium, situated above the eyes, presents certain modifications which may be related to the function of the ocellus; its cells are here very slender, more elongated than those adjoining, their appearance is different, and it appears to me possible that these cells play a certain rôle in the transmission of luminous rays to the ocellus and perform the function of a cornea."

While working upon certain problems connected with the larval development of chitons, I have many times noticed the ocelli in several species. In those forms enumerated above, save *Chiton polii*, I have traced these structures through all stages, from their first development until their final disappearance; and after the metamorphosis of the larva have determined their fate in *Ischnochiton mertensii*, *I. regularis*, *I. cooperi*, *Katharina tunicata* and *Tonicella lineata*. In its early stages in these species each eye appears essentially as described by Kowalevski, and this state of affairs continues as long as the ocellus may be distinguished. Under no circumstances does it become subepithelial. In many cases the pigmented cell sinks somewhat beneath the general outer surface of the epithelium and is partially overarched by neighboring cells, but these are in no wise different from those elsewhere in the skin and never give the impression of forming

[1] "Embryogénie du Chiton polii (Philippi) avec quelques remarques sur le développement des autres Chitons," *Ann. Mus. hist. nat. Marseille*, T. I, No. 5.

a lens or cornea. There is no reason to doubt the correctness of Kowalevski's observations, but the eye of *Chiton polii* is certainly not typical. On the other hand, the eyes of the chitons I have examined are in their histological details essentially like those of the annelid trochophore. In the latter organism they are placed in the velar field and are innervated by nerves from the cerebral ganglia; in the chitons they are posttrochal and are situated on the pallial cords. These facts, however, may not be fatal to the theory that the ocelli of the larvæ of these two phyla are homologous, especially in view of the fact that their early development is almost identical. I have shown in another paper[2]



A. Section through ocellus and pallial cord of sexually mature *Trachydermon raymondi* (6 mm. long). *B*. Anterior part of nervous system of *Ischnochiton mertensii* (4 mm. long); *b.g.*, buccal ganglion; *sr.g.*, subradular ganglia; *o.*, *ocellus*. *C*. Section through eye-spot of annelid (*Sabella*) trochophore.

that the head vesicle, or the part of the chiton larva anterior to the velum, "becomes transformed into part of the first valve of the shell, the mantle and mantle furrow of the same region, and into the proboscis." Now it is obvious that if the chiton eye were situated in front of the velum, as in the annelids, it would be most unfavorably placed after the metamorphosis. Under the circumstances the most available situation would be the furrow about the proboscis, where it

[2] "The Development of Ischnochiton," *Zool. Jahrb.*, Bd. XII, 1899, p. 630.

would be continually obscured and would be practically useless even if provided with special tentacles. It seems most reasonable to suppose that as the structures characteristic of the chitons appeared in the phylogenetic development, the eye-spots gradually shifted their position into the present more favorable location.

Pelseneer[3] has made a detailed study of the larval eyes of some of the *Mytilidæ* and the related genus *Avicula*. They arise in the embryo behind the velum and on the base of the first gill-filament. "Each eye is open, that is to say, an invagination of the skin, and consists of pigmented epithelial cells. . . . . The cavity is filled by an elongated crystalline body continuous with the overlying cuticle. . . . . They have a structure intermediate between the eyes of *Patella* and *Trochus*," and are innervated by fibers from the cerebral ganglia. Pelseneer considers that this type of eye and that of the chitons are homologous. This assumption must rest entirely upon the fact that both are post-trochal. They certainly are fundamentally different in structure. Even with *Chiton polii* this is the case, and, furthermore, this organ in the lamellibranchs is innervated by nerves from the cerebral ganglia, and in the chitons by the pallial nerves. Thiele's[4] contention that the eye of *Arca noæ* and the chiton eye are homologous rests upon the same foundation as Pelseneer's argument. Both are behind the velum, but fundamentally different structurally and in their innervation. As the matter now stands, the theory that the chiton and the annelid eye are homologous rests upon identity of structure; while the chiton and lamellibranch larval eye are supposed to be genetically related because of similarity of position.

It is improbable that the eyes of chitons are functional only in the larvæ. In the three species studied before the metamorphosis the pigment appears about twenty-four hours prior to the free-swimming stage, which lasts from fifteen minutes to twenty-four hours, according to conditions. After the metamorphosis, which ensues after the embryos have settled, these sense organs in at least eight species invariably persist for a considerable length of time. In fact, they appear to remain as long as the shell and mantle are sufficiently transparent to allow the light to penetrate, or until the animal is upward of 5 mm. in length. Some of the smaller species are at this time sexually mature; while some of the larger forms are only one-fourth or even one-tenth their adult size.

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[3] "Les yeux céphaliques chez les Lamellibranches," *Arch. de Biol.*, T. 16.
[4] "Ueber Sinnesorgane der Seitenlinie und das Nervensystem von Mollusken," *Zeit. f. w. Zool.*, Bd. XLIX.

March 15.

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

Eighteen persons present.

The death of William M. Canby, a member, March 10, 1904, was announced.

The Publication Committee reported that a paper entitled "A Revision of the Mammalian Genus Macrotus," by James A. G. Rehn, had been presented for publication (March 11).

James A. Nelson, Ph.D., made a communication on the life-history, structure, and relationships of *Dinophilus*, a primitive annelid worm. It was presented for publication under the title "The Early Development of Dinophilus: A Study in Cell-Lineage."

Henry Tucker and Waldemar Lee were elected members.

The following was ordered to be printed:

DESCRIPTIONS OF NORTH AMERICAN ARANEÆ OF THE FAMILIES LYCOSIDÆ AND PISAURIDÆ.[1]

BY THOMAS H. MONTGOMERY, JR.

A very considerable number of species of spiders of the families Lycosidæ and Pisauridæ have been described from North America, but for the most the descriptions have barely diagnostic worth. At the present time it is practically impossible to identify most of the species of Walckenaer, Blackwall, Hentz and some others, because some of their species are so insufficiently described that a particular description applies equally well to a number of species. By far the most thorough work so far is that of Keyserling. When the American species are better known than they are at present we shall be in better position to identify the species named by the earlier writers, for then the identification can be done by the process of elimination. The more deeply one enters into the closely intergrading species of the Lycosidæ especially, the more doubtful seems to be the character of attempts to recognize poorly described forms. Nearly the whole southeastern section of the United States and the greater part of the region west of the Mississippi river have been untouched by modern arachnologists; with such a hiatus in the material for comparison, it would be unscientific to make sure of the status of species known only by inadequate diagnoses. It is right to attempt, as far as possible, to recognize the species of earlier writers, but not to uphold names when the type specimens are lost and when the type descriptions are not decisive. When all the species are known, the trial can be undertaken of determining the earlier species.

The Lycosidæ and Pisauridæ are particularly interesting groups because of the difficulties in the way of their study. Not only do the species intergrade closely, but there is very considerable individual variation apart from geographical variation, and the genera are as difficult to define sharply as are the species. No groups are better adapted to prove the idea that the species, as the higher groups, are but concepts, and their delimitation necessary purely for purposes of de-

[1] Contributions from the Zoological Laboratory of the University of Texas, No. 57.

scription and interpretation. What is needed above all, as the preliminary to any morphological or broad ethological study of them, are full and ample descriptions of the structure—of the external genitalia, together with the form and proportions of the cephalothorax, the mouth parts and the legs. The number of the teeth on the tarsal claws is of no value, for it is subject to great individual variation, as has been shown by my student, Mr. Carl Hartmann. The number of teeth on the chelicera is of more importance, but must be used cautiously and at the most as a specific character, for I have found a specimen of *Trochosa purcelli* where one cheliceron differed in the number of its teeth from the other. The number of spines on the joints of the legs may not be greatly subject to individual variation, but in very closely related species it may differ, as *e.g.*, the spines of the ventral surface of tibia I in *Pardosa*. Characters of the relative position of the eyes are decidedly variable in different individuals of some species, apparently constant in some others. Again, some species, particularly of *Trochosa* and *Pirata*, show considerable secondary sexual structural differences. And the epigyna even, perhaps the best of any single structural character, are often variable in their form.

In the present paper I give descriptions of the structure of all those species seen by me, with figures of the genitalia in those cases where they have not been figured before or where the figures have been badly made, and descriptions of the color and dimensions only in the case of new species or where preceding descriptions were not detailed. Where such descriptions conflict with those of my previous papers, they are to be considered as emendations of the latter. In the measurements of the legs the coxæ are included; and by the term "height of the head in front" is meant the distance from the inferior margin of the clypeus to the superior border of the eyes of the second row. Only writers who have given descriptions are included in the synonymical list of each species. All the species previously described by me are described again, but in their structure much more in detail than before; also all the species described by Emerton (1885), except his *Lycosa nigroventris* and *Pirata insularis*, are described; and in the Keys all the species from the continent of North America described by Keyserling (1876) are included. No species have been considered from the North American continent south of the United States. With great care I have gone over again the previous descriptions of all the species from this region, but unfortunately the following papers were inaccessible to me: Banks (1894*a*), Blackwall (1846, 1871), Cragin, Giebel (1869), Girard (1854) and Thorell (1872). Doubtless on account of these missing papers some mistakes will be found to have crept into the identification of certain species.

My thanks are due to the Academy of Natural Sciences of Philadelphia, and to Mr. Witmer Stone in particular, for the loan of all of their type specimens; and especially to Mr. J. H. Emerton, who not only loaned me a considerable number of specimens, but also by correspondence aided me very materially in the question of the synonymy of certain species: thus he pointed out the identity of his *Pardosa brunnea*, *albomaculata* and *montana* with species described by Thorell; of my *Lycosa ocreata pulchra* with his *Pardosa bilineata*, and of my *Lycosa stonei* with the *Lycosa ocreata* of Hentz.

In regard to the genera I have employed, I must candidly admit that the delimitation of the genera was the most difficult part of the whole study. Simon (1898*a*) has withdrawn both *Trochosa* and *Pirata* into *Lycosa*, while I maintain their separateness, and this because these two genera intergrade no more closely with *Lycosa* than does *Pardosa*, so that if *Pardosa* is to be upheld, the others must likewise be. It is a question of either making one large comprehensive genus, and for purposes of description subdividing it into a number of subgenera, or of recognizing as many genera. In either case the boundaries of the groups, be they called subgenera or genera, are equally difficult to define. A new genus, *Geolycosa*, is proposed for forms which differ from *Lycosa* by the length and thickness of the first pair of legs. *Pardosa* is composed of rapidly running, usually or always diurnal species, of small size with great length of legs and large ocular area and small chelicera; they are essentially Lycosids which have become diurnal runners. *Geolycosa* is the very opposite, large forms with strong legs and jaws fitted for digging the deep cylindrical holes in which they live. Some of the species of *Pirata* are peculiar in forming small closed nests in which they pass the winter, little cups of silks attached to the under surface of stones. They are generally found close to water. The species of *Trochosa* are nocturnal, living under stones, where they apparently make no excavations. *Sosippus*, according to Simon, builds a large web-sheeting. *Aulonia* has the habits of *Pirata*, and is closely related to it. *Lycosa* is for the most part nocturnal, and many of the species build shallow excavations lined with silk under stones; others are, in the breeding season at least, diurnal, such as *scutulata* and *ocreata*, and these are forms which approach *Pardosa* in their structure. So we find that the structure corresponds pretty closely to the habit: long legs in the diurnal species, high cephalic region in the running and digging species, and low in the sedentary forms which do not form holes; weak chelicera and short labium associated with slender legs; large eye area is found in the diurnal species, while small eye area is associated with tubicolous forms and species with very short legs. So the genera here defined are based upon both morphological and ethological characters.

Finally, this paper is by no means a comprehensive monograph, but is intended to be a help to the one who comes later with sufficient material at his disposal to make the monograph.

Family **LYCOSIDÆ.**

Trochanters deeply emarginated below at their distal ends. Legs usually in the order IV, I, II, III. Inferior tarsal claw usually without teeth. Eyes homogeneous, usually unequal and in three rows, the eyes of the first generally smaller than the others. Palpal tibia of ♂ without apophyses.

Family **PISAURIDÆ.**

With the characters of the *Lycosidæ*, except that the palpal tibia of the ♂ has apophyses, that the inferior tarsal claws are usually toothed, that legs I, II and IV usually differ but little in length, and that the four posterior eyes are more nearly in a line.

Key to the North American Genera of Lycosidæ.

a. 1.—Tibia I with 5 ventral pairs of spines, eyes of the first row subcontiguous, ... Sosilaus.

a. 2.—Tibia I with 1–4 ventral pairs of spines, eyes of the first row not subcontiguous.

- *b.* 1.—Metatarsus IV in both sexes longer than the patella and tibia combined, eyes of the second row at least 1.5 times their diameter apart, sides of the head nearly or quite vertical, chelicera weak and nearly straight in front, dorsal eye area quite or almost one-quarter the length of the cephalothorax, ... Pardosa.
- *b.* 2.—Without such a combination of characters.
  - *c.* 1.—Posterior spinnerets fully 1.5 times as long as the anterior, chelicera weak with the anterior border nearly straight.
    - *d.* 1.—Posterior margin of the chelicera with 4 teeth, Sosippus.
    - *d.* 2.—Posterior margin of the chelicera with 2 or 3 teeth.
      - *e.* 1.—First eye row quite or almost as broad as the second, labium longer than broad, sides of head not vertical in the ♀, . . . Pirata.

e. 2.—First eye row shorter than the second, labium not longer than wide, sides of the head vertical, head projecting forward beyond the clypeus.

f. 1.—Metatarsus IV equal in length to the patella and tibia combined, dorsal eye area fully one-third the length of the cephalothorax, ... TRABÆA.

f. 2.—Metatarsus IV shorter than patella and tibia combined, dorsal eye area less than one-quarter the length of the cephalothorax, ... AULONIA.

c. 2.—Posterior spinnerets little or not longer than the anterior, chelicera usually robust with the anterior border arched.

d. 1.—Leg I shorter than IV by not more than one-half the length of tarsus I, and thicker than the other legs, ... GEOLYCOSA.

d. 2.—Leg I without such characteristics.

e. 1.—Cephalothorax highest at the middle and the sides of the head oblique, first eye row fully or almost as broad as the second, legs usually short with short spines, TROCHOSA.

e. 2.—Cephalothorax highest in the cephalic region, first eye row usually shorter than the second, legs usually long with long spines, LYCOSA.

Genus **SOSILAUS** Simon, 1898*a*.

I have not seen this genus, which was created by Simon for a species (*S. spiniger*) from Louisiana. His diagnosis is: "Cephalothorax postice convexus, antice longe declivis et attenuatus, facie sat angusta, obliqua atque obtusa. Oculi quatuor antici inter se subcontigui, in lineam leviter recurvam, medii lateralibus saltem duplo majores. Oculi ser. 2 mediocres, inter se appropinquati, spatium transversum oculorum linea antica multo angustius occupantes. Pars labialis longior quam latior, attenuata et obtusa. Pedes sat longi, metatarsis tarsisque tenuibus longis haud scopulatis, tibiis anticis aculeis pronis 5–5 metatarsis aculeis similibus 3–3 subtus armatis, aculeis que lateralibus minoribus munitis."

Genus **AULONIA** C. Koch, 1848.

Aulonia humicola (Montg.). Pl. XX, fig. 33.

Pirata humicolus Montgomery, 1902, 1903.
?*Pirata minutus* Emerton, 1885.

Numerous specimens from Pennsylvania and New Jersey.

Eyes.—First row shorter than the second on each side by the full diameter of one of its lateral eyes, its middle eyes slightly nearer to the lateral eyes than to each other, about double the size of the lateral and placed a little higher. Eyes of the second row very large, separated from each other by about four-fifths their diameter. Third eye row slightly wider than the second. Length of dorsal eye area to cephalothorax as 1 : 4.5. Quadrilateral of the posterior eyes broader than long.

Form.—Cephalothorax in front less than one-half its greatest transverse diameter, low and flattened above, highest just anterior to the middle, its posterior declivity describing an angle of 45° with its dorsal contour. Sides of head vertical. Chelicera with 3 pairs of teeth, shorter than the width of the clypeus, their length about 1.5 times the height of the head in front. Posterior spinnerets about 1.5 times as long as the anterior, with the terminal joint longer than wide. Labium about as broad as long, rounded apically. Metatarsus IV shorter than patella and tibia combined. Length of leg IV to cephalothorax (♀) as 3.4 : 1. The first two eye rows project forward beyond the clypeus. ♀ palpal claw with 6 fine teeth.

Comparisons.—This minute species agrees essentially with Simon's (1898*a*) diagnosis of *Aulonia*, except that the first row of eyes is less strongly procurved. It differs from *Pirata*, as I define it, in the sides of the head being vertical, and the labium being no longer than wide.

Genus **TRABÆA** Simon, 1876.

Trabæa aurantiaca (Emert.). Pl. XX, figs. 31, 32.

Aulonia aurantiaca Emerton, 1885.
Trabæa aurantiaca (Emerton), Simon, 1898.

(1 ♂ from Massachusetts, collected by Mr. Emerton.)

Eyes.—First row shorter than the second, eyes equal, middle eyes nearer to each other than to the lateral and higher than the latter. Eyes of the second row very large, on prominences, slightly less than their diameter apart. Third row slightly wider than the second, its eyes on prominences and directed backward. Dorsal eye area fully one-third the length of the cephalothorax. Quadrilateral of the posterior eyes as long as broad.

Form.—Cephalothorax in front truncated and almost one-half its greatest transverse diameter, the cephalic portion projecting forward beyond the clypeus, highest at the ocular area. The sides of the head vertical, head narrower at the clypeus than at the level of the eyes of the second row. Chelicera with 3 pairs of teeth (not 2 as stated by Simon, 1898*a*), slender and weak, their length less than the greatest height of the head, but greater than the width of the clypeus. Labium broader than long. Sternum longer than broad, pointed posteriorly. Posterior spinnerets about twice as long as the anterior. Tarsi without scopulæ; metatarsus IV as long as patella and tibia combined. Length of leg IV to cephalothorax as 4 : 1.

Comparisons.—This genus approaches both *Aulonia* and *Pardosa.*

Genus **PARDOSA** C. Koch, 1848.

The main distinguishing characters of this genus are those mentioned in the Key, namely: Metatarsus IV longer than patella and tibia combined; eyes of the second row at least 1.5 times their diameter apart; sides of the head more or less vertical; chelicera weak and nearly straight in front (their length not more than one and three-fifths times the height of the head in front, with 3 pairs of teeth); and the dorsal eye area quite or almost one-quarter the length of the cephalothorax. Further, the cephalothorax is always highest at the posterior eyes, and in front not more than one-half its greatest transverse diameter; and the legs are long and slender with long spines, the fourth leg never less than 4.2 times the length of the cephalothorax. and very frequently the legs are proportionately longer in the females than in the males (the reverse being the case in the other genera). The labium is small, not one-half the length of the maxillæ, and usually not longer than wide (except in *mercurialis, glacialis* and *groenlandica*). The posterior spinnerets are longer than the anterior, and the first eye row always shorter than the second. The ♂ palpal organ is usually very large. Tibia I has either 3 or 4 pairs of ventral spines.

The relationships of the genus are with *Trabæa* and *Lycosa.*

Key to Species of Pardosa.

a. 1.—Dorsal eye area more than one-quarter the length of the cephalothorax, cephalothorax less than 3 mm.
- *b.* 1.—Coxæ above without spots, middle eyes of the first row largest, ... *scita.*
- *b.* 2.—Coxæ above spotted with black, eyes of the first row adequal.
  - *c.* 1.—Median thoracal band much narrowed behind the dorsal groove, body dark colored, ... *minima.*
  - *c.* 2.—Median band of cephalothorax with nearly parallel margins, body pale colored, ... *pallida.*

a. 2.—Dorsal eye area not more than one-quarter the length of the cephalothorax.
- *b.* 1.—Cephalothorax from 3.8–5 mm. in length.
  - *c.* 1.—All the joints of the legs except the tarsi thickly covered with fine long hairs, ... *groenlandica.*
  - *c.* 2.—Hairs on the legs short, ... *glacialis.*

b. 2.—Cephalothorax from 2.2–3.5 mm. in length.
c. 1.—Sternum not darker than the coxæ, . . . *pauxilla.*
c. 2.—Sternum much darker than the coxæ.
d. 1.—Cephalothorax with distinct median and submarginal light bands.
e. 1.—Cephalothorax in front one-half its greatest transverse diameter, *flavipes* Keyserling.
e. 2.—Cephalothorax in front less than one-half its greatest transverse diameter.
f. 1.—Legs hairy, posterior half of abdominal dorsum with scattered light spots, *mercurialis.*
f. 2.—Legs with very few hairs, posterior half of abdominal dorsum with a row of 5–6 large transverse light spots, *nigropalpis.*
d. 2.—Cephalothorax without a light submarginal band, and with the median band indistinct.
e. 1.—Coxæ, trochanters and femora above darker than the other joints of the legs, *lapidicina.*
e. 2.—Coxæ, trochanters and femora not darker than the other joints of the legs, *tachypoda.*

Pardosa pauxilla n. sp. Pl. XIX, figs. 22, 23.

(Numerous males and females, Austin, Texas.)

Eyes.—First row nearer the second than the margin of the clypeus, shorter than the second, the middle eyes higher and twice as large as the lateral. Eyes of second row largest, about 1.75 times their diameter apart. Dorsal eye area one-fourth the length of the cephalothorax. Quadrilateral of the posterior eyes wider than long.

Form.—Cephalothorax in front truncated and not quite one-half its greatest transverse diameter, highest at the posterior eyes. The head is steep on the sides, proportionately much higher in the male. The chelicera are shorter than the width of the clypeus, weak, not more than 1.3 times the height of the head in front. Sternum longer than broad. Labium wider than long, apically rounded, less than one-half the length of the maxillæ. The legs are long and slender, leg IV to the cephalothorax, ♂ 4 : 1, ♀ 4.2 : 1; metatarsus IV longer than the patella and tibia combined. Posterior spinnerets fully 1.5 times the length of the anterior. ♀ palpal claw with 3 teeth. Four ventral pairs of spines on tibia I. ♂ palpus large, quite as long as the cephalothorax, tibia and tarsus thickened, two rows of long hairs on the inferior surface of the femur; tibia and tarsus with long hairs on the median and lateral aspects.

Dimensions.	♂	♀
Cephalothorax,	1.8	2 – 2.9
Abdomen.	2	2 – 3.5
Leg I,	5.5	6.3–10
Leg II,	5.4	5.5– 9.9
Leg III,	5	5.4– 9.2
Leg IV,	7	8.8–13

Color of Males (in alcohol).—*Cephalothorax* deep black in the eye region and forehead, this black becoming brown more posteriorly; a median yellow band arises at the dorsal groove and passes back (becoming gradually wider) to the posterior end of the thorax; on each side is a broad submarginal yellow band; the extreme margin is black. *Sternum* clear yellow, or suffused with black on its anterior half. *Abdomen* above deep black or brown. In light individuals there is a median yellow band, broadest anteriorly, extending the whole length of the dorsum, bordered anteriorly by four pairs of small black dots, and posteriorly banded by transverse lines of yellow wider than the band itself. In dark individuals the dorsum is deep black, with only a trace of the median band at the anterior end. Sides gray and the venter yellow in one specimen; in the others the venter is more or less blackish with a black mark at the genital aperture, and a broad median black band. *Chelicera, maxillæ* and *labium* deep black to yellowish. *Legs* clear yellow without rings, with more or less black on the first femora. *Palpi* deep black.

Color of Females (in alcohol).—*Cephalothorax* with the ocular region deep black and the forehead yellow. A median yellow band arises narrowly between the third eyes, shortly behind enlarges to a diameter somewhat less than the distance between these eyes, narrows again in front of the dorsal groove, enlarges again very slightly around this groove, and then passes back, becoming narrower, to the posterior end of the thorax. Medio-posteriorly from each eye of the third row a short brown line obliquely incises the median band. The median band is bordered on each side by a broader brown band transversed by radial lines of black. On each side is a broad submarginal yellow band, narrower than the contiguous brown band, which joins with its fellow of the opposite side below the anterior eyes. *Sternum* yellow like the coxæ, sometimes with indistinct darker marginal markings. *Abdomen* above quite variable, either (1) with a broad shining yellow median band along its entire length, containing in its anterior half a narrower greenish-yellow band terminating in a point at the middle, the latter band with four black spots on each margin; or (2) the greenish-yellow median band is not enclosed by a broader yellow one, and behind it is either a silvery (or yellowish) band with scalloped margins extending back to the spinnerets, or else a series of contiguous spots of one of these colors, each containing a pair of minute black dots. The median light area of the dorsum is bordered on each side by a broader black band, mottled with yellowish. The sides are gray or yellowish, streaked with black. Venter grayish-yellow, spinnerets clear yellow, epigynum reddish. *Chelicera, maxillæ* and *labium* yellowish. *Legs* yellow, distinctly ringed with black or brown on all joints except the tarsi. *Palpi* yellow, sometimes with black markings on the femora.

Comparisons.—This species approaches most nearly to *pallida* and *minima,* but differs from both in genitalia and coloration. The sexes are very dissimilarly colored, and sometimes show great differences in size.

Habits.—A common species, found always near water, the males abundant.

Pardosa mercurialis n. sp. Pl. XIX, figs. 20, 21.

(Numerous specimens from Austin, Texas.)

Eyes.—First row nearer the second than to the clypeal margin, straight, slightly shorter than the second, middle eyes largest, eyes equidistant. Eyes of second row largest, nearly twice their diameter apart. Third row widest, its eyes almost twice their diameter behind the second row. Dorsal eye area almost one-fourth the length of the cephalothorax. Quadrilateral of the posterior eyes slightly broader than long.

Form.—Cephalothorax in front not quite one-half its greatest transverse diameter, highest in the cephalic region, sides of head steep. Chelicera weak, longer than the width of the clypeus, with three pairs of teeth. Sternum longer than broad. Labium considerably less than one-half the length of the maxillæ, slightly longer than broad, rounded apically. Posterior spinnerets longest. Legs very long and slender, metatarsus IV longer than tibia and patella combined; length of leg IV to the cephalothorax, ♂ 4.8 : 1, ♀ 5.8 : 1. Tibia I with four ventral pairs of spines. ♀ palpal claw with three teeth.

Color of Females (in alcohol).—*Cephalothorax* above black in the eye area, followed by a broad reddish-yellow median band, which is constricted before the middle, enlarged to fully the diameter of the eye area around the dorsal groove (its widest portion), and narrowed to one-half that width behind the dorsal groove. There is a broad interrupted submarginal line of the same color, the region between these yellow bands being blackish. *Sternum* deep black, frequently with a median yellow band on its anterior half. *Abdomen* above intricately but distinctly patterned with black and greenish-yellow, as follows: on the anterior half of the dorsum is a broad median band, ending bluntly at the middle, yellow anteriorly and brown posteriorly and containing in its anterior portion a pair of short black stripes; behind this band are groups of small black dots on a yellow ground, the more posterior of them tending to form ill-defined transverse rows. The sides are yellow with black dots. The venter gray or yellow, blackish around the epigynum, sometimes with a narrow median blackish line that occasionally widens to form a spot in front of the spinnerets. *Chelicera* reddish-brown, *maxillæ* and *labium* lighter. *Legs* above distinctly banded with yellow and blackish on all the joints except the tarsi, the femora greenish below. *Palpi* yellowish.

Color of Males.—Like the females, but somewhat darker, and with the palpal tarsus black.

In life the markings are gray and black, making the animal very protectively colored; in alcohol the gray changes to yellow.

Dimensions.	♂	♀
Cephalothorax,	3	3.2
Abdomen,	3	4
Leg I,	11	13.5
Leg II,	10.5	13
Leg III,	10.2	13
Leg IV,	14.5	18.5

Comparisons.—This species comes closest to *lapidicina* Em., but is separable from it on account of the following characters: The posterior transverse plate of the epigynum is always much narrower, and the ♂ palpal organ with a large tooth not present in *lapidicina;* smaller absolute size, while the length of the legs is proportionately greater; the lighter coloring of the dorsal surface and the different abdominal pattern.

Habits.—The most abundant Lycosid in the vicinity of Austin, diurnal, and running with great swiftness. Usually found close to water.

Pardosa pallida Emerton.

Pardosa pallida Emerton, 1885.
Pardosa pallida Emerton, Montgomery, 1903.

(1 ♀ from Massachusetts.)

Eyes (♀).—First row straight, nearer the second row than to the margin of the clypeus, eyes adequal and equidistant. Eyes of second row largest, almost twice their diameter apart. Length of dorsal eye area to cephalothorax as 1: 3.75. Quadrilateral of the posterior eyes as long as wide.

Form (♀).—Cephalothorax highest at the posterior eyes, in front truncated and almost one-half its greatest transverse diameter, the sides of the head steep. Chelicera with 3 pairs of teeth, weak, as long as the width of the clypeus, their length 1.5 times the height of the head in front. Labium wider than long, apically truncated, not one-half the length of the maxillæ. Sternum longer than broad, truncated behind. Posterior spinnerets nearly double the length of the anterior. Metatarsus IV longer than the patella and tibia combined; leg IV to the cephalothorax as 4.4 : 1; tibia I with 3 pairs of ventral spines.

Pardosa lapidicina Emerton. Pl. XIX, fig. 24.

Pardosa lapidicina Emerton, 1885.
Pardosa lapidicina Emerton, Montgomery, 1903.

(Specimens from Wood's Hole, Massachusetts.)

Eyes.—First row shorter than the second, straight, equidistant from the second row and the clypeal margin, the middle eyes larger and nearer to the lateral eyes than to each other. Eyes of the second row largest, twice their diameter apart. Length of the dorsal eye area to the cephalothorax as 1 : 4.5. Quadrilateral of the posterior eyes decidedly broader than long.

Form.—Cephalothorax highest at the posterior eyes, in front truncated and less than one-half its greatest transverse diameter, the sides of the head moderately steep. Chelicera with 3 pairs of teeth, shorter than the width of the clypeus, in length 1.75 times the height of the head in front. Labium a little longer than wide, not one-half the length of the maxillæ, slightly rounded apically. Sternum longer than broad. Posterior spinnerets longest. Metatarsus IV longer than the patella and tibia combined; length of leg IV to cephalothorax, ♂ 4.5 : 1, ♀ 5 : 1. ♀ palpal claw with 3 teeth. Tibia I with 4 ventral pairs of spines.

Pardosa scita Montg.

Pardosa scita Montgomery, 1902.

(Specimens from Pennsylvania.)

Eyes.—First row narrower than the second, much nearer the second row than to the margin of the clypeus, straight, middle eyes larger, eyes equidistant. Eyes of second row largest, twice their diameter apart. Length of dorsal eye area to cephalothorax as 1 : 3.5. Quadrilateral of the posterior eyes slightly broader than long.

Form.—Cephalothorax highest at the posterior eyes, in front truncated and less than one-half its greatest transverse diameter. Chelicera with 3 pairs of teeth, weak, nearly straight in front, shorter than the width of the clypeus, in length 1.3 the height of the head in front. Labium broader than long, apically rounded, not one-half the length of the maxillæ. Sternum longer than broad. Posterior spinnerets nearly 1.5 times the length of the anterior. Length of leg IV to cephalothorax, ♂ 5 : 1; metatarsus IV longer than patella and tibia combined. Tibia I with 4 ventral pairs of spines.

Pardosa minima (Keys.).

Lycosa minima Keyserling, 1876.
Pardosa albopatella Emerton, 1885.
Pardosa albopatella Emerton, Stone, 1890.
Pardosa minima (Keys.), Montgomery, 1902.

(Specimens from Pennsylvania and Massachusetts.)

Eyes (♂).—First row narrower than the second, straight, slightly nearer the second row than to the margin of the clypeus, middle eyes nearer the lateral than each other. Dorsal eye area to cephalothorax as 1 : 3.5. Quadrilateral of the posterior eyes broader than long. Eyes of the second row largest, separated by 1.75 times their diameter.

Form (♂).—Cephalothorax highest at the posterior eyes, in front truncated and less than one-half its greatest transverse diameter, sides of head steep. Chelicera with 3 pairs of teeth, shorter than the width of the clypeus, in length 1.5 times the height of the head in front. Labium at the base as wide as long, truncated apically, not one-half the length of the maxillæ. Sternum longer than broad. Posterior spinnerets longest. Length of leg IV to cephalothorax as 4.3 : 1; metatarsus IV longer than patella and tibia combined. Tibia I with 4 ventral pairs of spines.

Comparison.—This species is most closely related to *nigropalpis.* The ♂ of *minima* can be readily distinguished from that of *nigropalpis* in having the palpal patella entirely white instead of deep black, in the different coloration of the legs, and in the difference in size of the eye area. But the females of the two are much more difficult to distinguish, and there is no good structural difference in the structure of the epigyna. In the ♀ of *minima* it is the usual case that the palpal patella has no dark spots below (they are usually present in *nigropalpis*); the sternum is brown (never deep black) with a yellow median line anteriorly and a broader black one posteriorly and with some black on the margins (in *nigropalpis* in the majority of specimens deep black with a yellow median line anteriorly); the femora below usually yellow spotted with black (in *nigropalpis* usually blackish); finally the cephalothoracal median yellow band usually encloses a broad reddish-brown area at its anterior end (usually not so in *nigropalpis*). Of all these differences the only one that appears to be constant is the first. *Minima* averages smaller in size, but then *nigropalpis* is very variable in this respect; and *nigropalpis* has generally the dark annulations on the legs much more distinct, but some individuals of *minima* from Wood's Hole, Massachusetts, have the legs just as distinctly banded.

Pardosa glacialis (Thor.). Pl. XIX, fig. 25

Lycosa glacialis Thorell, 1872.
Pardosa brunnea Emerton, 1885.

(Specimens from Mt. Washington, New Hampshire.)

Eyes.—First row narrower than the second, nearer to the second row than the clypeal margin, middle eyes larger and distinctly lower. Eyes of second row largest, separated by fully 1.5 times their diameter. Dorsal eye area to cephalothorax as 1 : 4.5. Quadrilateral of the posterior eyes broader than long.

Form.—Cephalothorax highest at the posterior eyes, in front less than one-half its greatest transverse diameter, sides of head rather vertical. Chelicera with three pairs of teeth, longer than the breadth of the clypeus, in length 1.5 times the height of the head in front. Labium longer than broad, rounded at the tip, not one-half the length of the maxillæ. Sternum longer than broad, pointed behind. Posterior spinnerets about 1.5 times as long as the anterior. Metatarsus IV slightly longer than patella and tibia combined, leg IV to cephalothorax as 4.3 : 1, the legs rather hairy with weak scopulæ. ♀ palpal claw with 4 teeth. Tibia I with 3 ventral pairs of spines.

Pardosa groenlandica (Thor.).

Lycosa groenlandica Thorell, 1872.
Pardosa albomaculata Emerton, 1885.

(Specimens from Mt. Washington, New Hampshire.)

Eyes.—First row shorter than the second, much nearer to it than to the clypeal margin, about straight, eyes adequal. Eyes of the second row largest, about 1.5 times their diameter apart. Dorsal eye area to length of cephalothorax as 1 : 4.5. Quadrilateral of the middle eyes broader than long.

Form.—Cephalothorax highest at the posterior eyes, in front one-half its greatest transverse diameter, sides of the head steep. Chelicera with 3 pairs of teeth, in length more than the width of the clypeus and 1.5 times the height of the head in front. Labium longer than broad, truncated apically, not one-half the length of the maxillæ. Sternum longer than broad, pointed behind. Metatarsus IV longer than the patella and tibia combined. Leg IV to cephalothorax as 4.4 : 1. Posterior spinnerets 1.5 times the length of the anterior. ♀ palpal claw with 5 teeth. The legs and upper surface of the body are thickly clothed with long, soft hairs. Tibia I with 3 ventral pairs of spines.

Pardosa tachypoda Thor. Pl. XIX, fig. 26.

Pardosa tachypoda Thorell, 1872.
Pardosa montana Emerton, 1885.
Pirata procursus Montgomery, 1902.

(1 ♀ from Mt. Washington, New Hampshire.)

Eyes (♀).—First row shorter than the second and nearer it than to the clypeal margin, eyes adequal, middle eyes distinctly lower. Eyes of second row largest, about 1.6 their diameter apart. Length of dorsal eye area to cephalothorax as 1 : 4.2. Quadrilateral of the posterior eyes broader than long.

Form (♀).—Cephalothorax highest at the posterior eyes, in front decidedly less than one-half its greatest transverse diameter, sides of the head rather oblique. Chelicera with 3 pairs of teeth, as long as the width of the clypeus, rather strong. Sternum longer than broad, pointed behind. Posterior spinnerets longer than the anterior. Labium wider than long, rounded apically, not one-half the length of the maxillæ. Third leg as long as the first; metatarsus IV longer than patella and tibia combined; leg IV to cephalothorax as 4.4 : 1.

Pardosa nigropalpis Emerton.

Pardosa nigropalpis Emerton, 1885.
Pardosa nigropalpis Emerton, Stone, 1890.
Pardosa nigropalpis Emerton, Montgomery, 1902.

(Numerous specimens from Pennsylvania, Massachusetts, New Jersey and Austin, Texas.)

Eyes.—First row shorter than the second, straight, nearer it than to the margin of the clypeus, middle eyes slightly larger and nearer the lateral eyes than to each other. Eyes of second row largest, 1.5 times their diameter apart. Dorsal eye area one-fourth the length of the cephalothorax. Quadrilateral of the posterior eyes broader than long.

Form.—Cephalothorax highest at the posterior eyes, in front truncated and less than one-half its greatest transverse diameter. Sides of the head steep. Chelicera with 3 pairs of teeth, weak, nearly straight anteriorly, shorter than the width of the clypeus and 1.3 times the height of the head in front. Labium shorter than broad, rounded apically, not one-half the length of the maxillæ. Sternum longer than broad, pointed behind. Posterior spinnerets fully 1.5 times the length of the inferior. Length of leg IV to cephalothorax, ♂ 4.5 : 1, ♀ 5 : 1.

Metatarsus IV longer than patella and tibia combined. Tibia I with 4 ventral pairs of spines. ♀ palpal claw with 1 small tooth.

Comparisons.—This species comes very close to *Lycosa* (*Pardosa*) *flavipes* Keyserling, and appears to differ from it mainly in that the leg IV is not longer than I by double the length of metatarsus IV. Compare also *P. minima.*

The Texas specimens are lighter than the northern ones, and the venter is often without black markings.

Genus **SOSIPPUS** Simon, 1888.

The North American species of this genus described by Simon (*S. floridanus*) has not been seen by me. The posterior spinnerets are longer than the anterior, with the apical joint as long or almost as long as the basal and garnished with fusules on its inner surface; the labium is longer than wide and quite one-half the length of the maxillæ; the posterior margin of the chelicera has 4 teeth. The face is vertical only in the plane of the anterior eyes. The legs are long, the anterior tarsi and metatarsi usually scopulated, metatarsus IV as long as the patella and tibia combined. First row of eyes broader than the second, the lateral eyes as large or larger than the middle ones. The integument is covered with plumed hairs. The sides of the head are nearly vertical.

Evidently this genus is most closely allied to *Pirata.* They spin a large web like that of an *Agalena.*

Genus **LYCOSA** Latreille, 1804 (ad partem).

I have followed Simon (1898) in defining this genus, except that I have excluded from it *Pirata* and *Trochosa.*

The main characters are the following: The cephalothorax is highest in the cephalic portion (except in the ♂ of *charonoides*), and the sides of the head usually only moderately oblique; the first eye row is shorter than the second (except in *inhonesta* and in the ♂ of *charonoides*); the eyes of the second row are never separated by more than 1.5 times their diameter; the chelicera are robust and their length is usually quite twice the height of the head in front (except in the Pardosoid species *bilineata, relucens* and *ocreata*); the posterior spinnerets are shorter, or but little longer, than the anterior (*antelucana, mccooki, scutulata*); tibia I has 3 pairs of ventral spines; the labium is shorter than one-half the length of the maxillæ, but longer than wide (except in *bilineata* and *scutulata*); metatarsus IV is shorter than the patella and tibia combined (except in the ♂ of *scutulata, antelucana* and *ocreata*). The length of the dorsal eye area to the cephalothorax varies from 1 : 4.5 to 1 : 7. The length of leg IV to the cephalothorax from 2.7 : 1 to 4.7 : 1. The legs are usually well scopulated.

Lycosa intergrades very closely with *Pardosa,* and the species *bilineata, relucens, ocreata* and *scutulata* are quite intermediate. The relationship with *Trochosa* is equally close. More remote are the relations to *Pirata,* yet *P. elegans* has a number of Lycosoid characters.

Key to Species of Lycosa.

a. 1.—Abdomen above with a distinct, broad dark median band extending its entire length.
- *b.* 1.—Sternum black, ... *punctulata.*
- *b.* 2.—Sternum yellow, ... *scutulata.*

a. 2.—Abdomen not so colored.
- *b.* 1.—Cephalothorax smooth, without hairs, not more than 2.5 mm. long.
  - *c.* 1.—Eyes of the second row about 1.3 times their diameter apart, venter brown, ... *nigra.*
  - *c.* 2.—Eyes of the second row not quite their diameter apart, venter yellow with a few brown spots, *rugosa* Keyserling.
- *b.* 2.—Cephalothorax haired, more than 2.5 mm. long.
  - *c.* 1.—Cephalothorax with a very narrow median light band, *inhonesta.*
  - *c.* 2.—Cephalothorax with a broad median band.
    - *d.* 1.—Cephalothorax 5 mm. or more in length.
      - *e.* 1.—Eyes of the second row fully 1.5 times their diameter apart, ... *pictilis.*
      - *e.* 2.—Eyes of the second row about their diameter apart.
        - *f.* 1.—Cephalothorax less than one-quarter longer than broad, *pulchra* Keyserling.
        - *f.* 2.—Cephalothorax decidedly more than one-quarter longer than broad.
          - *g.* 1.—Legs not annulated, abdomen with a dorso-median light band extending its entire length and including a dark band in its anterior half, *lepida.*
          - *g.* 2.—Legs distinctly annulated, abdomen not so colored.
            - *h.* 1.—Median band of the cephalothorax not or scarcely constricted anterior to the median groove, . . . *mccookii.*
            - *h.* 2.—Median band of the cephalothorax deeply constricted anterior to the median groove.
              - *i.* 1.—Venter light, *euepigynata.*

i. 2.—Venter black.

j. 1.—Legs pale yellow, first pair not annulated, *antelucana.*

j. 2.—Legs deep brown, all pairs clearly annulated with black, *insopita.*

d. 2.—Cephalothorax less than 5 mm. long.

e. 1.—Eyes of the second row only one-half their diameter apart, . . *modesta* Keyserling.

e. 2.—Eyes of the second row quite 1.5 times their diameter apart.

f. 1.—Sides of the cephalothorax yellow, submarginal band very distinct, sternum not darker than the legs, . *bilineata.*

f. 2.—Sides of cephalothorax black or blackish, submarginal band indistinct, sternum darker than the legs.

g. 1.—Legs distinctly banded, dorso-median band of the cephalothorax constricted at its middle, *ocreata.*

g. 2.—Legs not distinctly banded, dorso-median band of the cephalothorax not constricted at its middle, *relucens.*

e. 3.—Eyes of the second row about their diameter apart.

f. 1.—Metatarsus IV fully as long or longer than patella and tibia combined.

g. 1.—Cephalothorax in front little more than one-third its greatest transverse diameter, almost one-third longer than broad, venter yellowish with small brown spots, *rufa* Keyserling.

g. 2.—Cephalothorax in front almost one-half its greatest transverse diameter, one-quarter longer than broad, venter reddish with an indistinct dark spot surrounding the epigynum and extending to the middle, . *xerampelina* Keyserling.

f. 2.—Metatarsus IV shorter than patella and tibia combined.

g. 1.—Legs distinctly annulated, cephalothorax 3.3 mm. long, *mackenziana* Keyserling.

g. 2.—Legs not annulated, cephalothorax 4.3 mm. long, . . . *charonoides.*

Lycosa euepigynata n. sp. Pl. XVIII, figs. 1, 2.

(Numerous specimens from Austin, Texas.)

Eyes.—First row equidistant from the clypeal margin and the second row, shorter than the second (the middle points of its lateral eyes fully or almost as lateral as the middle points of the lateral eyes of the second row), its middle eyes higher than and double the size of the lateral. Eyes of second row largest, not quite their diameter apart. Eyes of third row about one and a half times their diameter behind the second row. Dorsal eye area about one-fifth the length of the cephalothorax. Quadrilateral of the posterior eyes broader than long.

Form.—Cephalothorax in front truncated nearly straight and in the ♀ about one-half its greatest transverse diameter (less in the ♂), highest between the posterior eyes and the dorsal groove. Sides of head steep. Chelicera longer than the width of the clypeus, about 1.75 times the height of the head in front, with 3 pairs of teeth. ♀ palpal claw with 4 teeth. Sternum longer than broad. Labium longer than broad, truncated apically, not one-half the length of the maxillæ. Anterior spinnerets longest. Legs rather slender, metatarsus of IV shorter than patella and tibia. Length of leg IV to cephalothorax, ♂ 4.1 : 1, ♀ 3.5 : 1.

Dimensions.	♂	♀
Cephalothorax,	6.5	7.3
Abdomen,	7	10
Leg I,	22	21.5
Leg II,	20	19.8
Leg III,	19]	19
Leg IV,	26	26

Color (in alcohol).—*Cephalothorax* with a broad median buff band arising at the posterior eyes and extending back (becoming gradually broader) to just in front of the middle of the dorsum where it is as broad as the eye area; just in front of the dorsal groove it is deeply incised laterally, it expands around this groove (where it is broadest), it is notched behind the groove and from there continues back as a narrower band; this band usually contains two pairs of minute black spots in its anterior third. On each side of this median band is a deep brown or blackish band, in its middle wider than the median band and with lobed lateral margins; the posterior sides of the median band are edged with deep black. Each cheek has a buff submarginal mark, and the sides of the thorax have large submarginal marks of the same color and of irregular shape, separated by lines of blackish radiating from the dorsal groove. The anterior eye area is black; the extreme margin of the thorax blackish. *Sternum* yellowish or reddish-brown, darker than the coxæ. *Abdomen* above deep brown or reddish-brown, on its anterior half a slightly darker median band which is widest at its anterior end, has a pair of short lateral diverticula at its middle, and terminates posteriorly in a transverse arc. On the posterior dorsum is a series of four transverse arches, which become posteriorly successively smaller, each in its anterior portion of the same color as the median band, but posteriorly narrowly edged with whitish. At each antero-lateral margin of the dorsum is a black mark of a U-shape, with the bend of the U directed medio-anteriorly, and on a line with each of these marks a row of four to six black spots which extend on each side of the dorsum back to the spinnerets; the first two of these spots are largest and always the most conspicuous, and sometimes all the spots of one line are connected so as to form a broken, longitudinal black line. The sides are deep brown mottled with spots of the same color as the median band. The venter has a band of yellowish extending from the epigastric slit to the spinnerets, which is in front almost as broad as the lung area but behind becomes slightly narrower; within this light band are two parallel longitudinal rows of small blackish spots, most distinct on the anterior half of the venter, and never extending back quite as far as the spinnerets. *Epigynum* deep reddish-brown. Spinnerets chocolate-brown. *Chelicera* deep reddish-brown or black, with black and white hairs, the macula pale red; *maxillæ* and *labium* lighter with yellowish tips. *Legs* distinctly banded above, less distinctly below, with black and buff on the femora, patellæ blackish proximally and buff distally, tibiæ blackish at the ends and buff at the middle, tarsi and metatarsi blackish.

Comparisons.—Cf. *L. insopita.*

Habits.—Abundant near Austin, under stones near water. The males most numerous in January.

Lycosa insopita n. sp. Pl. XVIII, figs. 3, 4.

(Numerous specimens of both sexes from Austin, Texas.)

Eyes.—First row narrower than the second, but the middle points of its lateral eyes more lateral than the middle points of the eyes of the second row, nearer the second row than the clypeal margin, its middle eyes higher and larger than the lateral. Eyes of the second row largest in the ♀, slightly more than their diameter apart, not quite in the ♂. Third row widest, its eyes slightly more than their diameter behind the second row. Dorsal eye area less than one-fifth the length of the cephalothorax. Quadrilateral of the posterior eyes distinctly wider than long.

Form.—Cephalothorax in front truncated nearly straight, about one-half its greatest transverse diameter, highest at the posterior eyes (in the ♂ behind the middle), sides of the head steep. Chelicera longer than the clypeus wide, about 2.5 the height of the head in front, with three pairs of teeth. Sternum longer than broad. Labium longer than broad, more than one-half the length of the maxillæ, slightly concave apically. Spinnerets equal in length. Legs short, leg IV to cephalothorax in ♂ 3.6 : 1, in ♀ 3.2 : 1. ♀ palpal claw with 6 teeth.

Dimensions.	♂	♀
Cephalothorax,	7.3	8
Abdomen,	6	10
Leg I,	24	22
Leg II,	22	20.5
Leg III,	20	20
Leg IV,	26.5	25.5

Color of ♀ (in alcohol).—*Cephalothorax* above dark reddish-brown, with a median paler red band arising at the second eye row, enlarging behind the eye area to a width equal to that of the second eye row, constricted deeply a little before the middle, enlarging again (to its greatest diameter) around the dorsal groove where its margins are dentated, and behind this groove terminating very narrow. There is a broad, interrupted submarginal band of the same color on each side. *Sternum* deep reddish-brown like the ventral surface of the coxæ. *Abdomen* above with a large black spot at the anterior end on each side of the mid-line, and from each of these spots a blackish, interrupted band passes back along the margin of the dorsum almost to the spinnerets; in the mid-line a series of five triangular and contiguous black markings, decreasing in size posteriorly, and the most anterior placed just anterior to the middle; the remainder of the dorsum is purplish-gray with minute black spots. The sides are finely mottled with purple-gray and brown; the whole venter black spotted laterally with brown, lung-books orange, *epigynum* deep reddish-brown, *spinnerets* brown. *Chelicera* black, *labium* and *maxillæ* the same but with light tips. *Legs* above and below distinctly annulated on all joints with black and yellowish. *Palpi* colored like the legs.

Color of ♂.—Like the ♀, except that the whole venter is black (with the exception of the lung-books); and that the abdominal dorsum has on each margin a broad band of black extending its entire length, the area between these brands being gray with transverse lines of black in its posterior half.

Comparisons.—This species comes closest to *L. euepigynata*, but differs from it in slightly shorter relative length of legs, in greater relative width of cephalothorax (in *insopita* less than one-quarter longer than broad, in *euepigynata* decidedly more than one-quarter), in the dark coloration of the venter, and in the structure of the genitalia. It differs also from *L. purcelli*, the epigynum of which is very similar, in the slightly greater relative length of the legs, in greater size, and markedly in the coloration.

Habits.—Less abundant than the preceding, and found in drier localities. They live under stones, where the female makes a shallow horizontal burrow lined with silk.

Lycosa antelucana n. sp. Pl. XVIII, figs. 5, 6.

(Numerous specimens from Austin, Texas.)

Eyes.—First row almost upon the clypeal margin, shorter than the second (but middle points of its lateral eyes as far lateral as middle points of eyes of the second row), its eyes equidistant, with the middle eyes decidedly larger and slightly higher than the lateral. Eyes of second row largest, almost or wholly their diameter apart. Third row little broader than the second, its eyes about 1.5 their diameter behind that row. Dorsal eye area about one-fifth the length of the cephalothorax. Quadrilateral of the posterior eyes nearly as long as broad.

Form.—Cephalothorax slender, in front truncated in ♂ and somewhat rounded in ♀, fully one-half its greatest transverse diameter (♀) or less (♂), highest at the posterior eyes with the sides of the head steep. Chelicera fully 2.3 times the height of the head in front, in the ♀ shorter than the width of the clypeus, with 3 pairs of teeth. Sternum longer than broad. Labium longer than broad, less than one-half the length of the maxillæ, apically truncated. ♂ palpal organ relatively small. Posterior spinnerets slightly longer than the anterior. Length of leg IV to cephalothorax, ♂ 4.1 : 1, ♀ 3.2 : 1. In the ♂, but not the ♀, the metatarsus IV is slightly longer than the patella and tibia combined. ♀ palpal claw with 4 teeth.

Dimensions.	♂	♀ ♀
Cephalothorax,	6.8	6.5– 8.5
Abdomen,	6.5	6.5–11
Leg I,	22.5	16.5–23
Leg II,	21	16 –21.5
Leg III,	20.5	15.5–20
Leg IV,	28	21 –29

Color of Females (in alcohol).—*Cephalothorax* pale brown, with a median buff stripe (white at its anterior end) arising as a narrow band in the eye area, enlarging between this region and the dorsal groove, largest around the dorsal groove (where its greatest diameter about equals the width of the eye area), and narrowed again behind the dorsal groove. To each side of the anterior part of this band, parallel to it and median to each eye of the third row, is a much narrower buff line. From the dorsal groove deep brown lines radiate to a submarginal, dentated buff band. *Sternum* black. *Abdomen* above with a black-edged, brown median band which terminates bluntly about the middle of the dorsum and is laterally dentate; behind this band are three or four transverse arches, each blackish anteriorly and whitish posteriorly, and between these arches are black spots in transverse rows; the rest of the dorsum is yellowish spotted and streaked with dark brown. The sides are buff, the whole venter deep black. *Epigynum* reddish-black. *Chelicera, labium* and *maxillæ* deep blackish-red. *Legs* above yellowish, femora I and II with an indistinct darker longitudinal band on the median side, femora III and IV spotted with brownish, fourth pair of legs with a black ring at ench end of the tibia and at the distal end of the metatarsus, these black markings being much more distinct on the ventral surface. Ventral surface of the coxæ brownish-yellow or deep black.

One female (the largest obtained) differed in coloration as follows: Cephalothorax chocolate-brown with the cheeks pale buff, this buff extending back as a narrow submarginal band to about the end of the anterior third of the cephalothorax, and succeeded by three to four indistinct buff spots.

Color of Males (in alcohol).—Differ from the females in that the median stripe on the abdominal dorsum is much more distinct, and with a buff band contiguous to each side of it. Sternum, labium, maxillæ and inferior surface of coxæ chocolate-brown.

Comparisons.—This species comes closest to *L. inhonesta* (Keys.), from which it differs: (1) In the first row of eyes being upon the clypeal margin; (2) in the head being relatively lower at the second row of eyes; (3) in the head of the female being rounded in front; (4) in the color of the abdominal dorsum; and (5) to some extent in the genitalia.

Habits.—Under stones, common in the autumn, but none found in the winter.

Lycosa mccooki n. sp. Pl. XVIII, fig. 11.

(Two females from Austin, Texas. Dedicated to Dr. Henry C. McCook, the eminent describer of the spinning habits of spiders.)

Eyes.—First row equidistant from the clypeal margin and the second row, its eyes adequal and its middle eyes decidedly higher, shorter than the second row. Eyes of second row much the largest, less than their diameter apart. Third row widest, its eyes nearly twice their diameter behind the second row. Dorsal eye area almost one-quarter the length of the cephalothorax. Quadrilateral of the posterior eyes broader than long. Third row scarcely wider than the second.

Form.—Cephalothorax in front about one-half its greatest transverse diameter, highest at the posterior eyes, sides of the head steep. Chelicera with three pairs of teeth, longer than the clypeus wide, their length barely 1.75 times the height of the head in front. Sternum longer than broad. Labium longer than wide, concave apically, about one-half the length of the maxillæ. Posterior spinnerets longest. Leg IV to cephalothorax as 4.2 : 1, its metatarsus shorter than the patella and tibia combined. Palpal claw with 4 teeth.

Dimensions.

Cephalothorax,	5
Abdomen,	5
Leg I,	15.5
Leg II,	15
Leg III,	15
Leg IV,	21

Color (in alcohol).—*Cephalothorax* brown or blackish, white between the eyes of the second row and a white line below each of these eyes. A median buff or reddish-brown band, almost as broad as the eye area, extends from the eye region along the whole length of the cephalothorax and is slightly constricted anterior to the dorsal groove. There is a narrow, undulating, buff submarginal band, and the extreme margin is black. *Sternum* brown or black, darker than the coxæ. *Abdomen* without a median band, a large whitish or pale yellow spot covers almost the anterior third of the dorsum, and behind it on the dorsum are 5–6 pairs of smaller spots of the same color, the posterior ones appearing as transverse stripes due to the confluence of their component spots; each row of these light markings is bordered laterally by a broad black stripe. Sides mottled with black or gray. Venter black in one specimen, mottled black and yellowish in the other. *Epigynum* yellow. *Chelicera* deep reddish-black, *labium* the same color with yellowish tip, *maxillæ* reddish-brown or yellowish. *Legs* with femora banded distinctly with brown and buff, and (most distinctly on the anterior pairs) with a longitudinal brown band on the posterior surface; the posterior two pairs with the tibia blackish at the ends and yellow in the middle, the metatarsi yellow at the ends and blackish in the middle; each coxa below with an elongate yellow spot proximally.

Comparisons.—Most nearly related to *L. pictilis*, but they differ noticeably in epigynum and coloration.

Lycosa nigra Stone. Pl. XX, figs. 40, 41.

Lycosa nigra Stone, 1890.
Lycosa nigra Stone, Montgomery, 1902.

(Of this species, hitherto known only by the ♀, an adult ♂ and ♀ were loaned to me by Mr. J. H. Emerton, collected in Long Island, New York.)

Eyes.—First row shorter than the second, equidistant from the second row and the clypeal margin, straight, eyes equidistant, middle eyes slightly larger. Eyes of second row largest, almost 1.5 times their diameter apart. Eyes of third row fully twice their diameter behind the second row, this row scarcely broader than the second in the ♂, distinctly broader in the ♀. Dorsal eye are to length of cephalothorax as 1 : 4.75. Quadrilateral of the posterior eyes as broad as long in the ♂, broader than long in the ♀.

Form.—Cephalothorax in front rounded, almost one-half its greatest transverse diameter in the ♀, not one-third this width in the ♂, highest at the posterior eyes, sides of the head almost vertical in the ♂, more oblique in the ♀. Labium distinctly longer than broad, narrow, not quite one-half the length of the maxillæ, its sides almost parallel, obliquely truncated at the tip. Chelicera in length almost twice the height of the head in front, rather weak but arched anteriorly. Sternum large, much longer than broad, continued between the posterior coxæ. ♂ palpus almost as long as the cephalothorax. Legs rather stout, short, without scopulæ, with very few hairs and short spines. Anterior spinnerets longest. Leg IV to cephalothorax, 3.1 : 1; metatarsus IV shorter than patella and tibia combined.

Dimensions.	♂	♀
Cephalothorax,	2.3	2.3
Abdomen,		2.8
Leg I,		5
Leg II,		4.5
Leg III,		4.3
Leg IV,	7.3	7.2

Color of Female (in alcohol).—Cephalothorax uniform shining black, hairless, with a reddish tone, clypeal margin a little lighter. *Sternum* the same color, also hairless. *Abdomen* above greenish-brown with a median yellow band on the anterior third, this band pointed at both ends and narrowly edged with blackish; to each side of the mid-line is a row of about 6 small spots, the posterior ones connected by narrow transverse lines of the same color. The sides are greenish-brown, flecked ventrally with yellow. Venter yellow with a median and a pair of closely approximated lateral blackish, longitudinal bands which converge as they pass caudad, but are separated from the spinnerets by an area of the same color as the sides; the lateral dark bands diverge around the epigynum and at some distance from it, but unite anteriorly close to the peduncle. *Chelicera* dark reddish-black with few hairs, *labium* the same color with yellow tip, *maxillæ* brownish. *Legs* with the femora black (except for a yellow spot on the distal anterior surface of the first pair); coxæ and trochanters blackish above but lighter below; the other joints light yellow, patellæ and tibiæ of the first three pairs blackish below, fourth pair with the patella blackish below and the tibia with a blackish ring at each end and extending to the dorsal surface. *Palpi* with femora black, other joints yellow with some blackish ventrally.

Color of Male (in alcohol).—*Cephalothorax* hairless, shining dark brown, a black stripe between the second and third eyes of each side. *Sternum* shining brown. *Abdomen* above with the median band bordered with small black dots, and enclosed in a broader bright yellow area which in its posterior two-thirds contains on each side a row of about 7 small black spots, each row more lateral than the median band, and the two rows meeting at the spinnerets. The sides are blackish, flecked with yellow. The venter is like that of the female, but the median dark band is lacking. *Legs* with femora darkest, these being greenish-brown, as are the trochanters; coxæ yellow proximally; the other joints pale yellow without dark markings. *Palpi* greenish, the ventral surface of the patella and the distal end of the tarsus yellow.

Comparisons.—This species is to be distinguished from *L. rugosa* (Keys.), another small species with hairless cephalothorax, in the structure of the palpal organ; in the wide separation of the eyes of the second row; in the chelicera being considerably longer than the first patellæ and arched in front; and in the different color of the abdominal venter. Hentz's *L. funerea* may be one of these species, but his description and figure gives so insufficient a diagnosis that it is doubtful whether *funerea* can ever be recognized with certainty.

Lycosa charonoides Montg.

Lycosa charonoides Montgomery, 1902, 1903.

(Specimens from Pennsylvania.)

Eyes.—First row as broad as the second (♂) or shorter (♀), straight, nearer the clypeal margin than to the second row, middle eyes not quite double the size of the lateral. Eyes of second row largest, their diameter apart (♂) or slightly more (♀). Length of the dorsal eye area to the cephalothorax, ♂ 1 : 6, ♀ 1 : 5.5. Quadrilateral of the posterior eyes broader than long.

Form.—Cephalothorax highest behind the middle (♂) or equally high there and at the posterior eyes (♀), its posterior declivity abrupt and steep, in front truncated straight and less than one-half its greatest transverse diameter. Chelicera with 3 pairs of teeth, longer than the width of the clypeus, their length fully twice the height of the head in front. Labium longer than broad, truncated apically, not one-half the length of the maxillæ. Sternum longer than broad, with few hairs, pointed posteriorly. Leg IV to cephalothorax, ♂ 3.5 : 1, ♀ 3.8 : 1; metatarsus IV shorter than patella and tibia combined. ♀ palpal claw with 3 teeth.

Lycosa lepida (Keys.).

Tarentula lepida Keyserling, 1876.
Lycosa communis Emerton, 1885.
Tarentula lepida Keys., Marx, 1889.
Lycosa communis Emerton, Stone, 1890.
Lycosa lepida (Keys.), Montgomery, 1902, 1903.

(Numerous specimens from Pennsylvania, New Jersey, Massachusetts, Texas.)

Eyes.—First row nearer to the clypeal margin than to the second row, its eyes equidistant, middle eyes larger and slightly higher. Eyes of the second row largest, more than their diameter apart. Length of dorsal eye area to cephalothorax as 1 : 5.5. Quadrilateral of the posterior eyes broader than long.

Form.—Cephalothorax highest at the posterior eyes, in front truncated and fully (♀) one-half or less (♂) its greatest transverse diameter, the sides of the head rather steep. Chelicera with 3 pairs of teeth, as long as the width of the clypeus, their length more than twice the height of the head in front. Labium longer than broad, truncated apically, not one-half the length of the maxillæ. Sternum longer than broad. Spinnerets equal in length. Length of leg IV to cephalothorax, ♂ 4.2 : 1, ♀ 3.3 : 1; in the ♂ metatarsus IV is almost as long as the patella and tibia combined, but shorter in the ♀. ♀ palpal claw with 4 teeth.

Lycosa pictilis Emerton. Pl. XVIII, figs. 7, 8.

Lycosa pictilis Emerton, 1885.

(♂, ♀, Mt. Washington, New Hampshire.)

Eyes.—First row shorter than the second, straight, eyes adequal, equidistant from the second row and the clypeal margin. Eyes of second row largest, about 1.5 times their diameter apart. Dorsal eye area to cephalothorax, 1 : 5 (♀) or 1 : 5.5 (♂). Quadrilateral of the posterior eyes broader than long.

Form.—Cephalothorax highest at the posterior eyes, in front truncated straight and more (♀) or less (♂) than one-half its greatest transverse diameter. Chelicera large, with 3 pairs of teeth, longer than the width of the clypeus, their length fully 2.5 times the height of the head in front. Labium slightly longer than broad, truncated apically, not one-half the length of the maxillæ. Sternum longer than broad, pointed behind. Spinnerets about equal in length. Length of leg IV to cephalothorax, ♂ 3.5 : 1, ♀ 3.3 : 1; metatarsus IV shorter than patella and tibia combined. ♀ palpal claw with 7 teeth.

Lycosa punctulata Hentz.

Lycosa punctulata Hentz, 1841.
Lycosa punctulata Hentz, Emerton, 1885.
nec *Lycosa punctulata* Hentz, Stone, 1890.

(Two females from Philadelphia, Pennsylvania.)

Eyes.—First row shorter than the second, nearly straight, nearer the clypeal margin than the second row, middle eyes slightly larger and nearer the lateral eyes than to each other. Eyes of second row largest, their diameter apart. Dorsal eye area to cephalothorax as 1 : 5.5. Quadrilateral of the posterior eyes longer than wide.

Form.—Cephalothorax highest at the posterior eyes, in front truncated and a little more than one-half its greatest transverse diameter, the sides of the head rather steep. Chelicera with 3 pairs of teeth, longer than the width of the clypeus, about one and four-fifths times the height of the head in front. Labium large, nearly as broad as long, slightly concave apically, not one-half the length of the maxillæ. Spinnerets about equal in length. Length of leg IV to cephalothorax as 3.4 : 1; metatarsus IV shorter than patella and tibia combined. Palpal claw with 5 teeth.

Lycosa ocreata Hentz.

Lycosa ocreata Hentz, 1841.
Lycosa ocreata Hentz, Emerton, 1885.
Lycosa stonei Montgomery, 1902, 1903.
nec *Lycosa rufa* Keyserling, 1876.

(Numerous specimens from Pennsylvania, New Jersey, Massachusetts, and Long Island, New York.)

Eyes.—First row narrower than the second, a little nearer the clypeal margin than to the second row, middle eyes slightly larger and higher. Eyes of second row largest, 1.5 times their diameter apart. Dorsal eye area to cephalothorax as 1 : 4.3. Quadrilateral of the posterior eyes broader than long.

Form.—Cephalothorax highest at the posterior eyes, in front one-half its greatest transverse diameter (♀) or one-third (♂), sides of head vertical (♂) or slightly oblique (♀), the anterior eye row overarching the clypeus. Chelicera with 3 pairs of teeth, longer than the width of the clypeus, in length 1.5 times the height of the head in front, weak and but slightly arched anteriorly. Labium slightly longer than wide, somewhat rounded apically, not one-half the length of the maxillæ. Sternum longer than broad, pointed posteriorly. Anterior spinnerets longer than the posterior. Leg IV to cephalothorax as 4.7 : 1; metatarsus IV as long as tibia and patella combined. ♀ palpus with 4 teeth. Tibia I of ♂ with a brush of long stiff hairs.

Lycosa scutulata Hentz.

Lycosa scutulata Hentz, 1841.
Lycosa scutulata Hentz, Emerton, 1885.
Lycosa scutulata Hentz, Stone, 1890.
Lycosa scutulata Hentz, Montgomery, 1902.

(Numerous specimens from New Jersey, Pennsylvania, and Austin, Texas.)

Eyes.—First row narrower than the second, equidistant from the clypeal margin and the second row, straight or the middle eyes slightly higher, middle eyes a little larger than the lateral. Eyes of second row largest, fully (♂) or not quite (♀) their diameter apart. Length of dorsal eye area to cephalothorax, ♂ 1 : 4.75, ♀ 1 : 5. Quadrilateral of the posterior eyes longer than wide.

Form.—Cephalothorax highest at the posterior eyes, in front truncated and almost (♀) or less than (♂) one-half its greatest transverse diameter, sides of head steep, first two eye rows overarching the clypeus. Chelicera with 3 pairs of teeth, longer than the width of the clypeus, their length 1.75 times the height of the head in front. Labium longer than broad, widest at the distal half, apically truncated, not one-half the length of the maxillæ. Sternum distinctly longer than broad. Superior spinnerets slightly longer. Length of leg IV to cephalothorax, ♂ 4.7 : 1, ♀ 4.1 : 1; metatarsus IV slightly longer (♂) or slightly shorter (♀) than the patella and tibia combined. ♀ palpal claw with 4 teeth.

Remarks.—The Texas specimens differ from the northern ones in greater size, the ♀ with a cephalothoracal length of 12 mm.

Lycosa bilineata (Emerton).

Pardosa bilineata Emerton, 1885.
Lycosa ocreata pulchra Montgomery, 1902.

(Numerous specimens from Pennsylvania, New Jersey and Massachusetts.)

Eyes.—First row shorter than the second, about equidistant from the clypeal margin and the second row, the middle eyes almost contiguous, larger and slightly higher than the lateral. Eyes of the second row largest and about 1.4 their diameter apart. Length of dorsal eye to cephalothorax as 1 : 4.5. Quadrilateral of the posterior eyes broader than long.

Form.—Cephalothorax highest at the posterior eyes, in front truncated straight and decidedly less than one-half its greatest transverse diameter, the sides of the head vertical and the two anterior rows projecting in front of the clypeus. Chelicera weak with 3 pairs of teeth, their anterior margin nearly straight, longer than the width of the clypeus, their length about 1.5 times the height of the head in front. Labium longer than broad, apically truncated, not one-half the length of the maxillæ. Sternum large, longer than broad. Spinnerets equal in length. Metatarsus IV shorter than patella and tibia combined; length of leg IV to cephalothorax, ♂ 4 : 1, ♀ 3.8 : 1. ♀ palpal claw with 3 teeth. Tibia I in ♂ with a thick brush of vertical hairs.

Remarks.—Emerton's description of *bilineata* was so brief, that I did not consider it to be identical with my *ocreata pulchra* until Emerton called my attention to the probable identity; Emerton had described only the female.

Lycosa inhonesta (Keys.). Pl. XX, figs. 38, 39.

Tarentula inhonesta Keyserling, 1876.
?*Lycosa babingtoni* Blackwall, 1846.
Lycosa nidicola Emerton, 1885.
Lycosa nidicola Emerton, Stone, 1890.
Lycosa nidicola Emerton, Montgomery, 1902, 1903
Lycosa tigrina McCook, 1878, 1893 (Plate 30).
Lycosa tigrina McCook, Stone, 1890.
?*Lycosa vulpina* Emerton, 1885.
Lycosa inhonesta (Keys.), Montgomery, 1902.

(Numerous specimens from Massachusetts, Pennsylvania, New Jersey and Austin, Texas.)

Eyes.—First row nearer to the clypeal margin than to the second row, shorter or quite as long as the second, middle eyes higher and slightly larger. Eyes of the second row much the largest, about three-fourths their diameter apart. Eyes of the third row about twice their diameter behind the second row. Dorsal eye area about one-sixth the length of the cephalothorax. Quadrilateral of the posterior eyes wider than long.

Form.—Cephalothorax highest just behind the third eyes, in front slightly rounded and about one-half its greatest transverse diameter. Sides of head oblique. Chelicera with 3 pairs of teeth, longer than the width of the clypeus, their length 2.5 times the height of the head in front. Sternum longer than broad. Leg IV to cephalothorax, ♂ 4 : 1, ♀ 3.4 : 1; metatarsus IV shorter than patella and tibia combined. ♀ palpal claw with 3 teeth. Spinnerets about equal in length. Legs stout with weak scopulæ.

Remarks.—The Texas specimens offer as great variation in size and color as do the northern ones (cf. Montgomery, 1903). Under stones in the bed of Shoal Creek, at Austin, where they are very numerous, two series of individuals may be distinguished:

(1) Smaller ones of lighter color. Cephalothorax with the light submarginal band as distinct as the median. Abdomen above with a pale brown to orange median band extending the whole length of the dorsum, and enclosing in its anterior half a narrower darker band edged with black; each side of the dorsum is darker with a row of whitish spots that are frequently connected by transverse white lines; venter pale brown, unspotted or with small spots. Sternum and coxæ darker brown to reddish-brown. Legs greenish or yellowish with darker annulations. Cephalothoracal length (♀) 7.5–8.5 mm.

(2) Larger ones of darker color. Cephalothorax with the submarginal bands frequently interrupted or indistinct. Abdomen very dark above and with the pattern indistinct; venter frequently blackish, with numerous small black spots which are sometimes arranged in longitudinal rows; rarely the entire venter is deep black. Sternum and inferior surface of coxæ reddish-brown to deep black. Legs dark brown with more or less distinct darker annulations; leg IV sometimes shows on the inferior surface deep black rings at both ends of the tibia and at the distal end of the tarsus. Cephalothoracal length (♀) 8.5–11.5 mm.

The intermediates between these two groups are not very numerous. The most constant color diagnostic is the very narrow light median band of the cephalothorax.

This species is so variable that without a large series of individuals one might easily conclude that it included two species, namely, a smaller one (*nidicola* of Emerton) and a larger and darker one, with distinct annulations on the legs (*inhonesta* of Keyserling, *tigrina* of McCook). But there are no valid distinctions in the genitalia of the two, and they intergrade in size and color, so that I have concluded to regard them as one species. It is possible that Emerton's *vulpina* is a color variety of this species; but of *vulpina* I have seen only an adult male (labelled so by Mr. Emerton), and no adult female, so that I could not decide the point.

Habits.—This is a species of moist ground and meadow land, and at Austin is very abundant under stones on the margin of Shoal Creek. The males and the young are more or less diurnal, the grown females nocturnal.

Lycosa relucens Montg.

Lycosa relucens Montgomery, 1902.
Lycosa verisimilis Montgomery, 1902, 1903.

(Specimens from Pennsylvania, New Jersey, and Austin, Texas.)

Eyes.—First row straight, narrower than the second, nearer to the clypeal margin than to the second row, eyes adequal in size. Eyes of second row largest, about 1.5 times their diameter apart. Length of the dorsal eye area to the cephalothorax, ♂ 1 : 4.5, ♀ 1 : 5. Quadrilateral of the posterior eyes broader than long.

Form.—Cephalothorax highest at the posterior eyes, in front truncated and not one-half its greatest transverse diameter, sides of the head nearly vertical (♂) or more oblique (♀), anterior margin of the head projecting slightly in front of the clypeus. Chelicera with 3 pairs of teeth, longer than the width of the clypeus, their length about twice the height of the head in front. Labium longer than broad, apically rounded (♀) or truncated (♂), not one-half the length of the maxillæ. Sternum large, longer than broad. Length of leg IV to cephalothorax as 4 : 1, metatarsus IV shorter than the patella and tibia combined. Spinnerets equal in length. ♀ palpal claw with 3 teeth.

Remarks.—The very considerable variation in the form of the epigynum led me originally to divide this into two species. Recently I have obtained individuals with the epigynum quite intermediate in structure between the extremes first found. The specimens from Texas are larger than the northern ones.

GEOLYCOSA nov. gen.

I propose this new genus for those species, previously included in *Lycosa*, in which the first leg is thickest and strongest, furnished with thick scopulæ on its three terminal joints, and almost as long as the fourth (shorter by not more than one-half the length of tarsus I). *Geolycosa latifrons* is the type species.

In *Geolycosa latifrons* the cephalothorax is very high in the cephalic portion, and from that point to its posterior margin its dorsal contour is almost straight without any demarcation of a posterior declivity; the posterior declivity is only slightly marked in *arenicola* and *carolinensis*, but well marked in *baltimoriana* and *texana*. In *latifrons* also the chelicera are very large and thick. The first row of eyes is about as broad as the second, except in *texana*. The other characters are essentially those of *Lycosa*.

This genus is better demarcated from *Lycosa* than either *Pardosa* or *Trochosa*. All the species dig deep cylindrical holes in the ground, and some of them build a low turret of sticks around the aperture (*arenicola, latifrons, texana*). This burrowing habit has occasioned the thickness of the first pair of legs, and occasioned also the height of the cephalothorax in front by the greater development of the muscles there. *Lycosa fatifera* Hentz probably belongs to this genus, but Hentz's very brief description: "Bluish black; cephalothorax deeper in color at the sides; chelicera covered with rufous hairs and with a red elevation on their external side near the base; one of the largest species," is insufficient. He states it "is common in Massachusetts," and this, together with his description of its tube, makes it possible that he had either a light variety of *carolinensis* or an unusually large and dark specimen of *arenicola*.

Key to Species of Geolycosa.

a. 1.—Lateral eyes of the first row larger than its middle eyes, whole venter deep black, ... *carolinensis.*

a. 2.—Lateral eyes of the first row not larger than its middle eyes, whole venter not black.

- *b.* 1.—Patellæ black below, almost the whole venter behind the lung-books deep black, this black not including lighter markings, ... *baltimoriana.*
- *b.* 2.—Not so colored.
  - *c.* 1.—First eye row distinctly shorter than the second, posterior declivity of cephalothorax describing an angle with the dorsal contour, ... *texana.*
  - *c.* 2.—First eye row fully as broad as the second, posterior declivity of the cephalothorax in a line with its dorsal contour.
    - *d.* 1.—Coxæ and femora of legs I and II black below, venter with a median black band, . *arenicola.*
    - *d.* 2.—Not so colored, ... *latifrons.*

Geolycosa texana n. sp. Pl. XVIII, figs. 13, 14.

(Numerous specimens from Austin, Texas.)

Eyes.—First row nearer the second than the clypeal margin, decidedly shorter than the second, its eyes subequal, middle eyes slightly higher. Eyes of second row largest, less than their diameter apart. Third row widest. Dorsal eye area less than one-fifth the length of the cephalothorax. Quadrilateral of the posterior eyes longer than broad.

Form.—Cephalothorax in front truncated, about one-half its greatest transverse diameter (♀) or less (♂), highest at the posterior eyes, the ocular region marked off by a groove from the cheek region. Sides of head rather steep. Chelicera massive, much longer than the clypeus wide, their length nearly twice the height of the head in front, with 3 pairs of teeth; their posterior surface with a row of numerous transverse striæ. Sternum longer than broad. Legs long but strong, length of the fourth to the cephalothorax in ♂ 4.1 : 1, in ♀ 3.6 : 1; in the ♂ the fourth metatarsus is slightly longer than the patella and tibia combined. ♀ palpal claw with 6 teeth. Anterior spinnerets longest and largest. Labium longer than broad, fully one-half the length of the maxillæ, apically truncated. Epigynum relatively small.

Dimensions.	♂	♀
Cephalothorax,	11	13.5
Abdomen,	11	14
Leg I,	40.5	43
Leg II,	37.5	40
Leg III,	34	36
Leg IV,	45	49

Color in Life.—*Cephalothorax* above grayish-black, with a grayish median band that occupies the whole surface between the eyes of the second and third rows, passes back to almost the middle of the cephalothorax, there becomes narrower and continues to the posterior margin. Extreme margin black. There is an interrupted submarginal gray band which is continued on to the cephalic portion. All the gray markings are due to long whitish hairs, and finer whitish hairs are scattered over the blackish regions. *Sternum* thickly covered with long, stiff, grayish hairs, sometimes black on the margins. *Abdomen* above on its anterior half with a median band of dark brownish edged narrowly with black and containing minute black spots; this band terminates truncated about the middle of the dorsum, and on each side of it at about its middle is a pointed black spot. This band lies in a less distinctly defined, broader pale brownish band which extends the whole length of the dorsum and becomes much narrower toward the spinnerets. In this broader band, behind the narrower enclosed darker one, are about 6–7 crescentic transverse markings each as wide as the broad band, each black anteriorly and white posteriorly, the most anterior being the most distinct; at each end of each of these crescentic markings is a large pale gray spot. Sides above dappled gray and blackish, below with larger black spots scattered on a gray or yellow ground. Venter in front of epigynum gray or yellow with a single pair of black spots. Just behind the rima epigastrica is a broad, transverse black band the anterior edge of which is straight and sharply demarcated, but the posterior edge of which is extended backward as a more or less interrupted median black band extending to a little in front of the spinnerets, and a pair of lateral black bands (or rows of black spots) which curve backward to meet the median band just in front of the spinnerets; thus the venter appears to possess a pair of elongate yellow or yellowish-gray areas, separated by the median black band, bordered laterally and posteriorly by the lateral black lines, and anteriorly by the transverse black band. *Spinnerets* blackish. *Chelicera* anteriorly with orange and black hairs, the macula red; *maxillæ* reddish-brown, *labium* darker. *Legs* above grayish with one or two black spots on the coxæ and black longitudinal markings on the posterior aspect of the femora; below each coxa is whitish, sometimes with a longitudinal black stripe, each femur whitish with a black ring at its distal end, each patella whitish, the first tibia blackish its entire length, the tibiæ of the other pairs whitish in the middle and black at the ends, the tarsi and metatarsi black. *Palpi* grayish, unmarked except that the terminal joint is black on the inferior surface.

Comparisons.—This large and beautiful species is quite distinct from any other. It is very abundant in open areas of the limestone region of Austin, and lives in deep cylindrical holes lined with silk, and with the opening of the tube raised above the surface of the ground, as in *G. arenicola.*

Geolycosa latifrons n. sp. Pl. XIX, figs. 15–18.

(Specimens from the vicinity of Austin, Texas.)

Eyes.—First row much nearer the second row than to the clypeal margin, almost or fully as broad as the second row, its middle eyes slightly larger and higher, and nearer the lateral eyes than each other. Eyes of second row largest, separated by almost their diameter. Third row broadest, about 1.5 times the diameter of one of its eyes behind the second row. Dorsal eye area to cephalothorax as 1 : 6.5. Quadrilateral of the posterior eyes broader than long.

Form.—Cephalothorax very broad in front, there from five-eighths (♂) to four-fifths (♀) its greatest transverse diameter, very high at the posterior eyes and from there gradually sloping to its posterior end, the posterior declivity not being separable from the dorsal outline. It is very high at the posterior eyes, and the cephalic portion is marked off from the thoracal on each side by a groove; the sides of the head are oblique and the cheeks very broad. Chelicera massive with a large macula basalis, with three pairs of teeth, longer than clypeus wide, in length about 2.5 times the height of the head from the clypeal margin to the superior border of the second eye row, at the base almost as thick in an antero-posterior direction as one-half their length. Sternum much longer than broad. Labium longer than wide, not one-half the length of the maxillæ, apically concave. Posterior spinnerets longest. Epigynum very large. First leg noticeably thicker than the others, particularly its three terminal joints which are thickly covered below with scopulæ. Scopulæ are also present upon the tarsus, metatarsus and distal half of the tibia of II, and on the tarsi of III and IV. Fourth leg to cephalothorax, ♂ 3.3 : 1, ♀ 2.7 : 1. Metatarsus IV shorter than patella with tibia combined.

Dimensions.	♂	♀
Cephalothorax,	8.5	10
Abdomen,	7	8
Leg I,	27	25.5
Leg II,	24.5	22
Leg III,	22	20.5
Leg IV,	28.3	27

Color of Females (in alcohol).—*Cephalothorax* with few and only short hairs; clear to dark reddish-brown in the cephalic portion, this clear area constricting anterior to the dorsal groove, then enlarging again around this groove; sides darker, interrupted by reddish bands radiating from the dorsal groove, the extreme margin black. *Sternum* yellow to yellowish-gray. *Abdomen* above dull brown to chocolate-brown without any distinct pattern on the dorsum; at each antero-lateral angle a large elongate black spot; sides behind this mark paler brown; venter very pale yellow along its whole extent, or else a little darker behind the rima epigastrica. *Epigynum* clear reddish-brown. *Spinnerets* brown. *Chelicera* and *labium* dark reddish-brown, *maxillæ* yellowish. *Legs* without annulations, above reddish-brown (usually paler than the light portion of the cephalothorax), below the coxæ, femora and patellæ lighter (of the same color as the sternum); owing to the thick scopulæ the inferior surfaces of the tibiæ, metatarsi (also the dorsal portion of the distal half of these), and the tarsi of I are black, as of the tibia, metatarsus and distal half of the tibia of II, and of the distal ends of the tarsi of III and IV.

Color of Males (in alcohol).—Differ from the female as follows: The *abdomen* above is orange-brown (more clear orange anteriorly); at each antero-lateral angle arises a broad black band that extends on the side posteriorly as far as the middle; venter pale brownish laterally, the median region behind the lung-books being silvery with a pair of closely approximated narrow, darker longitudinal lines. The *coxæ* and *femora* are greenish below. *Palpi* with all the joints brown above and greenish below, except the tarsus, which is wholly black.

Comparisons.—A species very well marked by the great width of the head region, and the gradual slope of the dorsal contour of the cephalothorax.

Geolycosa baltimoriana (Keys.). Pl. XIX, fig. 19.

Tarentula baltimoriana Keyserling, 1876.
Lycosa baltimoriana (Keys.), Montgomery, 1902.

(In addition to the single male originally described by me, I have secured three additional males from the vicinity of Austin, Texas.)

Eyes.—First row nearer the clypeal margin than the second row, almost as broad as the second, its eyes equidistant, the middle eyes higher and fully twice the size of the lateral. Eyes of the second row largest, about three-fourths their diameter apart. Third row broader than the second, its eyes almost 1.5 their diameter behind the second row. Dorsal eye area one-fifth the length of the cephalothorax. Quadrilateral of the posterior eyes broader than long.

Form.—Cephalothorax in front quite one-half its greatest transverse diameter, highest at the posterior eyes, the posterior declivity inclined at fully 45° with the dorsal outline. Head rather oblique and rounded. Chelicera longer than the clypeus broad, almost twice the height of the head in front, with three pairs of teeth. Labium longer than broad, apically concave, less than one-half the length of the maxillæ. Sternum longer than broad. Spinnerets adequal in length. Legs long and slender, the first slightly thicker than the other (most noticeably its tibia), and shorter than the fourth by only one-third the length of its tarsus. Metatarsus IV shorter than patella and tibia combined. On all the femora the hairs are short and few; there are thick scopulæ on the tarsi and metatarsi of I and II, and on the tarsi of III and IV. Leg IV to cephalothorax as 3.5 : 1.

Dimensions.	♂
Cephalothorax,	9
Abdomen,	7
Leg I,	29.5
Leg II,	28

Dimensions.	♂
Leg III, ...	26
Leg IV, ...	31.5

Color (in alcohol).—*Cephalothorax* above with a very narrow white median line in the eye area extending back to the dorsal groove; the extreme margin white; a broad submarginal band of orange on each side, not extending to the head; a small reddish-yellow area around the dorsal groove (and extending back to the posterior margin of the thorax as a narrow band), from which broad radiating bands extend to the submarginal band, about four of these bands on each side, and each band narrowly white in front, black behind this, then reddish-brown in its posterior half. The ocular area is blackish; the clypeus and cheeks whitish above, postero-ventral margin of each cheek with a black spot. *Sternum* deep black. *Abdomen* above on its anterior half with a broad median dark band edged with black, this band narrowest anteriorly with sinuate margins and concavely truncated posteriorly; it is bordered by orange-brown. At each antero-lateral margin of the dorsum arises a broader, interrupted black stripe which extends almost to the spinnerets, and in its posterior half is simply an area of black spots. Behind the median band is a series of four narrow, transverse black bands, whose lateral margins confluesce with the lateral black stripes. Sides orange-brown, marked posteriorly with blackish spots. Venter pale greenish, with a sharply bounded, deep black band extending from the rima epigastrica in front to a little anterior to the spinnerets behind, this black covering the whole venter behind the lungs but not extending up the sides. *Chelicera* black with orange hairs anteriorly, *labium* and *maxillæ* black with paler tips. *Legs* above yellowish, femora of I and II with two almost contiguous, parallel dark lines above, and another on the posterior aspect, these represented by lines of black spots on III and IV; the patellæ and distal ends of the tibiæ are brownish, the metatarsi and tarsi of I and II pale brownish. Below the coxæ are chocolate-brown, the femora very pale yellow, the patellæ and distal ends of the tibiæ deep black, the metatarsi and tarsi reddish-brown. *Palpi* yellow, femora above with two longitudinal darker stripes, patella below slightly darker than above, whole tarsus almost black.

Comparisons.—Of all the species of the genus it comes closest to *texana*, but apart from the differences in coloration and the palpal organ it may be distinguished by tarsus I being more than one-half the length of the metatarsus, while in *texana* this joint is decidedly less than one-half this length.

Habits.—The female is unknown. One male was found in a hole three inches deep below a stone, the other two below stones, but not in holes.

Geolycosa arenicola (Scudd.).

Lycosa arenicola Scudder. 1877.
Lycosa nidifex Marx, 1881.
Lycosa nidifex Marx, Emerton, 1885.
Lycosa arenicola Scudder, Stone, 1890.
Lycosa domifex Hancock, 1899.
Lycosa arenicola McCook, 1893 (Plate 30).
Lycosa arenicola Scudder, Montgomery, 1902.

(Numerous specimens from New Jersey, Massachusetts, and Long Island, New York.)

Eyes (♀).—First row as broad as the second, nearer the second row than to the clypeal margin, its eyes equidistant, the middle eyes slightly larger and slightly higher. Eyes of the second row largest, about their diameter apart. Dorsal eye area one-sixth the length of the cephalothorax. Quadrilateral of the posterior eyes broader than long.

Form (♀).—Cephalothorax highest at the posterior eyes and from there gradually declining to its posterior margin, with the posterior declivity barely demarcated from the dorsal, sides of the head oblique, in front somewhat rounded and about three-fifths its greatest transverse diameter. Chelicera with 3 pairs of teeth, their length almost twice the height of the head in front, longer than the width of the clypeus, at their base almost as thick antero-posteriorly as one-half their length. Thick scopulæ inferiorly upon the four terminal joints of legs I and II, and the two terminal joints of III and IV; leg IV to cephalothorax as 2.7 : 1; metatarsus IV shorter than patella and tibia combined.

Lycosa carolinensis Walck.

Lycosa tarentula carolinensis Walckenaer, 1837.
Lycosa tarentula carolinensis Hentz, 1841.
Lycosa carolinensis Hentz, Emerton, 1885.
Lycosa carolinensis Walck., Stone, 1890.
Lycosa carolinensis Walck., Montgomery, 1902.

(Specimens from New Jersey, Pennsylvania and Martha's Vineyard, Massachusetts.)

Eyes.—First row equidistant from the clypeal margin and the second row, somewhat shorter than the second, the lateral eyes slightly lower and slightly larger than the middle and placed upon tubercles so that they are directed downward. Eyes of second row largest, not quite their diameter apart. Dorsal eye area to the length of the cephalothorax as 1 : 6. Quadrilateral of the posterior eyes broader than long.

Form.—Cephalothorax flat and broad, the cephalic portion clearly marked off from the thoracic, in front fully (♀) or less (♂) than one-half its greatest transverse diameter, highest at posterior eyes; in the ♀ the dorsal outline gradually declines to the posterior margin with a posterior declivity only slightly defined, but in the ♂ the posterior declivity is well marked from the dorsal outline. Chelicera massive, their length more than twice the height of the head in front, longer than the width of the clypeus, with 3 pairs of teeth. Labium longer than wide, broadest at the tip where it is truncated, one-half the length of the maxillæ. Sternum longer than broad. Posterior spinnerets longest. Legs thick, length of leg IV to cephalothorax, ♂ 3.6 : 1, ♀ 3.2 : 1; metatarsus IV shorter than patella and tibia combined.

Genus **TROCHOSA** C. Koch, 1848.

This genus is most closely allied to *Lycosa*, and differs from it mainly in the following characters: The first row of eyes is fully as wide as the second, or at least (as in *avara* and *contestata*) the middle points of the lateral eyes of the first row are as far lateral as the middle points of the eyes of the second row; the sides of the head are obliquely arched, and the cephalothorax highest at or behind the middle (except in the ♀ of *frondicola*); the legs are usually comparatively short (only in *cinerea* has leg IV a length of four times the cephalothorax), and their spines are usually short (in *rubicunda* there is only one ventral spine on tibia I). The posterior spinnerets are never longer, usually shorter than the anterior. Metatarsus IV is always shorter than the patella and tibia combined. The chelicera are robust and arched anteriorly, with 3 teeth on their posterior margins (4 in *contestata*), and their length is fully twice the height of the head in front. The length of the dorsal eye area to the cephalothorax varies from 1 : 4.5 (*cinerea*) to 1 : 9 (*rubicunda*). The labium is longer than wide, and frequently one-half or more the length of the maxillæ (*sepulchralis, frondicola, purcelli, cinerea*).

There is a greater structural difference between *Trochosa rubicunda* and *Lycosa scutulata*, than between the latter and *Pardosa;* so that if we maintain the genus *Pardosa* we must also retain *Trochosa.*

Key to Species of Trochosa.

a. 1.—Dorsal eye area one-ninth the length of the cephalothorax, one spine on the ventral surface of tibia I, . . . *rubicunda.*

a. 2.—Dorsal eye area at least one-seventh the length of the cephalothorax, 3 pairs of spines on the ventral surface of tibia I.
- *b.* 1.—Posterior margin of chelicera with 4 teeth, . . *contestata.*
- *b.* 2.—Posterior margin of chelicera with 3 teeth.
  - *c.* 1.—Cephalothorax smooth, without hairs or with hairs only in the ocular area.
    - *d.* 1.—A distinct broad median and narrow submarginal bands on the cephalothorax, . *noctuabunda.*
    - *d.* 2.—Cephalothorax without stripes, . . . *sublata.*
  - *c.* 2.—Cephalothorax with hairs.
    - *d.* 1.—Median band of cephalothorax narrow, *helvipes* Keyserling, 1876.
    - *d.* 2.—Median band of cephalothorax on the anterior half about as broad as the ocular area, colors mainly gray and white, ... *cinerea.*
    - *d.* 3.—Median band of cephalothorax in its anterior half about half as broad as the eye area, colors dark.
      - *e.* 1.—Median band of cephalothorax not laterally notched anterior to the median groove.
        - *f.* 1.—Venter pale brown, sternum not darker than the coxæ, ... *avara.*
        - *f.* 2.—Venter black or blackish, sternum darker than coxæ, ... *frondicola.*
      - *e.* 2.—Median band of cephalothorax notched laterally anterior to the median groove.
        - *f.* 1.—Legs (at least the femora) distinctly annulated, venter and sternum not deep black.
          - *g.* 1.—Spines on the femora shorter than the greatest diameter of the femora, ... *pratensis.*
          - *g.* 2.—Spines on the femora longer than the greatest diameter of the femora, *purcelli.*
        - 2.—Legs not annulated, venter and sternum deep black, ... *sepulchralis.*

Trochosa noctuabunda n. sp. Pl. XVIII, figs. 9, 10.

(Several specimens from Austin, Texas.)

Eyes.—First row nearer the second than to the clypeal margin, straight, fully as broad as the second, the middle eyes nearly double the size of the lateral. Eyes of second row largest, separated by about 1.3 times their diameter. Third row little broader than the second, and almost twice the diameter of one of its eyes behind the second. Dorsal eye area less than one-sixth the length of the cephalothorax. Quadrilateral of the posterior eyes about as long as broad.

Form.—Cephalothorax in front in the ♂ rather pointed and about two-fifths its greatest transverse diameter, in the ♀ somewhat rounded and slightly more than one-half this diameter, highest at or slightly in front of the middle, entirely smooth except for a few long hairs in the ocular area. Head low and oblique on the sides. Chelicera massive with strong macula basalis, very strongly arched on the anterior border, longer than the width of the clypeus, in length about twice the height of the head in front, with 3 pairs of teeth. Sternum decidedly longer than broad, rather pointed posteriorly. Labium fully one-half as long as the maxillæ, longer than broad, truncated straight. Anterior spinnerets slightly the longest. Legs short and stout with short spines; vertically inserted, longer, fine hairs are particularly noticeable on the tibiæ and metatarsi; length of leg IV to cephalothorax, ♂ 3.8 : 1, ♀ 3.5 : 1; metatarsus IV shorter than patella and tibia combined. ♀ palpal claw with 4 teeth.

Dimensions.

	♂	♀	
Cephalothorax,	3.4	4	(3 in smallest)
Abdomen,	3.3	5	
Leg I,	9.2	10.3	
Leg II,	8.8	9.8	
Leg III,	8.2	9.3	
Leg IV,	13	14	

Color (in alcohol).—*Cephalothorax* above blackish or deep brown in the eye area, with a yellowish spot postero-lateral to each posterior eye. A median yellow band arises between the posterior eyes, just behind them enlarges to a width slightly broader than that of the ocular area, is deeply constricted in front of the dorsal groove, enlarged to its greatest diameter around this groove, constricted again behind this groove and then slightly enlarged again at the posterior margin; in its anterior portion this band contains a median and a pair of lateral darker lines. There is a more or less distinct broad, interrupted yellow submarginal band on the posterior two-thirds of the cephalothorax; a yellow line beneath the anterior eyes; while the remainder of the cephalothorax is shining dark brown or blackish. *Sternum* shining, with few hairs, yellowish-brown with darker margins. *Abdomen* in the brightest individuals above with a narrow median green band on its anterior half, this band pointed at each end and bordered laterally by a broader stripe of silvery-white interrupted by black spots; on the posterior half of the dorsum the silvery-white is continued as a few broad transverse areas, spotted by black; lateral to this silvery-white is a broader black area, deep black and not interrupted anteriorly (on the anterior aspect of the abdomen the black band of one side joins with that of the other), while posteriorly the black band widens and becomes mottled with buff; sides buff, spotted with black posteriorly; venter yellow in front of the lung-books, behind them pale brown with small spots of darker brown and black. In other individuals the dorsum shows the same general pattern, but the silvery-white is replaced by yellow and the black by brown. *Epigynum* reddish-brown. *Spinnerets* pale brown. *Chelicera* brown or almost black, the macula red. *Labium* as dark as the chelicera but with lighter distal end, and *maxillæ* lighter. *Legs* in the brightest individuals clear greenish-yellow, distinctly ringed with black on all the joints except the tarsi, each coxa black on its anterior and posterior aspects, the tarsi reddish-brown. *Palpi* colored like the legs.

Comparisons.—This species comes very close to *sublata*, but differs from it in the coloration of the cephalothorax and of the abdominal venter. The epigyna of the two are very similar.

Habits.—Not common, on damp ground under stones, on the margin of streams.

Trochosa pratensis (Emerton).

Lycosa pratensis Emerton, 1885.
Lycosa pratensis Emerton, Montgomery, 1903.

(♀ ♀ from Wood's Hole, Massachusetts.)

Eyes.—First row a little broader than the second, the middle eyes larger and slightly lower, lateral eyes nearer the second row than to the clypeal margin. Eyes of second row largest, their diameter apart. Length of dorsal eye area to cephalothorax as 1 : 6.5.

Form.—Cephalothorax highest between the posterior eyes and the dorsal groove, in front truncated and a little more than one-half its greatest transverse diameter, sides of head oblique. Chelicera longer than the width of the clypeus, 2.5 times the height of the head in front. Labium longer than wide, its sides nearly parallel, truncated apically, one-half the length of the maxillæ. Sternum longer than broad. Spinnerets equal. Legs thick, leg IV to cephalothorax as 2.7 : 1; metatarsus IV shorter than the patella and tibia combined. Palpal claw with 5 teeth.

Trochosa contestata (Montg.).

Lycosa contestata Montg., 1903.

(♀ from Wood's Hole, Massachusetts.)

Eyes.—First row slightly shorter than the second, much nearer the clypeal margin than to the second row, middle eyes double the size of the lateral and a little higher. Eyes of the second row nearly 1.5 times their diameter apart. Eyes of the third row nearly as large as those of the second. Dorsal eye area to the cephalothorax as 1 : 6.

Form.—Cephalothorax highest a little anterior to the middle, in front truncated and about one-half its greatest transverse diameter, the sides of the head rather oblique. Chelicera about as long as the width of the clypeus, fully 2.5 times the height of the head in front, with 4 teeth on the inferior and 3 on the anterior margin. Labium longer than wide, truncated apically, one-half the length of the maxillæ. Maxilla indented on the inferior surface near the distal end. Sternum longer than broad. Spinnerets equal. Leg IV to cephalothorax as 3.6 : 1; metatarsus IV shorter than patella and tibia combined. Palpal claw with 4 teeth.

Trochosa avara Keyserling. Pl. XX, fig. 42.

Trochosa avara Keys., 1876.
Lycosa avara (Keys.), Montgomery, 1903.

(One ♀ from Philadelphia; numerous individuals of both sexes from Austin, Texas.)

Eyes.—First row slightly narrower than the second, straight, equidistant from the second row and the clypeal margin, the middle eyes closely approximated and fully 1.5 the size of the lateral. Eyes of second row largest, fully (♂) or almost (♀) their diameter apart. Dorsal eye area to cephalothorax as 1 : 6. Quadrilateral of the posterior eyes longer than broad.

Form.—Cephalothorax highest behind the middle, in front truncated and one-half (♀) or less (♂) as wide as its greatest transverse diameter, the sides of the head oblique. Chelicera longer than the width of the clypeus, their length fully three times the height of the head in front, with 3 pairs of teeth. Labium longer than broad, truncated apically, not one-half the length of the maxillæ. Sternum longer than broad. Anterior spinnerets longest. Leg IV to cephalothorax (♀) as 3 : 1; metatarsus IV shorter than patella and tibia combined. ♀ palp with 5 teeth.

Remarks.—The Texas specimens agree essentially with Keyserling's description except in the following points: The epigynum is distinctly broader than long. The abdomen above has a more or less distinct median darker band edged with yellowish on the anterior half, and a pair of white spots on the posterior half, the rest of the anterior surface being finely mottled with black and brown; on the posterior dorsum are narrow transverse stripes of brown, between each two of which is a pair of black spots (each surrounded by a brown ring); the venter is pale brown with minute black spots.

Habits.—A common species in the vicinity of Austin, under stones on dry hillsides.

Trochosa purcelli (Montg.).

Lycosa purcelli Montg., 1902.
Lycosa kochii Keys., Emerton, 1885.
nec *Tarentula kochii* Keys., 1876.
Lycosa nigraurata Montgomery, 1902.

(Several specimens from Pennsylvania, New Jersey and Massachusetts.)

Eyes (♀).—First row slightly shorter than the second, nearer the clypeal margin than to the second row, about straight or lateral eyes slightly lower, middle eyes 1.5 times the size of the lateral. Eyes of second row largest, slightly more than their diameter apart. Dorsal eye area to cephalothorax as 1 : 4.75. Quadrilateral of the posterior eyes broader than long.

Form (♀).—Cephalothorax highest at about the middle, in front truncated and not quite one-half its greatest transverse diameter, the sides of the head oblique. Chelicera with 3 pairs of teeth, longer than the width of the clypeus, their length 2.25 times the height of the head in front. Labium longer than broad, slightly concave apically, not one-half the length of the maxillæ. Sternum rounded. Leg. IV to cephalothorax as 3.5 : 1. Metatarsus IV shorter than patella and tibia combined. Spinnerets about equal in length. Palpal claw with 4 teeth.

Remarks.—In addition to certain slight differences in the form of the epigyna (mentioned in my preceding paper), this form is to be separated from *kochii* in that the cephalothorax in front is less than one-half its greatest transverse diameter, instead of "vorn bedeutend mehr als halb so breit als in der Mitte," and in being highest at or behind the middle. The male which I had described as a new species (*nigraurata*) is an unusually bright-colored individual, with 4 teeth on the posterior margin of one of the chelicera.

Trochosa cinerea (Fabr.). Pl. XX, fig. 43.

Araneus cinereus Fabricius, 1793.
Lycosa lynx Hahn, 1831.
Lycosa halodroma C. Koch, 1848.
Arctosa cinerea Idem.
Arctosa lynx Idem.
Lycosa maritima Hentz, 1841.
Lycosa cinerea Fabr., Emerton, 1885.
Lycosa cinerea Fabr., Stone, 1890.
Lycosa cinerea Fabr., Montgomery, 1902.

(Numerous specimens from Austin, Texas; Wood's Hole, Massachusetts; Long Island, New York; New Jersey.)

Eyes.—First row straight, as broad as the second, nearer the clypeal margin than to the second row, middle eyes fully twice as large as the lateral. Eyes of second row largest, their diameter apart. Dorsal eye area to cephalothorax as 1 : 4.5. Quadrilateral of the posterior eyes slightly longer than broad.

Form.—Cephalothorax highest between the posterior eyes and the dorsal groove, in front more than one-half its greatest transverse diameter (♀) or less (♂) and truncated (♀) or rounded (♂). Sides of head moderately oblique and rounded. Chelicera with 3 pairs of teeth, much longer than the width of the clypeus, in length about 2.5 times the height of the head in front. Labium longer than broad, truncated apically, fully one-half the length of the maxillæ. Legs strong with short spines; leg IV to cephalothorax as 4 : 1; metatarsus IV shorter than patella and tibia combined. ♀ palpal claw with 3 minute teeth. ♂ palpal tibia twice as long as the patella, and narrower, the point of the tarsus fully as long as the bulbus. Anterior spinnerets longest.

Comparisons.—This differs from the European form, judging from Simon's description (*Arachnides de France*), in that the fourth tibia and patella combined are considerably longer than the cephalothorax (instead of the same length), and in that the fourth leg is 4 times the length of the cephalothorax instead of 3.3 times. The two species may prove to be distinct.

The Texas specimens differ from the northern ones in large size (♀ with a cephalothoracal length of 7.5 mm.), and in being much paler colored.

Habits.—In the North this is a species of the sea coast. At Austin it is common, particularly in the fall, under stones close to fresh water.

Trochosa frondicola (Emerton).

Lycosa frondicola Emerton, 1885
Lycosa frondicola Emerton, Stone, 1890.
Lycosa frondicola Emerton, Montgomery, 1902, 1903.

(Specimens from Pennsylvania and Massachusetts.)

Eyes.—First row fully as broad as the second, middle eyes larger and slightly lower, nearer the clypeal margin than to the second row. Eyes of second row largest, 1.4 times their diameter apart. Dorsal eye area to cephalothorax as 1 : 5. Quadrilateral of the posterior eyes broader than long.

Form.—Cephalothorax slightly highest behind the middle, in front truncated and quite (♂) or more than (♀) one-half its greatest transverse diameter, with the sides of the head oblique. Chelicera with 3 pairs of teeth, longer than the width of the clypeus, their length twice the height of the head in front. Labium longer than broad, apically truncated, one-half the length of the maxillæ. Sternum large, longer than broad. Leg IV to cephalothorax, ♂ 3.8 : 1, ♀ 3 : 1. Metatarsus IV shorter than patella and tibia combined. ♀ palpal claw with 3 teeth.

Trochosa sepulchralis (Montg.).

Lycosa sepulchralis Montgomery, 1902, 1903.

(Specimens from Pennsylvania, and from Austin, Texas.)

Eyes.—First row fully as broad as the second, middle eyes twice as large as the lateral, straight (♂) or middle eyes lower (♀), equidistant from the second row and the margin of the clypeus (♀) or upon the margin of the clypeus (♂). Eyes of second row three-fourths their diameter apart. Dorsal eye area to cephalothorax as 1 : 7. Quadrilateral of the posterior eyes broader than long.

Form.—Cephalothorax highest between the posterior eyes and the dorsal groove, the sides of the head oblique, in front more than one-half as broad as its greatest transverse diameter (♀) or less (♂). Chelicera with 3 pairs of teeth, their length about 2.5 times the height of the head in front, as long (♂) or longer (♀) than the width of the clypeus. Labium longer than broad, apically truncated, in the ♀ one-half the length of the maxillæ but less in the ♂. Sternum large with few hairs. Anterior spinnerets longest. Leg IV to cephalothorax, ♂ 4 : 1, ♀ 3.3 : 1. Metatarsus IV shorter than the patella and tibia combined. ♀ palpal claw with 3 pairs of teeth.

Trochosa rubicunda Keys. Pl. XIX, fig. 30.

Trochosa rubicunda Keyserling, 1876.
Lycosa polita Emerton, 1885.

(One ♀ from Massachusetts, from J. H. Emerton.)

Eyes.—First row broader than the second on each side by the diameter of a lateral eye, the middle eyes slightly lower than the lateral and larger. Eyes of the second row largest, one-half their diameter apart. Third row slightly wider than the first. Ocular area much wider than long, and not more than one-ninth the length of the cephalothorax.

Form.—Cephalothorax without hairs, rounded anteriorly where it is more than one-half its greatest diameter, highest at the middle and gradually sloping down to the eye region, oblique on the sides. Chelicera with 3 pairs of teeth, longer than the width of the clypeus, their length three times the height of the head in front. Labium longer than broad, slightly concave apically, less than one-half the length of the maxillæ. Sternum very large and with few hairs, truncated straight anteriorly and pointed posteriorly. Anterior spinnerets longest. Legs short and thick, 1 ventral spine on tibia I, 2 on tibia II, 3 pairs on tibiæ III and IV; metatarsus IV shorter than patella and tibia combined; leg IV to cephalothorax as 2.4 : 1.

Trochosa sublata (Montg.).

Lycosa sublata Montgomery, 1902.

(♀, type, Point Pleasant, New Jersey.)

Eyes.—First row slightly broader than the second, straight, nearer the second row than to the clypeal margin, middle eyes slightly larger. Eyes of second row largest, their diameter apart. Third row slightly broader than the first, its eyes more than twice their diameter behind the second row. Quadrilateral of the posterior eyes longer than broad. Dorsal eye area to length of cephalothorax as 1 : 5.

Form.—Cephalothorax in front somewhat rounded and more than one-half its greatest transverse diameter, highest at the middle; head low and its sides oblique. Chelicera with 3 pairs of teeth, their length greater than the width of the clypeus and quite 3 times the height of the head in front. Labium longer than wide, truncated apically, not one-half the length of the maxillæ. Legs thick, metatarsus IV shorter than patella and tibia combined. Length of leg IV to cephalothorax as 3.6 : 1.

Genus **PIRATA** Sundevall, 1833.

The main combinations of characters of this genus are: The first eye row is fully as broad as the second (slightly shorter in *elegans* and *nigromaculatus*); the length of the posterior spinnerets is quite 1.5 times that of the anterior, frequently twice; the metatarsus IV is in both sexes shorter than the patella and tibia combined by only one-third the length of the patella (one-half in *marxi*); the inferior tarsal claw is toothed (except in *marxi*); the sides of the head are oblique (except in *elegans* and the ♂ of *liber*); the chelicera are weak, rather straight anteriorly, their length not more, usually less, than twice the height of the head in front; the labium is large and longer than broad. The chelicera have 2 or 3 teeth on the posterior border. The eyes of the second row are less than 1.5 times their diameter apart. The cephalothorax is highest behind the middle, or in the cephalic region (*elegans*). Tibia I has 3 ventral pairs of spines. The length of leg IV to the cephalothorax varies from 3.3 : 1 to 4.6 : 1; the legs have generally long spines and frequently fine long hairs.

It is somewhat doubtful whether this genus is a homogeneous one; *marxi* approaches *Trochosa*, and *elegans*, *Lycosa*. There are also some resemblances to *Aulonia*. All the species of *Pirata* known to me live beneath stones close to water, and spin for themselves during the cold season little closed nests.

Key to Species of Pirata.

a. 1.—Eyes of the second row not more than one-half their diameter apart, chelicera with 2 teeth on the posterior margn, . *marxi.*

a. 2.—Eyes of the second row nearly or quite their diameter apart, chelicera with 3 teeth on the posterior margin.

- *b.* 1.—Sternum blackish with a yellow median band and 3 yellow spots on each side, cephalothorax of the ♀ only one-quarter longer than broad, *prodigiosus* Keyserling, 1876.
- *b.* 2.—Sternum not so colored, cephalothorax in the ♀ one-half longer than broad.
  - *c.* 1.—Venter with dark bands or rows of dark spots, femora usually distinctly annulated, ... *liber.*
  - *c.* 2.—Not so colored.
    - *d.* 1.—Legs almost devoid of hairs, . . . *elegans,*
    - *d.* 2.—Legs covered with fine soft hairs.
      - *e.* 1.—A large dark spot at each side of the spinnerets, ♀ with leg IV 3.3 times the length of the cephalothorax, . *nigromaculatus.*
      - *e.* 2.—No such black spots, ♀ with leg IV 4.4 times the length of the cephalothorax, *sedentarius.*

Pirata marxi Stone. Pl. XIX, fig. 27.

Pirata marxi Stone, 1890.
Pirata marxi Stone, Montgomery, 1902.
Pirata piraticus Clerck, Emerton, 1885.
nec *Pirata piraticus* Clerck.

(♀, type, Pennsylvania; ♀ from Massachusetts.)

Eyes.—First row fully as broad as the second, straight, nearer the second row than the margin of the clypeus, the middle eyes only slightly larger than the lateral. Eyes of the second row one-half their diameter apart. Length of dorsal eye area to cephalothorax as 1 : 5.5. Quadrilateral of the posterior eyes much wider than long.

Form.—Cephalothorax without hairs, highest behind the posterior eyes, posterior declivity very abrupt and steep, in front one-half its greatest transverse diameter. Chelicera with 3 teeth anteriorly and 2 posteriorly, rather straight anteriorly, their length greater than the width of the clypeus and about twice the height of the head in front. Labium longer than broad and more than one-half the length of the maxillæ, broadest behind its middle, rounded apically. Sternum large, nearly round. Length of leg IV to cephalothorax as 3.8 : 1; metatarsus IV shorter than patella and tibia combined by one-half the length of the patella. No teeth on the inferior tarsal claws. Palpal claw with 5 teeth.

Comparisons.—This is the species identified by Emerton with the European *piraticus*. But they are distinct, judging from the description given by Simon in his *Arachnides de France*. The structure of the epigyna differs; in *marxi* the median anterior eyes are but little larger than the lateral (instead of almost double their size) and almost contiguous (instead of being separated by a little more than their diameter), and further, these median eyes are much nearer each other than to the lateral; in *marxi* also tibia and patella IV combined are longer than the cephalothorax (instead of shorter); and there are differences in coloration.

Pirata elegans Stone.

Pirata elegans Stone, 1890.
Pirata elegans Stone, Montgomery, 1902.

(Four ♀♀, types, York county, Pennsylvania.)

Eyes.—First row somewhat shorter than the second, middle eyes slightly higher and a little smaller than the lateral, and nearer each other than to the lateral, equidistant from the clypeal margin and the second row. Eyes of the second row largest, slightly more than their diameter apart. Third row broadest, its eyes about twice their diameter behind the second row. Quadrilateral of the posterior eyes as long as broad. Length of dorsal eye area to cephalothorax as 1 : 4.3.

Form.—Cephalothorax in front truncated and not quite one-half its greatest transverse diameter, highest at the posterior eyes, sides of head rather steep, head projecting in front of the clypeus. Chelicera with 3 pairs of teeth, their length greater than the width of the clypeus and not quite twice the height of the head in front, nearly straight anteriorly. Labium longer than broad, not one-half the length of the maxillæ, widest just behind its middle, rounded apically. Sternum longer than broad. Posterior spinnerets longest (almost twice the length of the anterior). Length of leg IV to cephalothorax as 3.7 : 1; metatarsus IV not quite as long as patella and tibia combined. One tooth on the inferior tarsal claw.

Comparisons.—This species is intermediate between *Lycosa* and *Pirata*, resembling the former in the height of the head and the shortness of the first eye row.

Pirata nigromaculatus Montg.

Pirata nigromaculatus Montgomery, 1902.

(Types, Luzerne county, Pennsylvania.)

Eyes.—First row almost as broad as the second, equidistant from the clypeal margin and the second row, eyes equal, straight or the middle eyes slightly higher. Eyes of the second row largest, 1.3 times their diameter apart. Third row broadest, its eyes nearly twice their diameter behind the second row. Quadrilateral of the posterior eyes broader than long. Length of the dorsal eye area to the cephalothorax as 1 : 4.8.

Form.—Cephalothorax in front rounded (♀) or truncated straight (♂), almost (♀) or decidedly less (♂) than one-half its greatest transverse diameter, about equally high at the posterior eyes and the middle, the eyes projecting in front of the clypeus. Chelicera with 3 pairs of teeth, nearly straight anteriorly, their length greater than the width of the clypeus and about 1.8 times the height of the head in front. Labium longer than broad, about one-half the length of the maxillæ, truncated (♀) or rounded (♂) apically. Posterior spinnerets nearly double the length of the anterior. Metatarsus IV shorter than the patella and tibia combined; length of leg IV to cephalothorax (♀) as 3.3 : 1. Inferior tarsal claw with 1 tooth.

Pirata liber Montg.

Pirata liber Montgomery, 1902, 1903.

(Numerous specimens from Pennsylvania, New Jersey and Massachusetts.)

Eyes.—First row almost or quite as broad as the second, straight, equidistant from the second row and the clypeal margin, eyes adequal. Eyes of the second row 1.3 times their diameter apart. Length of the dorsal eye area to the cephalothorax as 1 : 5.5. Quadrilateral of the posterior eyes much broader than long.

Form.—Cephalothorax very slightly higher behind the middle than at the posterior eyes (♀) or decidedly highest at the median groove (♂); the median groove lies on the dorsal surface and not on the posterior declivity, this declivity being very abrupt in the ♂; the cephalothorax in front is almost (♀) or decidedly less (♂) than one-half its greatest transverse diameter; the sides of the head nearly vertical (♂) or more oblique (♀). Chelicera with 3 pairs of teeth, weak and straight in front, their length about 1.75 times the height of the head in front and (in the ♀) shorter than the width of the clypeus. Labium large, truncated apically, longer than broad, fully one-half the length of the maxillæ. Sternum longer than broad. Posterior spinnerets more than twice the length of the anterior. Metatarsus IV a little shorter than the patella and tibia combined. Length of leg IV to cephalothorax (♀) as 3.3 : 1. Palpi and legs with long soft hairs, most noticeable on the tibiæ and metatarsi (especially in the ♂). Inferior tarsal claw with 2 or 3 teeth. ♀ palpal claw with 3 or 4 teeth.

Pirata sedentarius n. sp. Pl. XIX, figs. 28, 29.

(Numerous specimens from Austin, Texas.)

Eyes.—First row as broad or slightly broader than the second, straight or the middle eyes a little higher, equidistant from the second row and the clypeal margin, the middle eyes largest and slightly nearer to the lateral eyes than to each other. Eyes of the second row slightly more than their diameter apart. Third row considerably broader than the second. Quadrilateral of the posterior eyes broader than long. Length of the dorsal eye area to the cephalothorax as 1 : 6.

Form.—Cephalothorax in front truncated and not one-half its greatest transverse diameter, highest at the median groove, the posterior declivity making an angle of 45° with the dorsal contour. Sides of the head low and rounded, with long scattered hairs in the cephalic region. Chelicera with 3 pairs of teeth, nearly straight in front in the ♂, but more arched and robust in the ♀, their length about twice the height of the head in front. Labium longer than wide, apically truncated, more than one-half the length of the maxillæ. Maxillæ slender, only slightly enlarged distally, with nearly parallel sides, convex on the inner and concave on the outer border. Sternum much longer than wide, pointed posteriorly. Posterior spinnerets twice the length of the anterior. Legs with long spines and (particularly on the tibia and metatarsus of I and II) with long soft hairs. Palpi long and slender. Metatarsus IV a little shorter than patella and tibia combined; length of leg IV to cephalothorax as (♂) 4.6 : 1, (♀) 4.4 : 1. Inferior tarsal claw with 1 or 2 teeth. ♀ palpal claw with 4 teeth.

Dimensions.	♂	♀
Cephalothorax,	2.3	2.5
Abdomen,	2.4	2.6
Leg I,	9.3	8
Leg II,	8	7.5
Leg III,	6	6.8
Leg IV,	10.5	11

Color (in alcohol).—The *cephalothorax* is marked with pale yellow and pale brown; the yellow forms a median band (half as wide as the eye area) extending from this area to the median groove, and continuing from there as a slightly broader band to the posterior margin; a little distance behind each posterior eye is another yellow band which joins the median one at the median groove; there is a broader yellow submarginal band which does not extend to the head; the remainder of the cephalothorax is pale brown. *Sternum* yellow like the coxæ, with a narrow brown margin. *Abdomen* above with a rather narrow median yellow band largest at the anterior end and narrowing to a point at the middle; from this point to the posterior end, with more or less distinctness, is a series of 4–5 broad transverse yellow markings, and a larger elongate yellow mark on each side of the median band; all these yellow markings are demarcated by a ground color of pale brown or dark greenish. The sides are mottled or streaked with yellow or brown; the venter uniform pale yellow or pale brown. *Epigynum* black. *Chelicera* and *maxillæ* shining brownish, *labium* darker. *Legs* yellow, femora annulated with greenish or brownish, a white ring at the middle of the tibiæ; in the ♂ the tibiæ, tarsi and metatarsi of I and II and the metatarsi of IV are darker than the other joints. *Palpi* yellowish, in the ♂ the tarsal joint is brown.

Comparisons.—This species differs from the related *liber* mainly in form; greater relative length of legs; their greater hairiness; sides of the head very oblique in the ♂ instead of vertical; the posterior declivity of the cephalothorax in the ♂ much less steep.

Habits.—Very abundant at Austin, under moist stones close to water.

Key to the North American Genera of Pisauridæ.

(This key has been compiled from Simon, 1898, since I have not seen representatives of the genera Maypacius and Thanatidius.)

a. 1.—Area of the middle eyes longer than broad; tarsi usually provided with an onychium.
- *b.* 1.—First eye row strongly procurved, the lateral usually larger than the middle eyes; clypeus narrow.
  - *c.* 1.—Lateral anterior eyes with the middle anterior occupying an area not broader than long, Maypacius Simon, 1898.
  - *c.* 2.—Lateral anterior eyes with the middle anterior occupying an area much broader than long, Thanatidius Simon, 1898.
- *b.* 2.—First eye row straight, eyes subequal; clypeus broad, *Pisaurina.*

a. 2.—Area of the middle eyes broader, or not less broad, than long; tarsi without an onychium, ... Dolomedes.

Genus **DOLOMEDES** Latreille, 1804.

Key to the Species of Dolomedes.

(For the females only.)

a. 1.—Second eye row broader than the first, posterior edge of the eyes of the second row on a line with the anterior edge of the eyes of the third row, . . . *scapularis* Koch, Keyserling, 1876.

a. 2.—Eyes not so.

- *b.* 1.—Head not demarcated from the cephalothorax; cephalothorax with a very distinct, white submarginal band; sternum with 3 pairs of black spots, . . *sexpunctatus.*
- *b.* 2.—Head demarcated from the cephalothorax; not so colored.
  - *c.* 1.—Median piece of epigynum only one-half its length; leg IV longer than I by less than one-third the length of its terminal joint, ... *idoneus.*
  - *c.* 2.—Median piece of the epigynum extending its whole length; leg IV longer than I by almost the full length of its terminal joint.
    - *d.* 1.—Epigynum distinctly broader than long; legs uniform dark color without rings below, with indistinct yellowish markings on the superior surface of the femora, coxæ the same color as the sternum; sternum with median band indistinct; cephalothorax without a yellow median line; abdominal dorsum with a yellow median band, anteriorly to the anterior end of which joins a pair of less distinct yellow lines, and posteriorly with 3 pairs of small white spots connected by transverse whitish lines that are slightly curved, *urinator.*
    - *d.* 2.—Epigynum almost as long as broad; legs above with distinct yellow marbling on the femora, below with distinct rings on the patellæ, tibiæ and metatarsi, the coxæ below clear yellow and lighter than the sternum; sternum blackish with a distinct yellow median band; cephalothorax with a distinct yellow median line; abdominal dorsum anteriorly with 3 pairs of lateral yellow lines connected with the median one, posteriorly without pairs of white spots and with a series of transverse yellow bands each of the shape of a W, ... *fontanus.*

Dolomedes sexpunctatus Hentz. Pl. XX, fig. 34.

Dolomedes sexpunctatus Hentz, 1841.
Dolomedes sexpunctatus Hentz, Emerton, 1885.
Dolomedes sexpunctatus Hentz, Montgomery, 1903.

(Numerous specimens from Austin, Texas, and one from Massachu-

Eyes.—First row broader than the second, much nearer to the second row than the clypeal margin, middle eyes lower and slightly larger. Eyes of the second row quite their diameter apart (♀) or less (♂). Third row broadest, its eyes on tubercles and nearly as large as those of the second row. Dorsal eye area about one-seventh the length of the cephalothorax. Quadrilateral of the middle eyes as long as broad (♀) or slightly broader than long (♂).

Form (♂).—The ♂ differs from the ♀ in the cephalothoracal outline being much more rounded, the head in front only one-third its greatest transverse diameter, the clypeus vertical so that the eyes project forward beyond it. The legs are very slender, the fourth longest and 5.8 times the length of the cephalothorax, the first slightly longer than the second, the third extending only to the end of the metatarsus of the second. The palpal tibia has a large process on its external surface as long as length of the tibia, and with a small tooth on the ventral distal apex.

Dimensions.	♂	♀ from Texas.
Cephalothorax,	4.5	9.5
Abdomen,	4	11
Leg I,	25	35
Leg II,	24	34.5
Leg III,	21	32
Leg IV,	26	40

Color of Male (specimen from Austin, in alcohol).—*Cephalothorax* pale yellowish-brown, sides below the submarginal white stripe darker, otherwise as in the ♀. *Sternum* pale yellowish-white with 3 pairs of distinct dark spots. *Abdomen* with the dorsal pattern very distinct. There is a dorso-median band along its entire length, yellow in color and bordered on each side by a somewhat narrower blackish band containing a row of 5 white spots, the two anterior of which are largest and furthest apart, while the three posterior are connected with the corresponding ones of the opposite side by transverse white lines; lateral to each of these blackish bands is a broader greenish-brown stripe. The sides are whitish, finely streaked with brownish. The venter is pale yellow. *Legs* very pale yellow, metatarsi and tarsi a little darker. *Palpi* pale yellow, the spine of the tibia and the lower surface of the palpal organ black.

Form (♀).—Cephalothorax in front truncated straight, somewhat less than one-half its greatest transverse diameter, its greatest diameter barely equalling the distance from the third eye row to the posterior margin, the cephalic portion not demarcated from the thoracic, highest behind the middle, posterior declivity very steep, clypeus obliquely inclined. Chelicera with 4 teeth on the inferior margin. Sternum longer than broad, rounded. Labium slightly longer than broad, truncated straight apically, widest a little behind its middle. Relative length of legs IV, II, I, III, III only slightly shorter than I and II, all rather stout and scopulated; length of leg IV to cephalothorax as 4.3 : 1.

Remarks.—The Texas specimens are larger than the northern ones, and the femora are more or less banded above with brownish.

Habits.—Very abundant at Austin, under the stones close to streams. Females with cocoons are most abundant in the fall. An adult male was found in November, and numerous nearly full-grown males in January.

Dolomedes fontanus Emerton. Pl. XX, figs. 35–37.

Dolomedes fontanus Emerton, 1885.
?*Dolomedes scriptus* Hentz, 1841.

(Specimens from Pennsylvania and North Carolina.)

Eyes.—As in *urinator.*

Form.—The general form of the ♀, proportions of the legs, mouth parts, etc., are as in *urinator.* The ♂ differs in having the truncated anterior end of the cephalothorax but little broader than one-fourth its greatest transverse diameter, in the cephalothorax being distinctly highest behind the middle, and in the greater slenderness of the legs, which in order of length are IV, I, II, III. The palpus is longer than the cephalothorax, its terminal joint large, the tibia with an elevated lamina on the outer side, this lamina longer than wide and with its free border forming two larger and one smaller tooth, the ventral apical edge of the tibia with two teeth; the proximal dorsal portion of the tarsus has an elongated prominence and a small elevated knob lateral to this.

Dimensions.	♂	♀
Cephalothorax,	7	7
Abdomen,	7	10
Leg I,	36	30.5
Leg II	33	31
Leg III,	32	28
Leg IV,	37	34

The largest ♀ has a cephalothoracal length of 9 mm.

Color of Females (in alcohol).—*Cephalothorax* brown with a narrow median line (splitting into two around the dorsal groove) from the clypeus to the posterior margin, from the median side of each posterior eye arises a yellow line which passes backward and is so curved that with its fellow of the opposite side it forms nearly a circle, its indistinct posterior end joining the median band anterior to the middle and at the point where a pair of small elongate black spots are apposed to the median line. On each side of the thoracal portion are three submarginal, rather broad and always distinct yellow marks which are placed obliquely. The extreme margin is black, and there are reticular black lines radiating from the dorsal groove. *Sternum* blackish with a yellow median band. *Abdomen* above greenish-brown, patterned distinctly with yellow as follows: There is a narrow median orange band, pointed at each end, which extends caudad not quite to the middle, from which arises on each side three oblique yellow lines, one from its posterior end, one (the longest) from its middle, and from its anterior end one which passes like the others latero-caudad and then bends at an angle to join the median band where the middle line joins it. On the posterior half of the dorsum are 4 transverse yellow bands, each of the shape of a W, the first of which is broadest and the first and second most distinct. The sides are greenish-brown, the venter paler greenish or yellowish. *Chelicera* black, *labium* and *maxillæ* reddish-brown with yellow ends. *Legs* above more or less distinctly ringed with yellow and reddish-brown, with a number of alternating rings on the femora, patellæ brownish, tibiæ yellow at the middle and brown at the ends, metatarsi dark at the middle and yellow at the ends, tarsi yellow proximally and brown distally; below the annulations are not as distinct as above, the femora finely mottled with greenish-brown and yellow, the coxæ yellow and lighter than the sternum. *Palpi* like the legs.

Color of Male (specimen from North Carolina, in alcohol).—*Cephalothorax* with the same pattern as in the ♀, but with yellowish-brown in place of dark brown. *Abdomen* like the ♀, but the yellow lines edged with black. *Mouth parts* yellow. *Legs* pale yellow without annulations, the distal ends of the tibiæ, metatarsi and tarsi black. The *pal pus* yellow, tibial apophysis and dorsal proximal portion of tarsus black.

Comparisons.—This may possibly be the same as *D. scriptus* of Hentz, but that species is hardly recognizable from Hentz's brief description and poor figure. It is nearly related to *D. urinator* Hentz (cf.).

Dolomedes urinator Hentz.

Dolomedes urinator Hentz, 1841.
Dolomedes tenebrosus Hentz, Emerton, 1885.
Dolomedes tenebrosus Hentz, Stone, 1890.
Dolomedes urinator Hentz, Montgomery, 1902.

(Numerous ♀♀ from Massachusetts, Pennsylvania, New Jersey, and Austin, Texas; 1 ♂ from Massachusetts.)

Eyes (♀).—First row broader than the second, its lateral eyes about their diameter from the second row, nearly straight, the middle eyes being only slightly lower than the lateral. Eyes of the second row almost their diameter apart. Third row broadest, its eyes almost as large as those of the second row and placed upon tubercles. Quadrilateral of the middle eyes about as broad as long.

Form (♀).—Cephalothorax in front truncated straight and not quite one-half its greatest transverse diameter, highest behind the middle, the cephalic portion demarcated from the thoracic, its greatest transverse diameter equalling the distance from the posterior eyes to its posterior end, clypeus high and slightly inclined. Chelicera with 4 ventral and 3 dorsal teeth. Labium slightly longer than broad, slightly rounded apically, not one-half the length of the maxillæ. Sternum rounded. Legs slender, IV, II, I, III, IV longer than I by not quite the length of its terminal joint. Length of leg IV to cephalothorax as 4.1 : 1. Femur IV with a tuft of thickened hairs posteriorly near its distal end.

Color in Alcohol (♀).—The abdominal dorsum in all the specimens shows anteriorly a more or less distinct median yellow line ending in a point in front of the middle, and (generally less distinctly) a short oblique yellow line at each side of its anterior end; on the posterior half are 3 pairs of small white spots, connected transversely by as many black lines which are not of the shape of a W, but slightly curved with the concavity directed caudad; each of these white spots is surrounded by black, and only the 3 pairs on the posterior half of the dorsum are always distinct, but anterior to them are 1–3 pairs which are usually very indistinct (represented usually by small obscure black spots without white centers).

Characters of the ♂.—An adult dried specimen of one of the original males, described by Emerton as the male of *tenebrosus*, was kindly loaned to me by Mr. Emerton. The eyes are as in the ♀, the first row almost straight. The legs are in order I, II, IV, III. Femur IV has on its posterior border near the distal end a prominent bunch of long thickened hairs or short spines, which are much more prominent than in the female. The palpal tibia has on its outer surface a long curved tooth, and is on its ventro-distal border prolonged into a long toothed process; the palpus is longer than the cephalothorax. This being a dried specimen it is difficult to compare it with the alcoholic specimens of the females; but the color of the legs is the same, and also the general abdominal pattern (the 3 pairs of white spots are very distinct, and also the slightly curved transversed blackish lines connecting them); the cephalothorax has a broad submarginal white band on each side, continued also across the forehead.

Comparisons.—There is no doubt that this is the *urinator* of Hentz; it possesses the pairs of small white spots on each posterior abdominal dorsum, and the slightly curved black lines (not of the shape of a W) connecting them, all shown distinctly in Hentz's figure. It is closely related to *fontanus*, and the epigyna of the two are very similar, but in *urinator* it is always much broader than long, and its median piece has a transverse groove just behind the middle, while in *fontanus* it is nearly as long as broad and is without such a groove. There are a number of constant differences, expressed in the key, which will serve to separate the species. The females of *idoneus* may be easily distinguished from those of both *urinator* and *fontanus* by the entirely different structure of the epigynum, and by leg IV being longer than I by less than one-third the length of the terminal joint.

Dolomedes idoneus Montgomery.

Dolomedes idoneus Montgomery, 1902.
?*Dolomedes tenebrosus* Hentz, 1841.

(♀ ♀ from Pennsylvania, New Jersey and Massachusetts.)

Eyes.—First row broader than the second, its middle eyes slightly larger and decidedly lower than the lateral (the dorsal margin of the middle eyes extends dorsad to a little beyond the level of the ventral margin of the lateral eyes), lateral eyes quite twice their diameter in front of the eyes of the second row. Eyes of the second row not quite their diameter apart. Third row broadest, its eyes on tubercles. Quadrilateral of the middle eyes as broad as long.

Form (♀).—Cephalothorax in front truncated straight, not quite one-half its greatest transverse diameter, the cephalic portion demarcated from the thoracic, highest at the posterior eyes. Chelicera with 4 ventral and 3 dorsal teeth. Labium as in *urinator*. Sternum slightly longer than broad. Legs rather slender, IV, II, I, III, IV and II nearly equal in length. Length of leg IV to cephalothorax as 4.1 : 1.

Comparisons.—Of all of Hentz's species this most nearly approaches his *tenebrosus*. But as I wrote before (1902), Hentz's description is entirely insufficient as a diagnosis; further, he placed *tenebrosus* under the "tenebrosæ" with the "eyes subequal, lower row as much curved as the upper," which is not the case in *idoneus;* and his figure of the mouth parts shows them entirely different from the condition in *idoneus*. It is high time that *tenebrosus*, which has occasioned so much dispute, should be allowed to fall into the synonymy on account of being insufficiently characterized.

Genus **PISAURINA** Simon, 1898.

Pisaurina mira (Walck.).

Dolomedes mira Walckenaer, 1837.
Dolomedes virgatus Idem.
Micrommata undata Hentz, 1841.
Micrommata serrata Idem.
nec *Micrommata carolinensis* Hentz, 1841.
Ocyale undata Hentz, Emerton, 1885.
Ocyale undata Hentz, Stone,1890.
Pisaurina mira Walck., Simon, 1898.
Ocyale undata (Hentz), Montgomery, 1902.

(Numerous specimens from Pennsylvania, New Jersey, Massachusetts and Texas.)

Eyes (♀).—First row separated from the clypeal margin by about the diameter of its eyes, broader than the second row, almost straight eyes equidistant, the middle slightly larger. Second row slightly broader than the area of the middle eyes of the first, its eyes not quite their diameter apart, slightly more than their diameter behind the first row and in diameter about 1.3 times the middle eyes of that row. Third row broadest, its eyes on tubercles and as large as those of the second row. Quadrilateral of the middle eyes longer than wide.

Form (♀).—Cephalothorax in front truncated straight and quite one-half its greatest transverse diameter, the cephalic portion quite well demarcated from the thoracic, about equally high at the posterior eyes and the dorsal groove, the clypeus nearly vertical. Sternum almost as broad as long, pointed behind. Labium widest at the middle, fully as wide as long, not one-half the length of the maxillæ, slightly convex apically. Posterior spinnerets longest. Legs slender, scopulæ not apparent, II, I, IV, III, legs I, II, and IV nearly equal in length. Length of leg IV to cephalothorax as 4.4 : 1.

Chelicera with 3 pairs of teeth.

Form (♂).—The eyes are as in the ♀, also the form and the relative length of the legs. The palpal tibia has on its outer border one small pointed tooth, little longer than wide.

Color of Male (in alcohol).—The only adult specimen seen (one from Massachusetts, loaned by Mr. Emerton) had the cephalothoracal pattern as in the ♀, but with the median band little darker than the sides. The abdomen above with the narrow green median line on the anterior half as in the ♀, but the broad brown band not at all defined, so that the dorsum is pale orange with on each side a row of several pale yellow, short oblique lines, corresponding in position to the margin of the broad brown band in the ♀. The rest of the coloration as in the ♀.

Nearly mature males from Texas have the dorsal dark bands as distinct as in the female.

Dimensions of ♂.

Cephalothorax,	5
Abdomen,	6
Leg I,	32.5
Leg II,	34
Leg III,	27
Leg IV,	30.5

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Explanation of Plates XVIII, XIX, XX.

All the figures have been drawn by me with the aid of the camera lucida, but the degree of magnification varies for the different figures. All the drawings of the palpal organs were made from the right-hand palpus.

Plate XVIII, Fig. 1.—*Lycosa euepigynata*, ♂, type, palpal organ.
Fig. 2.—*Idem*, ♀, type, epigynum.
Fig. 3.—*Lycosa insopita*, ♂, type, palpal organ.
Fig. 4.—*Idem*, ♀, type, epigynum.
Fig. 5.—*Lycosa antelucana*, ♂, type, palpal organ.
Fig. 6.—*Idem*, ♀, type, epigynum.
Fig. 7.—*Lycosa pictilis*, ♂, palpal organ.
Fig. 8.—*Idem*, ♀, epigynum.
Fig. 9.—*Trochosa noctuabunda*, ♂, type, palpal organ.
Fig. 10.—*Idem*, ♀, type, epigynum.
Fig. 11.—*Lycosa mccooki*, ♀, co-type, epigynum.
Fig. 12.—*Trochosa avara*, ♂, palpal organ.
Fig. 13.—*Geolycosa texana*, ♂, palpal organ.
Fig. 14.—*Idem*, ♀, type, epigynum.

Plate XIX, Fig. 15.—*Geolycosa latifrons*, ♂, type, palpal organ
Fig. 16.—*Idem*, ♀, type, epigynum.
Fig. 17.—*Idem*, ♀, dorsal view of cephalothorax.
Fig. 18.—*Idem*, ♀, lateral view of cephalothorax.
Fig. 19.—*Geolycosa baltimoriana*, ♂, palpal organ.
Fig. 20.—*Pardosa mercurialis*, ♂, type, palpal organ.
Fig. 21.—*Idem*, ♀, type, epigynum.
Fig. 22.—*Pardosa pauxilla*, ♂, type, palpal organ.
Fig. 23.—*Idem*, ♀, type, epigynum.
Fig. 24.—*Pardosa lapidicina*, ♂, palpal organ.
Fig. 25.—*Pardosa glacialis*, ♀, epigynum.
Fig. 26.—*Pardosa glacialis*, ♀, epigynum.
Fig. 26.—*Pardosa tachypoda*, ♀, epigynum.
Fig. 27.—*Pirata marxi*, ♀, from Massachusetts, epigynum.
Fig. 28.—*Pirata sedentarius*, ♂, type, palpal organ.
Fig. 29.—*Idem*, ♀, type, epigynum.

PLATE XX, Fig. 30.—*Trochosa rubicunda*, ♀, epigynum.
Fig. 31.—*Trabœa aurantiaca*, ♂, palpal organ.
Fig. 32.—*Idem*, ♂, lateral view of cephalothorax.
Fig. 33.—*Aulonia humicola*, ♀, lateral view of the cephalothorax.
Fig. 34.—*Dolomedes sexpunctatus*, ♂, palpal organ.
Fig. 35.—*Dolomedes fontanus*, ♂, palpal organ.
Fig. 36.—*Idem*, ♂, palpal tibia from the ventral surface.
Fig. 37.—*Idem*, ♀, epigynum.
Figs. 38, 39.—*Lycosa inhonesta*, ♀♀, epigyna of Texas specimens.
Fig. 40.—*Lycosa nigra*, ♂, type, palpal organ.
Fig. 41.—*Idem*, ♂, epigynum.
Fig. 42.—*Trochosa avara*, epigynum, ♀ from Texas.
Fig. 43.—*Trochosa cinerea*, epigynum, ♀ from Texas.

April 5.

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

Twenty persons present.

Mr. Arthur Erwin Brown made a communication on post-glacial centres of dispersal for reptiles in North America, the substance of which will be embodied in a paper to be presented later.

The following were ordered to be printed:

THE CELL-LINEAGE AND EARLY LARVAL DEVELOPMENT OF FIONA MARINA, A NUDIBRANCH MOLLUSK.[1]

BY DANA BRACKENRIDGE CASTEEL, PH.D.

OUTLINE.

Introduction.
Material and Method.
Nomenclature.
Earlier Work on Opisthobranch Development.
Maturation and Fertilization.
The Unsegmented Egg.
First Cleavage.
Second Cleavage.
Origin of Germ Layers.
  Segregation of the Ectoblast.
  Segregation of the Ento-Mesoblast.
  Segmentation of the Entoblast.
Cleavage History of the Ectomeres.
  The First Quartet.
  The Second Quartet.
  The Third Quartet.
Gastrulation.
  Ecto-Mesoblast
  Closure of the Blastopore.
Organogeny.
  The Velum.
    Later Velar Development.
  Head Vesicle.
  Nerve and Sense Organs.
    Cerebral Ganglia.
    Otocysts and Pedal Ganglia.
    Eyes.
  Excretory Organs.
  The Enteron.
  Stomodæum and Mouth.
  Shell Gland and Foot.
  Larval Musculature.
Change of Axis and Form of the Developing Organism.
Abstract.
Table of Cell-Lineage.

INTRODUCTION.

The study of the cleavage and early larval history of *Fiona marina* (Forsk.)[2] embodied in this paper was undertaken with the view of

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[1] Contribution from the Zoölogical Laboratory of the University of Pennsylvania.

[2] Dr. H. A. Pilsbry, of the Academy of Natural Sciences of Philadelphia, has kindly assisted me in identification.

obtaining, as far as possible, an exact knowledge of the development of this Opisthobranch, in order that certain doubtful points regarding the embryology of Mollusks in general, and this group in particular, might be better understood. *Fiona* has proved in many ways a difficult object for study, but in certain respects offers advantages to the investigator. The exact origin of the germ layers as they arise in the segmenting egg has been particularly sought throughout the cleavage history, while in later stages attention has been directed to the rise of larval organs from their particular protoblasts where these could be definitely determined. Where this has been found impossible, approximate results are given. Certain questions have presented themselves both at the beginning and during the progress of this work, some of which may here be indicated briefly. Though it has not been my purpose to consider particularly the mechanics of cleavage, this phase of development has been borne in mind, and in certain instances discussed. Comparisons are made between the nearly equal cleavage of *Fiona* and the more unequal segmentation of many other molluscan and annelidan eggs. The manner of origin of the germ layers is naturally a point of cardinal interest to the cell-lineage worker, since by this method of investigation the most exact results are possible and very definite comparisons with other forms may be made. The exact derivation of the middle germ layer has been sought particularly. Has it a single or double mode of origin? If both "primary" and "secondary" mesoderm be present, which is "larval" and which forms permanent organs? How is the mesoderm segregated from the two primary germ layers? In the study of larval structure and development the excretory organs are of much interest, since widely diverse views are held regarding the mode of origin and the significance of both primitive and definitive molluscan kidneys. The axial relations between ovum and larva and the relations of the early cleavage planes to the median plane of the larva and adult are points of great interest. How and when does bilaterality first appear? When does trosion first become manifest and what is its immediate cause? These and other questions have arisen and have been borne in mind during the progress of the work. Unfortunately material for the study of later larval stages and metamorphosis has not been obtainable, so that a complete record of development from ovum to adult has been impossible.

The work was begun in the early summer of 1901, at the Zoölogical Laboratory of the University of Pennsylvania, and continued, together with general graduate study, during the two following years at this

University, as well as throughout the two intervening summers at the Woods Hole Marine Biological Laboratory.

I am glad to acknowledge the many courtesies extended to me at both institutions. I am particularly indebted to Prof. Conklin, at whose suggestion the work was undertaken, and it is a pleasure to express here my sincere appreciation of the valuable assistance which he has given me by way of suggestion and kindly criticism.

Material and Methods.

For the material upon which this study has been made, I am indebted to Drs. E. G. Conklin and M. A. Bigelow, by whom it was collected at Woods Hole, Massachusetts, during the summers of 1897 and 1898. The Nudibranchs were found spawning upon floating gulf-weed in Vineyard Sound, taken to the Laboratory and kept in aquaria for some weeks, where they spawned prolifically and where, from day to day, the eggs were collected and preserved. They were fixed in Kleinenberg's stronger picro-sulphuric solution and Boveri's picro-acetic for one-half to three-quarters of an hour and washed in 50 and 70 per cent. alcohol, as is the usual custom. Living material upon which to study the breeding habits of the animals has not been accessible to me, though search has been made in the same locality during the last two summers. This lack of the living adult animals and embryonic stages has been a considerable drawback, as it is particularly desirable that one investigating the developmental history of an organism should be able to observe its physiological activities and thereby verify conclusions gained through purely morphological work. The material at hand has been amply sufficient for carrying the work up to the stage of the free-swimming veliger, but not to the metamorphosis. It is my hope that in the near future material for the study of later stages and of the metamorphosis into the adult may be obtained, as many questions relative to the fate of larval organs must remain unanswered until this be accomplished.

Contrary to the conditions found among some other Nudibranchs, the gelatinous mass surrounding the egg-capsules does not become greatly hardened upon fixing, for upon being brought into water the jelly usually dissolves, leaving the eggs free in their individual capsules. The eggs may be sectioned without removing the jelly, as it cuts without difficulty. Both whole mounts and sections were stained in Delafield's hæmatoxylin diluted with six to ten times its volume of distilled water and slightly acidulated by the addition of a trace of HCl, or Kleinenberg's stronger solution after the method of Conklin.

This stain gives a reddish tint which differentiates the nuclei with great distinctness. Iron hæmatoxylin proved entirely unsatisfactory for sections of both early and late stages, for even in the old veligers almost all the cells are found to contain small yolk spherules which take up the hæmatoxylin so strongly and hold it so tenaciously that nuclei and cell walls are indistinguishable. Eggs which have just been stained and mounted are not favorable objects for study, but they should, if possible, stand for some time, the longer the better, until they gradually become more transparent by the penetration of balsam. Indeed, the most favorable slides are a few put up at the time the material was collected. By the addition of a little cedar oil to the balsam, or by moistening the edges of the cover with xylol at the time of using, it is always possible to roll the eggs by moving the cover—a very necessary process in cell-lineage work. Most of the observation and drawing was done with the aid of a Leitz objective 7, ocular 4, a Zeiss camera being used, with the paper at table level and plates reduced as indicated. A $\frac{1}{12}$ Leitz immersion was also used for observation when necsseary.

Nomenclature.

As a matter of convenience and for the sake of uniformity, I have followed the system used by Conklin (1897) with but slight variation.

A cleavage is oblique to the right when the upper daughter cell lies to the right of an imaginary observer whose body corresponds in position to the primary egg axis, his head being at the animal pole and facing the cell considered; *vice versa,* a division oblique to the left is one in which the upper cell lies to the observer's left. In the first instance the cleavage is *dexiotropic*, in the second *læotropic* (Lillie, 1895).

The term "quartet" is used to designate a generation of cells or their derivatives given off from the four cells meeting in the center of the vegetative pole, regardless of their fate. The different quartets are designated by coefficients placed before the letter indicating in which of the four quadrants the cells lie, while the cell generations are marked by exponents which follow the letter. The upper cell resulting from a cleavage is, in all cases, indicated by the smaller exponent; thus, $2b^{11}$ indicates the upper cell in B quadrant of the second quartet arising from the division of $2b^{1}$, while $2b^{12}$ is the lower. When the spindle lies in a horizontal direction or, in other words, when the cleavage plane is meridional, the cell which lies to the right is given the smaller exponent, to the left the larger. The capital letters A, B, C, and D are reserved for the four cells which meet at the center of the vegetative pole ("macromeres") and from which the "micromeres" arise; for these latter the small letters a, b, c and d are used. Child (1900) and Treadwell (1901) have been followed in giving coefficients to the macromeres also, to indicate their generation, this being desirable when dealing with an egg in which, after the first few cleavages, the "macromeres" are large in name only. "Thus A, B, C, and D form the four-cell stage. At their next division from A arises 1A and 1a; from B, 1B and 1b, etc.; 1A then divides into 2A and 2a, while 1a divides into $1a^1$ and $1a^2$" (Treadwell).

Earlier Work on Opisthobranch Development.

A rather large number of older investigators have worked upon Nudibranch larval development. Grant (1827) described the veligers of *Æolis* and *Doris*. In 1837 Sars discovered that the young of *Tritonia, Doris* and *Æolis* possess a nautiloid shell; additional researches by the same investigator appeared in 1840 and 1845. Lovén (1839) described a number of Nudibranch larvæ together with those of other mollusks. Alder and Hancock's magnificent monograph upon the British Nudibranchs appeared in 1845 and contains a good general account of the results thus far obtained upon the subject of Nudibranch embryology. Reid in 1846 published an interesting paper upon the breeding habits of *Doris, Goniodoris, Polycera, Dendronotus, Doto,* etc., together with the constitution of the larvæ. An account of the embryology of *Tergipes* by Nordman appeared in the same year. An extremely thorough account of the development of the Tectibranch *Actæon* by Vogt also appeared in 1846. In 1848 Koren and Danielssen described the early stages of a number of Nudibranchs from the Norwegian coast. Schneider (1858) described the veliger of *Phyllorhöe.* Keferstein and Ehlers (1861) gave an account of some of the developmental stages of *Æolis.*

The later investigations of Langerhans (1873), Lankester (1875), Trinchese (1880–1–7), Lacaze-Duthiers and Pruot (1887), Rho (1888), Mazzarelli (1892–3–5), Heymons (1893), Viguier (1898), Carazzi (1900), Guiart (1901), and other works upon Opisthobranch embryology, together with those of importance pertaining to the remaining molluscan groups, Annelids and Platodes, will be considered during the course of this paper.

A good general account of spawning habits of Nudibranchs is found in Alder and Hancock's "Monograph of the British Nudibranchiate Mollusca" (1845).

Maturation and Fertilization.

It is not the purpose of this paper to discuss in detail the maturation processes of the egg, but a few words in that connection may not be amiss. Maturation appears to have begun at the time of laying, since the first polar spindle is already formed in all eggs examined. In fig. 1 the chromosomes have moved to opposite ends of the first maturation spindle, and at a slightly later period, fig. 2, the sperm may be seen making its way through the yolk globules toward the upper pole. In a large number of sections examined the sperm is seen to have entered at some point below the equator of the egg, though apparently never directly at the center of the vegetative pole. The chromatin of the sperm nucleus is but slightly evident at this time, but astral radiations are strongly marked in the surrounding cytoplasm. The clear more protoplasmic substance of the egg becomes aggregated principally around the first polar spindle and in the neighborhood of the sperm nucleus, though long strands of finely granular protoplasm extend through nearly the entire egg, forming the astral rays. The yolk, which is in the form of rather small yolk globules, encroaches closely upon these centers, but is not, as a rule, found within them. As the first polar body arises, the upper surface of the egg becomes distinctly indented immediately above the first polar spindle and from this depression the first polar body emerges, bearing with it the distal end of the first maturation spindle, which rises as a whole toward the upper surface of the egg. During this process the sperm nucleus and aster remain in relatively the same position as before. There appears to be no telophase to this division, but without entering into a rest stage the second polar body is given off. This arises from the same place as the first, pushing the latter farther outward or somewhat toward the side (Pl. XXI, fig. 3). Both finally lie in the slight depression at the surface of the egg. The female nuclear elements still left within the egg then come to rest, at first lying closely against the cell wall below the polar bodies. The first polar body does not divide again immediately and may never do so, though usually at a later period three are found. If it remains undivided the first polar body exceeds the second in size.

With the close of maturation the sperm nucleus is seen to have moved upward through the yolk; its chromatic elements have become more evident several large nucleoli being present. The same is true of the female pronucleus. They now approach each other, and come to lie with their nuclear walls closely appressed (fig. 4), the egg nucleus lying above and the sperm, which is the smaller, below. The clear granular protoplasm of the egg together with the sphere material surrounds both nuclei. The upper surface of the egg has resumed its former rounded outline, pushing the polar bodies farther outward. Their connection with the egg does not appear to be a very intimate one for they do not, in most cases, maintain at a later period any fixed relation to the poles of the egg and so are of little value in orientation, though they are often found in the apical region.

Unsegmented Egg.

The unsegmented egg of *Fiona* averages in diameter 80 micra with polar axis slightly less. The two polar bodies lie at the animal pole. Though the ovum is rather densely yolk-ladened, the yolk globules are of such small size that in future cleavages they tend to become more equally distributed among the resulting blastomeres than is the case with eggs containing yolk in larger spheres. The yolk which encroaches upon the more protoplasmic environs of the nucleus consists of smaller globules, but otherwise its distribution throughout seems quite equal.

The universal distribution of yolk to all the cells of the segmenting egg of *Fiona* is probably to be correlated with the smaller size of the individual yolk globules. It is safe to infer that each yolk body in an egg, whether it be small or large, is surrounded by a thin layer of protoplasm. In eggs containing a relatively larger number of yolk globules or, in other words, where they are small in size, a greater amount of cytoplasm will be distributed throughout the egg, when compared with that aggregated around the nucleus, than is the case when the single aggregations of yolk are large. When this is the case and division occurs the whole mass will be more influenced by nuclear and cytoplasmic divisional activity than when the cytoplasmic constituents are more definitely separated from the yolk. Just what this activity is we do not know, but a comparative study of eggs showing large macromeres with those like *Fiona*, in which cleavage is more equal, will, I think, show that in the former case the individual yolk masses are much larger than in the latter, thus allowing for greater cytoplasmic influence where more finely divided yolk is found. The more equal division of cells naturally results in a wider spread of yolk through the developing organism, and it might also be added, as a corollary to this, that the absorption of more finely divided yolk is doubtless much more readily accomplished than where large globules are found, thus rendering it possible that such a wide distribution should occur in cells not alimentary in function.

Before segmentation the nucleus lies but slightly above the center of the egg, having moved downward with its surrounding mass of granular protoplasm. An extremely thin and easily ruptured vitelline membrane surrounds the egg, and on account of the delicacy of this membrane no micropyle is present. Usually one but often two or three eggs lie together within a roomy egg capsule, containing also a fluid substance which does not coagulate in reagents. In unstained fixed material, and also doubtless in the living state, the eggs are quite opaque from the yolk which they contain.

First Cleavage.

The first cleavage is initiated by nuclear rupture and increased evidence of stellar radiation. With the formation and elongation of the spindle the surrounding yolk spherules give place to the more protoplasmic constituents of the cell which form the immediate nuclear environs. The spindle as it elongates moves somewhat farther downward in the egg and lies but slightly above the equatorial plane. In length it measures about half the diameter of the egg. From the first constriction is almost equally marked all around the egg, though slightly greater at the animal pole. After the chromosomes have separated and are moving toward the opposite ends of the spindle, one end appears somewhat higher than the other (fig. 5), a position which would indicate a spiral trend of cleavage; but this is not evident in the telophase and completed division, for in the two-cell stage the nuclei lie directly opposite each other.

As in the usual history of cleaving eggs, the resulting blastomeres are at first much rounded, but as their nuclei form they become closely pressed together, forming a flattened contact surface between which no cleavage cavity exists (fig. 6). The nuclei, together with their surrounding cytoplasm, again approach the upper surface of the egg and lie at rest just beneath the surface on opposite sides of the polar bodies. There is no evidence in their position to indicate a "virtual" rotation before the next cleavage, as is the case in *Crepidula* (Conklin, 1897). The daughter nuclei of the first cleavage becomes much dilated, containing several nucleoli suspended in the chromatin network and surrounded by clear nuclear fluid.

The two blastomeres thus formed are equal or so nearly equal in size that they present to the observer no mark of distinction, and it can only be conjectured which will form the anterior and which the posterior region of the larva. Indeed, not until the appearance of the mesentodermal cell at the close of the twenty-four-cell stage can this distinction be drawn, for until that time all quadrants appear identical, though doubtless cytoplasmic and nuclear differentiation is present. As a result of this similarity of all the quadrants the figures, until the appearance of the mesentoderm cell, have of necessity been labelled arbitrarily. Of course, even in the two-cell stage lateral may be distinguished from terminal areas, for by following succeeding cleavages and marking the relation which the lower polar furrow bears to the first cleavage plane and the later relation of both to the median plane of the embryo, it can be determined that the first cleavage plane is obliquely transverse to the median plane. But not until a later period does posterior become distinguishable from anterior end.

In the formation by first cleavage of two cells of equal size, *Fiona* agrees with a large number of Mollusks and Annelids, among the former of which may be mentioned *Ischnochiton* (Heath, 1899), *Neritina* (Blochmann, 1881), *Crepidula* (Conklin, 1897), *Ercolania* (Trinchese, 1880), *Tethys* (Viguier, 1898), *Planorbis* (Rabl, 1879, and Holmes, 1900), *Limax* (Kofoid, 1895, and Meissenheimer, 1896), and among the latter *Lepidonotus* (Mead, 1897) and *Podarke* (Treadwell, 1901).

Unequal cleavage appears to occur as commonly as equal among Opisthobranchs, examples of which are *Acera* (Langerhans, 1873), *Aplysia* (Blochmann, 1883; Carazzi, 1900), *Umbrella* (Heymons, 1893) and *Philine* (Guiart, 1901).

Second Cleavage.

The second cleavage results in four cells of approximately equal size. The spindles which precede it lie at right angles to the first cleavage spindle. and nearly parallel to each other, the left end of each, however, being slightly higher than the right, showing the læotrophic character of the division. As cleavage proceeds this tendency becomes more marked, the upper or left-hand cells (A and C) lying higher than the right (B and D). In consequence of this the second cleavage planes do not meet in a line at the vegetative pole, but a portion of the original first cleavage plane unites them in the ventral polar furrow ("Querfurche" or "Brechungslinie"), the cells B and D being in contact below, while A and C never meet at the lower pole. At the upper pole no furrow is present in *Fiona*, the four cells all joining in a common central point. As is the rule among Annelids and Mollusks in which the second cleavage is læotropic, the ventral polar furrow taken in connection with the first cleavage plane, bends to the right when viewed from the animal pole, and, *vice versa*, it turns to the left if considered as a part of the second cleavage plane. *Fiona* is no exception to the above rule, and by observing the position of this furrow the first and second cleavage planes may be kept distinctly in mind until outwardly visible differential changes in the quadrants present other landmarks for orientation.

Origin of Germ Layers.

Segregation of the Ectoblast.

By the next three divisions in which the four macromeres participate the entire ectoblast arises.

First Quartet.—The spindles which precede the appearance of the first quartet of micromeres lie at first nearly radial, their proximal ends being distinctly higher than the distal. As a rule, all four spindles do not show the same stage of karyokinetic activity, though irregularities of this nature are not as yet greatly marked (fig. 9). As division proceeds they turn in a dexiotropic direction and with associated cytoplasmic constrictions four small cells are given off toward the animal pole (Pl. XXII, figs. 10, 11). These, the first quartet of micromeres, are in size about one-fourth that of their parent macromeres. As they round out in shape they are pushed farther toward the right, and finally come to lie in the furrows to the right of the large cells from which they arose. With the completion of cleavage the whole egg again takes on a decidedly rounded contour, the micromeres changing materially in shape, becoming more flattened on their outer surfaces and sharp-angled below to fit the indentations between the macromeres (fig. 14).

Second Quartet.—The second quartet arises læotropically, thus regularly alternating in direction of cleavage with the first. The derived micromeres are but slightly smaller than the underlying cells from which they arise and are pushed strongly toward the left as they are given off. By this movement the four cells of the first quartet are also carried somewhat to the left, though the rotation is not great. All the second quartet cells are alike in size, there being no sign of increase in D quadrant, as is the case with many Annelids and some Mollusks; nor is there marked difference in their time of origin, though in future cleavages of the egg irregularities in the time at which divisions occur in similar cells of the four quadrants become more and more marked. In cytoplasmic structure these cells appear to differ little from their parent macromeres, though probably they contain less yolk. Their ultimate position is opposite and beneath the division walls of the first quartet, but they do not appear to become so flattened as their predecessors (figs. 13, 14).

The Trochoblasts.—Before the macromeres again divide the first quartet is seen to be in process of cleavage. There result eight cells of nearly equal size, the more peripheral being slightly smaller than those at the apical pole. The spindles which precede division are læotropically directed, and the lower cells are pushed downward and outward between the second quartet cells and just above the macromeres (figs. 15, 16). These "primary trochoblasts" or "turret cells" do not again divide until about sixty cells are present (Pl. XXV, figs. 33, 38), when they have become considerably flattened and lie between the arms of the forming ectoblastic cross. The fate of these very characteristic cells will be discussed later.

Third Quartet and First Division of Second Quartet.—The first division of the second quartet and the third division of the macromeres occur simultaneously. Each second quartet cell forms two of equal size by a distinctly dexiotropic cleavage, the spindles being from the first inclined in that direction. As may be seen in figs. 17 and 18, these cells do not all divide at exactly the same time, and this lack of regularity is also characteristic of the macromeres. By this division of the second quartet the eight cells of the first are pushed backward dexiotropically so that, in relation to the macromeres, they occupy the same place as when given off. The division of the macromeres results in the four cells of the third quartet. They arise in a dexiotropic manner and are equal in size to the four cells left at the lower pole. From this stage on these latter are "macromeres" in name only, being equalled in size by the third quartet and but slightly larger than the eight derivatives of the second. Nor, indeed, do the macromeres appear at this stage to contain much more yolk than the micromeres. At a later period they are easily discernible from the micromeres by their clear yellow appearance, but as the latter divide much more rapidly and by growth distribute the yolk which they contain over a larger area, while much of it is doubtless absorbed, the preponderance of this material in the individual cells of the endoderm and the larger cells of the mesoderm as well is easily explained. As has been mentioned before, in the larva the amount of yolk in ectodermal structures is quite considerable, showing its wide and universal distribution throughout the entire organism.

The twenty-four-cell stage has thus been reached and as yet the egg is radially symmetrical (Pl. XXIII, fig. 19). At the center of the upper pole lie four "apical" cells, while the "trochoblasts" or "turret cells" extend from them into the angles between the second and third quartet cells. The third quartet and first generation of second quartet lie between them and the macromeres beneath, but from the nature of the cleavages do not form so marked a ring as in *Crepidula* or other Mollusks with large macromeres. The ectoblast has been entirely separated from the underlying macromeres, which contain all of the entoblast and the greater portion of the mesoblast. A small portion of the latter is to be derived, as will be shown later, from the third quartet of ectoblast cells. The egg has become somewhat flattened along its polar axis and within is a small cleavage cavity, which arose during the last few divisions and which later becomes of considerable size. Upon the lower surface the polar furrow remains distinct and offers a convenient means of orientation.

The fact that in Mollusks, Annelids and Platodes the entire ectoblast is separated from the entoblast by the first three successive divisions in which the macromeres participate is a point of similarity of the highest importance in considering the question of the possible genetic relationships of the groups. With scarcely an exception (*Dreissensia*, Meissenheimer, 1901) this is accomplished by regularly alternating spiral cleavages. In most cases the first three quartets of micromeres are small protoplasmic cells and differ widely from the yolk-ladened macromeres, and this is particularly true of the first series being correlated with the later history of the cells which compose it, since in all cases they form the apical pole and the sense organs of the larva. Where much yolk is not present, or the spherules are small, more equal cleavage results, so that the macromeres are reduced in size; as examples may be cited many Pulmonates (*Planorbis*, *Physa*, *Limnæa*, *Limax*) and Lamellibranchs (*Unio*, *Cyclas*, *Dreissensia*), *Chiton* and *Ischnochiton* among the Amphineura, *Trochus* for the Prosobranchs and the Opisthobranchs *Tethys* and *Fiona*. The same is true of many Annelids (*Podarke*, *Amphitrite*, *Clymenella*, *Arenicola*, etc.).

Both in size of cells and rate and direction of division the egg of *Tethys* (Viguier, 1898) exactly parallels that of *Fiona* up through the twenty-four-cell stage. The same may be said of *Aplysia* (Carazzi, 1900, and Georgeovitch as corrected by Carazzi, 1900), except for the larger size of the macromeres, particularly the anterior ones, and Carazzi's statement that the trochoblasts arise from division of the first quartet—"con fusi distintamente dessiotropici." Such is, however, not the case, as his figures show. Carazzi has evidently, in some unaccountable way, become confused with regard to the direction of cleavage of these cells, for in another place, after quoting Conklin's statement regarding the trochoblasts of *Crepidula*, that these cells "continue to rotate in a clockwise direction," he adds "E la sua fig. 16 mostra i fusi dessiotropic". As any one acquainted with cell-lineage work can see by reference to the figure mentioned, the upper ends of the spindles all lie to the left of the lower, and if there be any question as to the ultimate læotropic direction of these cleavages a glance at Conklin's fig. 17 removes all doubt. In *Trochus* (Robert, 1903), *Crepidula* (Conklin, 1897) and *Fiona* the trochoblasts are given off by division of the four cells of the first quartet before the second quartet cells divide. In the case of *Trochus* the second quartet is just being formed when the trochoblasts divide. Moreover, *Trochus* shows no rest stage at twenty-four cells as do the other two, for while the third quartet is forming and the second is dividing for the first time all eight cells of the first quartet again divide, and these cleavages are followed by renewed division of second quartet cells. The mesoblast cell, 4d, does not form in *Trochus* at this time but much later (sixty-four-cell stage), while in *Crepidula* and *Fiona* it appears immediately after a short rest period following the twenty-four-cell stage. The sequence of cleavages of *Planorbis* (Holmes, 1900) up to the twenty-four-cell stage closely follows *Crepidula* and *Fiona*.

Segregation of Ento-Mesoblast.

After a period of rest during which no cells are dividing and twenty-four are present in the egg, cleavage occurs in one of the macromeres. This macromere corresponds to that which has heretofore been arbitrarily designated 3D, and from this period onward the four quartets may be definitely distinguished. The division is læotropic and the larger daughter cell, 4d, will later gradually sink into the segmentation cavity, forming a depression at the posterior end of the vegetative surface in the angle formed by the macromeres 3C and 4D, and otherwise bounded by 3d, 3c and the derivatives of 2d. 4d is thrown toward the left and, therefore, in the direction of the median plane, though at first it does not lie quite in that plane but slightly to the left of it or, in terms of spiral cleavage, to its right (Pl. XXIV, fig. 24). In contradistinction to conditions found in heavily yolk-ladened eggs, this cell takes on from the beginning the position of a middle germ layer coming shortly to lie within the cleavage cavity, though, as will be seen later, its derivatives do not all appear to be mesodermal in character. After all three quartets and also the macromeres with the exception of 4D have divided, and when there are present about 44 cells (fig. 25), 4d or, as it hereafter will be designated more usually, the mesentoblast, ME, divides dexiotropically into cells of equal size. Before their next cleavage occurs the egg contains about seventy cells (fig. 42). By this division, which is bilateral, one small cell arises anteriorly from each of the large ones (figs. 42, 49). The small cells, E^1 and E^2, correspond to the "Primary Enteroblasts" of Conklin, and will be so designated. Considerable variation may be observed in different eggs as to the later position of these cells, as in some they appear to have moved backward along the sides of the large cells, Me^1, Me^2, from which they arose, but, as a rule, they remain in close relation to 4D, and always in later stages may be seen associated with the derivatives of this cell, from which it is hard to distinguish them (Pl. XXIX, figs. 71, 73). The large cells soon divide again into almost equal parts, though the posterior and dorsal pair (m^1z^1, m^2z^2) are slightly smaller (fig. 71). These latter soon divide again, giving rise to two small cells, z^1 and z^2, which are posterior to the larger (fig. 73). Just before this cleavage the two cells M^1e^1, M^2e^2 divide, giving rise anteriorly and toward 4D to two small cells, e^1 and e^2 (corresponding to the "Secondary Enteroblasts" of Conklin), which lie close to the first pair of small cells, E^1, E^2, the four forming a group of little cells with deeply staining nuclei in close contact with 4D, 5C and 5B. Behind them lie the large cells M^1, M^2. In the nomenclature used these would correspond to "Mesoblastic Teloblasts," but before they begin to function directly as such each again divides, giving off a small cell laterally, and these two cells appear to be dorsally directed toward the cleavage cavity above and to the sides of the enteron, but may remain associated with E^1, E^2, e^1 and e^2. However this may be, the mesoblastic teloblasts soon begin to divide, giving off an irregular row of cells which extend around the gastrula laterally. The cells m^1 and m^2 also behave in a similar manner, their derivatives being closely associated with those of the large teloblasts. In figures 80, 81 and 82 only the derivatives of the latter are shown, the other lying dorsal to them. As the teloblasts and the cells m^1 and m^2 divide they diverge laterally and leave behind and between them the smaller cells E^1, E^2, e^1, e^2, closely associated with the posterior elements of the enteron. When these cells are first given off they lie decidedly above the level of the enteric invagination projecting upward into the cleavage cavity, and while in this position might well be characterized as mesodermal elements; but later they change their position, slipping in between the teloblasts and the posterior cells of the enteron, and by the time the teloblasts begin to separate and wander toward the sides of the gastrula these small cells, which have been derived from 4d, lie nearer the ventral surface than the cells which form the bottom of the invaginating enteron and closely appressed against the posterior boundary of this region. The small cells z^1, z^2, which are the posterior derivatives of the division of m^1z^1, m^2z^2, also continue to lie near the median line in the posterior region of the gastrula, closely pressed and flattened against the ectoderm.

The later history of the enteroblasts, which I believe are concerned in the formation of the intestine, will be discussed in connection with the development of the enteron.

In comparing the mesoblast formation of *Fiona* with that of other forms, *Crepidula* will be considered first, since in this Prosobranch 4d was first found to contain both entoblastic and mesoblastic material (Conklin, 1897). Here 4d arises when twenty-four cells are present and by a læotropic division. This cell soon cleaves dexiotropically into two of equal size. At the next cleavage there result in *Crepidula* four cells of similar size, the posterior and lower pair being the first enteroblasts, while in *Fiona* it is the anterior smaller cells which are entoblastic. At the next cleavage in *Crepidula* the large cells Me^1, Me^2, which still contain both mesoblast and entoblast, give off smaller purely mesoblastic cells anteriorly (m^1, m^2), while in *Fiona* the larger posterior cells give rise posteriorly to similar cells, though they may not be purely mesoblastic. The next cleavage of M^1e^1, M^2e^2 in *Crepidula* completely segregates mesoblast and entoblast, the cells of the latter lying posterior to the mesodermal elements. This division separates two more small enteroblasts in *Fiona*, which here lie with the first enteroblasts anterior to the large cells, M^1, M^2; each gives rise to another small cell anteriorly in *Fiona* which may be enteroblastic, otherwise from this period on they function as teloblasts of the mesoderm.

From the above comparison it is evident that if we consider the position of the mesodermal and endodermal constituents of 4d in connection with the segmented egg as a whole, directly opposite conditions are found. In *Crepidula* the derivatives of this cell form mesoderm anteriorly and laterally, entoderm posteriorly, while in *Fiona* the reverse is the case. But in both forms, if we consider the position of the enteroblasts not in relation to the egg as a whole, but only in connection with the macromeres with which they are to be associated, it will be seen that in both *Crepidula* and *Fiona* these cells are directed toward the posterior region of the cells 4D, 4C, or their derivatives, and that the reverse relations of the enteroblasts and mesoblasts in *Crepidula* and *Fiona* is the direct result of epibolic gastrulation in the one case, embolic in the other, which is in turn caused by the quantity and nature of the yolk which the macromeres contain. An intermediate condition is found in *Nereis* (Wilson, 1898). Text-figure 1 (a) shows a sagittal section through the cleaving egg of *Crepidula* after one enteroblast has been separated from the mesoblast. The ectoblast has here but half covered the yolk, and the entoblastic element is thrown downward and backward in the direction in which it must go if it follows the ectoderm over the yolk, and finally reaches a position posterior to the blastopore as that structure is closing (Conklin's fig. 61). In *Nereis*, text-figure 1 (b), the ectoderm has advanced much farther over the yolk when the enteroblasts arise, and here we see that these elements are also directed downward but at the same time anteriorly. The next and last step in their change of position is illustrated by *Fiona*, text-figure 1 (c), in which, on account of its invaginate gastrula, the enteroblasts are not only anteriorly directed, but also at first lie higher than the cells from which they arose.

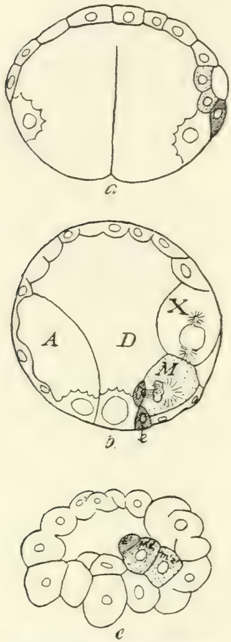

Fig. 1.—Sagittal sections through the gastrulæ of (*a*) *Crepidula* (Conklin), (*b*) *Nereis* (Wilson) and (*c*) *Fiona*. The enteroblasts are lined, the mesoblastic cells stippled.

In *Trochus* (Robert, 1903) the mesoblast arises at about the sixty-four-cell stage by a læotropic division which separates the very large cell 4d from 4D. This cell divides dexiotropically and equally when eighty-nine cells are present. When there are one hundred and eighteen cells, each of the two derivatives of 4d divides, and of the resulting four cells the anterior pair are the smaller. Later the two larger posterior cells divide. Robert has not found endodermal elements to arise from 4d, but does not reject the possibility of such a condition.

As might be expected from their close relationship, a nearer correspondence in the cleavage series is found when we compare *Fiona* with

Umbrella, although Heymons' conclusion regarding the fate of the descendants of 4d is at wide variance with the conditions which are found in *Fiona*. After the cleavage of 4d into equal parts, Heymons states that two small cells are given off from these, so that they lie in the posterior region of the macromeres. It is very evident from his figures that these cells, which would correspond to E^1, E^2 of *Fiona*, at first lie quite dorsal to the enteron and in the cleavage cavity. The large cells next divide nearly equally, the most posterior being slightly smaller and corresponding in size and origin to m^1z^1, m^2z^2. These latter shortly change their position in *Umbrella* exactly as in *Fiona*, for, says Heymons, "Bald beginnt eine interessante Lagerungsverschiebung einzutreten. Es rucken namlich die hinteren Zellen weiter nach dem animalen Pol hin und legen sic vollkommen auf die vorderen auf". While this rearrangement is occurring and after its completion two and later other small cells are given off by the large underlying cells toward the smaller cells originally budded forth. Exactly the same process occurs in *Fiona*—compare Heymons' figs. 23 and 24 with my fig. 71. Heymons' smaller cells M′, M′ (corresponding to m^1z^1, m^2z^2 of *Fiona*), which have moved toward the animal pole of *Umbrella*, do not appear from the account to divide again so quickly as in *Fiona*, but that they later divide teloblastically is evident. As has been mentioned before, the small anterior cells of *Umbrella*, which correspond to E^1, E^2, e^1, e^2, of *Fiona*, at first lie entirely within the segmentation cavity. Figures of later stages, however (Heymons' fig. 29), show that they then lie at a level with the posterior cells of the enteron (D, A′, C′, etc.), and are directly between these and the anal cells. The same relative position is taken by the corresponding cells of *Fiona*.

In interpreting the results of Heymons the above point of view is somewhat different from the comparison of Conklin between *Umbrella* and *Crepidula*, in which he suggests a resemblance and possible similarity of origin between the enteroblasts of *Crepidula* and the teloblastic cells M, M, M′, M′, of *Umbrella*. In both these "are large cells containing a considerable quantity of yolk, about equal in size and grouped in a characteristic way"; but the same may be said of the similar cells of *Fiona*, yet they have no part whatever in the formation of the enteron, though from their appearance I was led to think such might be the case before a knowledge of their later history proved otherwise. The explanation of the whole matter lies in the axial change which the derivatives of 4d have undergone in the forms considered. The posterior macromeres (particularly D) of *Umbrella* are relatively small, the same result being here obtained as in *Fiona*, in which the entoblastic elements are produced from the anterior rather than from the posterior side of the teloblasts. If any of the descendants of 4d of *Umbrella* described by Heymons are entoblastic in nature they are those which arise in this way, and these are the cells which must be compared with the enteroblasts of *Crepidula* and the small anterior cells in *Fiona*.

Viguier (1898) describes and figures the formation of the mesoderm in *Tethys fimbriata* as similar to that of *Umbrella*, and a comparison of figures will show almost exact correspondence. Like Heymons, Viguier does not consider the derivatives of 4d to be other than mesodermal in fate.

Carazzi (1900) derives both mesoderm and endoderm from the cell 4d ("EM") of *Aplysia*. He states that the cleavage which forms this cell is dexiotropic in direction, and such appears to be the case from his figures. The cell 3A of *Aplysia* is larger than the others, thus throwing 3D so much to the right of the median line that a dexiotropic cleavage is necessary tc place the mesentomere upon this line. The divisions of 4d which follow are identical with those of *Fiona*, but Carazzi's conclusions regarding the fate of the remaining blastomeres are quite different. Four pairs of small cells are derived from the two large cells and lie anterior to them. These correspond in position to the four (or more?) enteroblasts of *Fiona*, but by Carazzi are described as mesodermal. Two larger cells have been given off posteriorly and correspond to m^1z^1, m^2z^2 of *Fiona*. From each of these a small cell buds forth posteriorly, the two lying near the ectoderm. These small cells are, according to Carazzi, enteroblasts, and go into the intestine. Cells similar to these in origin and, for the time at least, in position are found in *Fiona* (z^1, z^2) lying closely pressed against the ectoderm in the posterior region of the gastrula. They are small in size, and at a later time I have found it impossible to distinguish them from many small mesodermal cells which crowd that region of the gastrula. If they do not shift their position, they would naturally become involved in the formation of the distal end of the intestine either directly, as lining cells of that organ, or as muscle cells for its walls. One cannot help feeling in comparing the development of the two forms and noting the great similarity in the history of the early derivatives of 4d that their fate is also the same; and the same might also be said of the small anterior elements which Carazzi indicates as mesodermal.

Lillie (1895) concluded that in *Unio* the derivatives of 4d were entirely mesoblastic. The two teloblasts give origin to two small cells anteriorly which lie near the enteron and are probably concerned in the formation of splanchnic musculature. Similar conditions are found to exist in *Dreissensia*, according to Meissenheimer (1901).

Among the Pulmonates the work of Rabl (1879) is confirmed by Holmes (1900), who finds that all the derivatives of the primary mesoblast are mesoblastic in fate. More particularly he states that the two bilaterally placed teloblasts give rise to a pair of small cells anteriorly, after which the large cells divide into equal moieties. Wierzejski (1897) says of *Physa fortinalis*, "Dass der Modus der Bildung eines Theiles des Mesoderm bei *Physa*, desjenigen aus der Urmesoderm-Zellen fast ganz derselbe ist wie ihn Heymons für *Umbrella* eingehenden dargestellt". In the last stage described the mesoderm consists of twelve cells, a group of six small cells anteriorly placed, behind which are a pair of "Urmesoderm-Zellen" from which they arose, while behind and above lie two other rather large mesoderm cells which have given off a pair of small cells posteriorly. Both in sequence of origin, in relative position and in size this group corresponds to the similar series in *Aplysia* and *Fiona;* but Wierzejski ascribes a mesodermal fate to the whole.

In *Limax* Meissenheimer (1896) describes the cleavage of 4d to a stage in which there are four cells, the anterior pair of which are the smaller. In fate they serve as anlagen for mesodermal structures. Similar conclusions were also reached by Kofoid (1895) on *Limax*.

Heath (1899) has accurately traced the origin of the mesoblast in *Ischnochiton* at the seventy-two-cell stage, and its later cleavage into cells of equal size which lie bilaterally. At a more advanced stage two more divisions were noted giving origin to small cells dorsally and anteriorly. Heath was unable to determine whether these cells were purely mesodermal or partly endodermal.

Mead (1897) describes for the Annelid *Arenicola* two small cells budded off from the bilaterally situated pair of mesodermal cells, and by further division of the large teloblasts these cells are seen later lying at the ends of the mesodermal bands and appear to be mesodermal in fate. The same conclusions were reached regarding *Clymenella*, though in this case the lineage has not been traced so far. In this Annelid the divisions of M^1, M^2 result in cells of nearly equal size, a condition which may indicate a variation in later stages.

In 1897 Wilson, having reinvestigated the history of the second somatoblast of *Nereis*, discovered that the two small cells budded from the teloblasts toward the enteron, to which in his earlier paper (1892) a mesoblastic fate was assigned, are entoblastic in nature, and the same he thinks probably to be true of *Aricia* and *Spio.*

Child (1900) has found for *Arenicola* that 4d after its first cleavage forms mesoblastic teloblasts, from which later arise two bilaterally placed mesoblastic bands; all these cells are mesoblastic in fate, and it is evident from his figures and discussion that he does not find here any entoblastic material. Though in *Sternapsis* the lineage was not followed so far as that of *Arenicola,* Child reaches the same conclusion, and particularly in the latter case he states that the mesoblastic cell is "purely protoplasmic and without yolk".

In the Annelid *Podarke* (Treadwell, 1901) 4d arises, together with the other members of the fourth quartet, at the sixty-four-cell stage and is equal in size and appearance to them. It sinks inward with the invagination which forms the enteron, divides and lies in close connection with the endodermal cells. By this division from the larger cells four small cells are given to the enteron, while the remaining two are purely mesodermal.

Torrey (1902), in a preliminary on the cytogeny of *Thalassema,* assigns to the two small cells arising from the teloblasts the fate of enteroblasts, in a similar manner as in the Annelids above considered.

Segmentation of the Entoblast.

Shortly after the origin of the mesentoblast 4d, when the egg contains forty-one blastomeres, all the "macromeres" except 4D are seen to be dividing læotropically (fig. 24), with the result that three large cells, 4a, 4b, 4c, are given off from their respective macromeres. These cells are slightly greater in size than those centrally grouped, but are not so large as the cell 4d, and on this account we find that of the four cells, 4A, 4B, 4C and 4D, the last is the smallest, nor does it again divide until over one hundred and fifty blastomeres are present. The position of the fourth quartet may be seen in fig. 25 and those following. When the egg contains over eighty blastomeres, 4A, 4B and 4C again divide into equal moieties, the outer three of which (5a, 5b, 5c) lie to the right of the central group. All these cells have become much flattened and form a comparatively thin roof over the segmentation cavity, into which as yet invagination has not begun. The mesentoderm has sunken completely beneath the external layer and extends forward as far as the center of the cavity (figs. 45, 57). At a much later period, when there are nearly one hundred and fifty cells present, 4a, 4b and 4c again divide (figs. 71, 72, 73), giving off small cells to the left and outwardly ($4a^1$, $4b^1$, $4c^1$). The invagination to form the enteron has already begun by the depression of the smaller cells which lie in the center of the vegetative pole, while the small cells, E^1, E^2, e^1, e^2, at the anterior end of the teloblasts have become drawn into the posterior region of the invagination (except for some variation, an instance of which is shown in fig. 72), where at this time they help to close that portion of the gastral pit. As the primary enteric cells sink into the cleavage cavity the small cells, E^1, E^2, e^1, e^2, come into close connection with the posterior edges of 5C, 5D, 4a. Thus a more or less complete cup-like invagination is brought about among the entomeres, in which the smaller elements lie at the bottom with the larger ($4a^2$, $4b^2$, $4c^2$) between, and the small cells which have arisen from these latter lying peripheral to them. Above, toward the ventral surface, lie small cells of the second and third quartets around the blastopore opening.

In the formation of the enteric cells the manner in which the fourth quartet arises appears to be characteristic of a number of Opisthobranchs. This quartet is in *Umbrella* (Heymons, 1893), *Aplysia* (Blochmann, 1883; Carazzi, 1900) and *Tethys* (Viguier, 1898), as well as in *Fiona*, larger than the macromeres remaining at the center of the vegetative pole.

The further development of the enteron will be discussed later.

Cleavage History of the Ectomeres.

As has been seen, the ectoblast arises immediately after the four-cell stage by the three successively alternating cleavages in which the macromeres participate, giving rise respectively to the First, Second and Third Quartets of micromeres. The cleavage history of these cells will now be taken up and their ultimate fate, as far as can be determined, considered.

The First Quartet.

The formation of the "turrets," $1a^2$–$1d^2$, and the "apicals," $1a^1$–$1d^1$, leading to the radially symmetrical twenty-four-cell stage, has already been considered. Shortly afterward the apical cells divide in a dexiotropic direction, thus alternating with the preceding cleavage, and by this division the four "basal" cells of the ectoblastic cross arise, while between these and the central point of the egg lie the four small apical cells from which they were derived (fig. 23). Before this cleavage had occurred the upper and dextral cells of the second quartet had in each quadrant given off a small cell in a læotropic direction (fig. 21), which after the formation of the basals occupy positions just peripheral to them and slightly to the left. These four small second quartet elements are the "tip" cells of the cross, $2a^{11}$–$2d^{11}$, and together with the basals and apicals form the ectoblastic cross.

From the time of its formation and until a late period of cleavage the cross of *Fiona* is a distinctly dexiotropic structure, the apicals of the four arms lying to the right of their respective tips. The cross is thus at the time of its formation (fig. 23) composed of twelve cells, of which the apicals are the central, is radially symmetrical and its anterior and posterior arms lie very near to, if not exactly in, the median plane of the future embryo. In the future history of this structure the tip cells will for convenience be described in connection with the rest of the cross, since they are so closely connected with it.

Before further cleavage occurs in the first quartet the second and third quartets and the macromeres show marked karyokinetic activity, the number of cells in the egg having increased to nearly sixty. The basal cells and the turret cells or trochoblasts then divide simultaneously (fig. 33), though considerable variation in time occurs in different eggs and in different quadrants, it being, however, universally observed that $1d^{12}$ divides last of the basals. It may be noted in this connection that in all species of *Crepidula* examined except *C. adunca* the division in the basal cell of the posterior arm is delayed for a much longer period. The direction of cleavage of the basals $1d^{12}$ and $1b^{12}$ is læotropic and so alternating with the last, those of the other two doubtful; $1a^{12}$ usually shows a læeotropic to radial position of spindle, while in $1c^{12}$ variations are present all the way from læotropic to dexiotropic. After examining a large number of eggs the occurrence of this irregularity was more strongly confirmed, and it thus appears that in this cell, $1c^{12}$, there is a strong tendency, more marked in some cases than in others, toward non-alternation with resulting bilaterality of cleavage in relation to its opposite cell, $1a^{12}$. In *Crepidula*, *Planorbis* and *Neritina* the cleavage of all these basal cells is non-alternating, while in *Umbrella* it is regularly alternating.

In *Fiona* it would appear that we have an intermediate condition in which, though regular alternation is found in the anterior and posterior basal cells, the two lateral, particularly $1c^{12}$, show a tendency toward non-alternation under the influence of approaching bilaterality. It is just at this time that the first distinctly bilateral cleavages occur in two cells of the third quartet in the two posterior quadrants, $3d^1$ and $3c^1$ (figs. 31, 32), and this suggestion of bilateral divisions of the cross may be correlated with them. However, the influence toward bilaterality must be very slight, as the radial symmetry of the upper pole is not disturbed to any appreciable degree.

By the divisions of the basal cells above described each arm of the cross is composed of four cells—an outer tip cell ($2a^{11}$–$2d^{11}$), next to it the "middle" cell ($1a^{122}$–$1d^{122}$), an inner "basal" cell ($1a^{121}$–$1d^{121}$), which is larger than its sister middle cell, and an apical ($1a^{11}$–$1d^{11}$).

Synchronously with the cleavage of the basals occurs that of the turrets, the cell of this series in each quadrant dividing into two of nearly equal size, the outer being the smaller. All divisions are dexiotropic and alternating with those by which these cells arose (fig. 33).

Comparing the cleavage of the turrets with conditions found in other forms, it will be noted that considerable variation exists. While in *Fiona* these cells divide when there are about sixty blastomeres in the whole egg, in *Umbrella* (Heymons) approximately seventy are present; like *Fiona* all four turrets divide at relatively the same time. In *Crepidula* the anterior trochoblasts do not divide until there are over one hundred cells in the egg, and Conklin states that he believes the posterior ones never divide. The trochoblasts of *Trochus* (Robert) arise very early, at the sixteen-cell stage, and have all divided when there are thirty-two cells present. In *Planorbis* Holmes finds them in division at about forty cells, and *Limax* (Kofoid) shows a similar condition. In *Unio* (Lillie) there are about fifty cells, while in *Ischnochiton* (Heath) but thirty-two, when the "primary trochoblasts" of the latter form divide. Thus *Fiona* appears to occupy an intermediate position in relation to these and other molluscan forms in which the time of cleavage of these cells has been determined.

Division next occurs in the cross at a stage of about eighty-four cells and results in the division of the apicals into eight small cells, of which those lying centrally form the "apical rosettes" ($1a^{111}$–$1d^{111}$), while the outer series are the "peripheral rosettes" ($1a^{112}$–$1d^{112}$) of Conklin. Direction of cleavage is læotropic, and of the resulting cells the outer are the larger (Pl. XXVII, fig. 53). Shortly after the rosette series are established the basal cells of all arms divide again, the posterior one last. In the anterior quadrant the spindle and resulting cells, $1b^{1211}$ and $1b^{1212}$, lie radially in the lateral arms, the division of $1c^{121}$ is læotropic, that of $1a^{121}$ dexiotropic, again showing bilateral influence, while in $1d^{121}$ the spindle is so strongly turned in læotropic direction that the resulting cells lie transversely across the posterior arm (figs. 56, 62). While this last cleavage of the basals is being accomplished a similar process is seen in the four inner trochoblasts ($1a^{21}$–$1d^{21}$), resulting in eight cells of equal size and occurring at relatively the same time in all four quadrants.

With the completion of the above-described divisions the large number of cells of similar size at the upper pole of the egg makes their exact lineage difficult to follow, so that it is desirable to make here some comparisons with the structure and development of the cross and trochoblasts in other forms, and to bring together the results already obtained before proceeding to more uncertain ground. In formation the cross of *Fiona* arises in the same manner as in *Umbrella* and *Planorbis,* by the completion of the tip cells before the basals; and in this it differs from *Neritina* and *Crepidula*, where the tip arises shortly after division has occurred to form the four basal cells. In *Trochus* the tips are relatively late in appearing, as the basals have completed their cleavage before these cells arise. At the first cleavage of the basals another striking similarity to *Umbrella* is found, for in this Opisthobranch the cleavage is læotropic, while in *Crepidula* and *Neritina* it is dexiotropic, thus breaking the law of alternating cleavages; and likewise in *Planorbis* with reversed type the division is læotropic and non-alternating with the preceding. *Trochus* shows an extremely marked læotropic division of these cells, so much so, in fact, that the resulting cells lie almost transversely. In *Fiona* the anterior and posterior basals are distinctly læotropic in origin and so regularly alternating, while considerable variation is found in the lateral arms, a radial type often occurring with $1c^{12}$, sometimes showing a decided dexiotropic direction of spindle. It would appear from this variation in the lateral arms that *Fiona* shows tendencies toward bilaterality in the first quartet at this time, and such a condition would be in harmony with the bilateral cleavages of the third quartet cells, $3c^1$ and $3d^1$, occurring just previously. However, the radial symmetry of the cross as a whole appears not to be disturbed appreciably, so that though these variations may show either a tendency toward bilaterality or toward entire reversal in all quadrants, as is found in *Neritina, Crepidula* and *Planorbis,* this influence has not as yet become sufficiently marked to affect the radial symmetry of the upper pole of the egg to any appreciable degree. In discussing the lack of alternation of these cleavages in *Crepidula* as opposed to alternation in *Umbrella,* Conklin suggests "upon this difference the future recognizability of the cross in the last-named cases (*Crepidula* and *Neritina*) depends". In *Umbrella* the læotropic division of the basals is much more marked than in *Fiona,* but even in the latter case Conklin's prediction is in part, at least, fulfilled, as the cross of *Fiona,* after a slightly older stage than thus far described, becomes so irregular that its component cells are neither among themselves distinguishable nor may they be definitely separated from the surrounding blastomeres. Of course, this is largely due to the multiplication of the trochoblasts and the similarity in size of most of the cells upon the upper surface of the egg, yet the læotropic twist given to the basal elements at their initial cleavage is largely responsible for that irregularity of contour which so early marks the outlines of the cross. The peripheral ends of the arms of the cross of *Fiona* become strongly twisted to the left, and as the structure becomes older the ends tend to bend around in that direction to a marked degree, greatly confusing their component cells with those arising by multiplication of the trochoblasts. Up to the stage shown in fig. 53 the cross has, with the exception of a slight tendency toward variation in the first division of the basals, been radially symmetrical, but at the next cleavage of the basals the cell of this series in the posterior arm divides so that its daughter cells lie transverse to the longitudinal axis of this arm. In the anterior quadrant this division produces cells which lie radially, while in C quadrant the cleavage is læotropic, in A dexiotropic.

The first indication of transverse splitting of the arms is thus seen to occur in the basal cell of the posterior quadrant. In *Crepidula* the reverse is the case, the anterior and lateral arms alone increasing in width, while the posterior later elongates by radial cleavages. In *Fiona* all the arms become longitudinally split at a later period. The inner and outer rosettes have not yet arisen in *Crepidula* when the splitting begins in the cells, $1a\text{–}b\text{–}c^{122}$, while in *Fiona* they are present and the egg contains many more cells, the basal cells of the anterior and lateral arms having again divided in such a manner that these arms are lengthened before increase in breadth occurs. The same is true of *Planorbis*. The early splitting of the arms of the cross in *Crepidula* is probably in part due, as Holmes suggests, to the fact that, through pressure, they have become much wider and tend to divide in a direction opposite to this elongation. It might also be suggested that the extreme breadth of the cross of *Crepidula* and the early transverse division of its anterior and lateral arms may be correlated with the presence of a large amount of yolk which must be covered by the ectoblast, while in the posterior region the extensive multiplication of the elements of the second quartet obviates the necessary broadening of the arm which reaches in that direction.

The transverse cleavage of the anterior and lateral arms of the cross of *Fiona* occurs shortly after the initiation of a similar process in the posterior arm, but it has been found impossible to trace the lineage of all the cells accurately though, after lateral extension has occurred, the structure may be demarkated from the trochoblasts and underlying second quartet cells. In fig. 75 its structure and probably cell derivation may be seen. Holmes finds for *Planorbis* that the tip cells divide in a transverse direction first, while in *Crepidula* the middle cells are the first to cleave. The tips appear to divide last in *Fiona*. In the posterior arms after the first transverse division most of the cells divide obliquely across the arms, and in this way the arm becomes longer than the other three. While the cross is increasing in lateral extension the outer turret cells of all quadrants divide, so that the four groups each consist of four cells of equal size (fig. 75) lying in the angles formed by the arms of the cross.

The apical pole of the egg at this period shows a slight depression in the region of the rosette series. It is but transient and disappears with the elongation of the gastrula. A similar depression has been observed in *Neritina, Crepidula* and *Trochus*. Whether the structure is normal in *Fiona* is yet doubtful. Robert insists that such is the case with *Trochus*.

The entire formation of the cross of *Trochus* is peculiar. The basals have arisen and divided before the tips appear, and this division of the basals is so directly læotropic as to be practically transverse. At the next cleavage these two cells form an oblong group of four in each arm. The tips which lie peripherally to these groups next divide, the cleavages of $2a^{11}$ and $2c^{11}$ being bilateral, the first of this nature to occur in the egg.

From the cases cited above of the manner of formation of the ectoblastic cross of Mollusks, it will be seen that this characteristic structure shows great diversity of details throughout the group, though fundamental similarity is evident. Some of the probable causes of such variation are (1) varying amounts of yolk, leading to early lateral extension of the arms in those forms possessing yolk-ladened entomeres, and (2) differences in the manner and rate of development of the trochoblasts, correlated with the later structure and functional importance of the locomotor organ to which they largely give rise. The radial arrangement of blastomeres around the apical pole of the cleaving egg is primarily the result of successively alternating spiral cleavages, and a similar arrangement may be expected in eggs which exhibit this mode of division. A definitely marked cross does not always arise from such an arrangement of blastomeres, as, for example, in Polyclad cleavage, so that this but suffices as a partial explanation. Regarding the form of the crosses of Mollusks and

Annelids Conklin says: "The cross and rosette series are the direct result of the *position, size and shape* of their constituent cells". The *original position* of cells resulting from regularly alternating spiral cleavages is a function of that mode of division. The *shape* of cells depends largely upon the relations which they bear to one another. Their *size* is not so easily explained, and upon this factor depends, to a large extent, the varying forms of crosses met with in different instances. If it be supposed that the original arrangement of the upper pole cells of Mollusk and Annelid eggs was radial in form, the modifications which have arisen in the two groups may, in part at least, be referred directly to the size of the cells comprising that area. The importance and early development of the trochoblasts of Annelids has resulted in encroachment upon that area which in the segmenting eggs of these forms corresponds to the cross region of Mollusks. As a result the "intermediate" series of Annelids, corresponding to the molluscan cross cells, lack the prominence characteristic of the same cells in the latter group. Moreover, it is interesting to note that such a Mollusk as *Ischnochiton,* which in the development of its trochoblasts and prototroch shows a condition intermediate between Mollusks and Annelids, also exhibits a cross which is intermediate in character. Though the trochoblasts have been taken here as an example of the influence which variation in size or rate of division may have upon the primitive arrangement of blastomeres in the spirally cleaving egg, it is doubtless true that other cells may in like manner undergo modifications which will result in similar rearrangements.

Thus it may be concluded that the group of cells constituting the cross owes its radial arrangement primarily to the form of cleavages by which it arose, but that the cross as a definitely marked structure is the result of variations in the size, shape and rate of division of the cells comprising or surrounding it, these variations leading, on the one hand, to the formation of the molluscan cross; on the other, to the annelidan.

Second Quartet.

While the egg is yet radially symmetrical and its blastomeres number twenty-four, the original second quartet cell of each quadrant has divided in a dexiotropic direction into cells of equal size. After the mesentoblast has arisen, but before the basal cells of the cross are formed, all of the second quartet cells divide in a læotropic direction, the upper four giving off the four tip cells ($2a^{11}$–$2d^{11}$) toward the upper pole, while the lower four give origin to small cells resembling the tips in size, which are directed toward the vegetative pole (Pl. XXIII, figs. 21, 22, 23, Pl. XXIV, fig. 24).

The second quartet at this time consists of four similar groups of cells, each group consisting of two large cells, $2a^{12}$–$2d^{12}$ and $2a^{21}$–$2d^{21}$, lying together, with the smaller cells above and below. The two large cells in all four quadrants, $2a^{12}$–$2d^{12}$, $2a^{21}$–$2d^{21}$, next divide almost simultaneously. The direction of cleavage of the right upper cells ($2a^{12}$–$2d^{12}$) is dexiotropic, and of the resulting cells the upper ($2a^{121}$–$2d^{121}$) are slightly larger than the lower ($2a^{122}$–$2d^{122}$), the divisions being identical in all four quadrants. Synchronously with these divisions cleavage spindles appear in the other large cells of the second quartet ($2a^{21}$–$2d^{21}$). Of the resulting cells the lower are much the smaller. In direction the cleavages are probably all læotropic and therefore non-alternating, though in C and D quadrants the spindles are almost meridional in position, and the cleavages horizontal. Figures 28, 29, 30, 31 and 32 show these divisions in the different quadrants.

The lack of alternation found in the above instance may be explained as the direct result of the relative sizes of the foregoing derivatives of the second quartet and the positions in which they lie. By an examination of fig. 30 it will be seen that should the two large cells, $2c^{12}$ and $2c^{21}$, have divided in the same direction a diagonal row of cells would have been the result, with great pressure against one another and upon the cells in the first and third quartets at the ends of the row. Lack of alternation in direction of cleavage in one of the cells would relieve this pressure, and this is the actual condition found. Such an explanation appears to fit this individual case of non-alternation, but no generalization may be made, as in many other instances the cleavage of blastomeres appears to follow no rules of mutual pressure and can be explained on no grounds so simple.

Division again occurs in this quartet at a stage of about eighty cells and great variation in time is marked in their occurrence.

The following table shows the average sequence observed in the different quadrants, though any one egg may show marked variation from the tabulated result:

	1st.	*2d.*	*3d.*	*4th.*
2a	121	211	122	212
2b	121	211	212	122
2c	121	211	212	122
2d	211	121	212	122 (or 22)

The table should be read: In A quadrant $2a^{121}$ cleaves first, $2a^{211}$ second, $2a^{122}$ third and $2a^{212}$ fourth. In B quadrant, etc. Cleavages in A quadrant are found in figs. 50, 58 and 63; in B, figs. 52 and 59; in C, figs. 44, 48, 54, 60 and 65; in D, figs. 47, 51 and 61.

The divisions of $2a^{121}$–$2d^{121}$ are læotropic in all quadrants, of $2a^{211}$–$2d^{211}$ universally dexiotropic, of $2a^{212}$–$2d^{212}$ everywhere dexiotropic, while variation is found in the direction of cleavage in the cells $2a^{122}$–$2d^{122}$. Of these latter a decidedly læotropic direction is found in B quadrant, horizontal to dexiotropic in D, horizontal to læotropic in A and approximately horizontal in C. With regard to the size of the derivative cells, it may be said in a general way that variation is evident. More particularly considered the following conditions are found to prevail. The divisions of $2a^{121}$, $2c^{121}$, $2d^{121}$ result in cells of equal size, while in the case of $2b^{121}$ the upper cell $2b^{1211}$ is much smaller than $2b^{1212}$; $2a^{211}$, $2b^{211}$, $2d^{211}$ form upper small and lower larger parts, while $2c^{211}$ divides equally; $2b^{212}$, $2c^{212}$, and $2d^{212}$ show similar divisions into upper small and lower large cells, while $2a^{212}$ remains so long undivided that its derivatives are uncertain; $2a^{122}$–$2d^{122}$ divide equally.

As a result of the foregoing cleavages the second quartet contains in all approximately forty cells. The irregularities which have characterized the preceding divisions are increased in number as cleavage continues, though until a much later period all four quadrants show relatively the same number of cells for this quartet. If figs. 67–70, representing the different sides of the same egg, be examined it will be seen that in A quadrant $2a^{1212}$ has divided dexiotropically, while $2a^{2112}$ has divided horizontally; quadrant B shows no further multiplication of elements; in C quadrant, $2c^{1211}$ is in process of division, while $2c^{2111}$ and $2c^{2112}$ have both given off small cells toward the upper pole; D quadrant remains as before.

At a stage in which there are six cells of the second quartet in each quadrant in *Crepidula* these groups very closely resemble the similar ones of *Fiona.* When there are four cells in each group in *Crepidula* the larger middle pair divide and, as in *Fiona,* one of them shows lack of alternation; but in *Crepidula* the direction of the cleavage is slightly læotropic in the right cell and dexiotropic in the left, while just the opposite is true of *Fiona.* *Planorbis* shows a group of second quartet cells in each quadrant, which may be said in this sinistral form to be almost the mirrored image of the same cells of *Fiona,* though the tips and the corresponding cells at the lower pole are somewhat larger in *Planorbis,* which probably accounts for their earlier division in that form. The large second quartet cells of *Trochus,* as in *Fiona,* show lack of alternation in the left cells of the series ($2a^{21}$–$2d^{21}$), while the right ($2a^{12}$–$2d^{12}$) show regular alternation. The early cleavages in the second quartet of *Tethys* (Viguier, 1898) closely parallel those of the same series in *Fiona.* Viguier has mistaken the lower elements of this quartet, $2a^{22}$–$2d^{22}$, for members of the fourth, as Robert has pointed out. Further note of the errors in this paper will not be taken here, since they have been so thoroughly discussed by Robert. Heymons (1893) for *Umbrella* shows the second quartet series up to a stage of six cells in each quadrant, and here also similar conditions are found. Carazzi (1900) figures the egg of *Aplysia,* where each quadrant contains four second quartet cells, and here also is a marked similarity to the other forms considered. The second quartet of *Fiona* maintains a radial symmetry for a much longer period than *Planorbis,* this being the result of similar cleavages in all four quadrants for a much later period than in that Pulmonate. The same may be said of *Umbrella* and *Crepidula,* and, as Holmes suggests, this phenomenon is probably correlated with the earlier development and larger size of the head vesicle of *Planorbis* than of the corresponding structure of *Crepidula, Umbrella* or *Fiona.*

The Third Quartet.

Of the three quartets the third is the first to show evidences of bilateral divisions. When the egg has cleaved into twenty-four blastomeres this quartet has but one cell in each quadrant, and these cells do not divide until after the second cleavage of the second quartet. They then all divide in a læotropic direction, but the resulting cells are not of the same size in the different quadrants. 3a and 3b produce cells of equal size, while 3c and 3d give rise to small cells in the direction of the vegetative pole with very large ones above, thus forming an additional landmark for distinguishing anterior from posterior quadrants (Pl. XXIV, fig. 25). The larger cells of the posterior quadrants, $3c^1$ and $3d^1$, divide next; the spindle in $3c^1$ being dexiotropic and alternating, that of $3d^1$ læotropic and non-alternating; and this lack of alternation in one of the large cells of the third quartet, taken in connection with the regular alternation of the similar cell on the opposite side of the posterior region of the egg, establishes the first bilateral cleavage (Pl. XXV, figs. 31, 32, 34). Both upper and lower cells of A and B quadrants are the next third quartet elements to divide, the direction in all cases being dexiotropic or in some instances nearly meridional (figs. 37, 40, 41). The lower cells, $3a^2$ and $3b^2$, always divide before the upper, $3a^1$ and $3b^1$, and in all cases cleavage is equal, a group of four similar cells arising in each of the two anterior quadrants. In the posterior quadrants cleavage occurs next in $3d^{12}$, $3d^{11}$, $3c^{12}$ and $3c^{11}$. It will be remembered that when these cells were formed it was through a læotropic and non-alternating division of $3d^1$ and a dexiotropic and alternating division of $3c^1$, thus producing a bilateral cleavage of similar cells of opposite sides. Now the cells $3c^{11}$ and $3c^{12}$ again divide dexiotropically, thus showing lack of alternation, while $3d^{11}$ and $3d^{12}$ again exhibit distinct læotropic cleavage and a second failure to alternate. Thus arise in each posterior quadrant two very small cells, $3c^{112}$, $3c^{122}$ and $3d^{112}$, $3d^{122}$, lying below the large ones, $3c^{111}$, $3c^{121}$, $3d^{111}$ and $3d^{121}$ (Pl. XXVI, figs. 43, 44, 45, 47). After these cleavages about eighty blastomeres are present (figs. 67, etc.). When this number has increased to slightly over a hundred, $3a^{21}$, $3a^{22}$, $3b^{21}$ and $3b^{22}$, each gives off a small cell toward the vegetative pole by cleavages which appear horizontal (Pl. XXVII, figs. 57, 59), and these divisions are followed by equal and probably horizontal cleavages in the posterior quadrants of the large cells, $3c^{111}$, $3d^{111}$ and $3c^{121}$ and $3d^{121}$, the former pair always dividing before the latter (figs. 61, 66), so that each posterior group contains seven cells, of which three are small and lie nearest the blastopore, being bounded externally by four large cells, $3c^{1111}$, ^{1112}, ^{1211}, ^{1212}, and $3d^{1111}$, ^{1112}, ^{1211}, ^{1212} respectively.

The history of the third quartet of *Fiona* thus far given adds another to the number of Mollusks in which it has been found that bilateral cleavages first appear in the posterior quadrant, and more particularly in the cells of the third quartet.

The initial divisions of these cells in *Umbrella* appear from Heymons' description to be nearly radial, but his figures show that in the case of 3c and 3d cleavage is læotropic. The lower products of these cleavages are all smaller than the upper, in which they parallel only the posterior quadrant cells of *Fiona*. Moreover, these cells, $3c^1$ and $3d^1$, divide again before the anterior ones as in *Fiona*, and these cleavages are the first bilateral divisions described. It would appear from Heymons' figures that the two cells next the median plain lie higher than the outer, and this is the condition found in *Fiona*. If such be the case, these two forms stand in contradistinction to *Crepidula*, in which the median pair are the lower. The cells $3c^{11}$, $3d^{11}$ are the protoblasts of Heymons' excretory cells, and it will be seen later that $3c^{11}$ serves a similar purpose in *Fiona*. It is interesting to note that Conklin says of $3c^{11}$ and $3d^{11}$ that they are "large and clear" and "have the same characteristics in *Crepidula*", though he does not know their fate. Heymons describes divisions at a later stage in the anterior quadrants, while in the posterior $3c^{11}$ and $3c^{12}$, $3d^{11}$ and $3d^{12}$ give rise by horizontal divisions to small cells which lie next to $3c^2$ and $3d^2$—these latter in exact correspondence with *Fiona*.

Of this quartet Holmes says of *Planorbis;* "The first cleavage forms a transition from the spiral to the bilateral type, and subsequent cleavages show a bilateral character in a more marked degree. At nearly the same time the lower pair of cells in the two anterior quadrants and the upper pair of cells in the posterior quadrants divide in a nearly horizontal direction into equal moieties. Later the upper pair of cells in the anterior quadrants divide in the same direction as the lower pair. The lower pair of cells in the two posterior quadrants remain undivided until a much later stage". These divisions closely follow those of *Fiona*, and the same may be said of subsequent ones.

In *Aplysia* (Carazzi) the two third quartet cells of each anterior quadrant divide into equal moieties, while in the posterior quadrants small cells are given off toward the vegetative pole; the same is true of *Fiona*. At the next divisions of $3c^1$ and $3d^1$ "si dividono con fusi transversali, cioè con divisione bilaterale," while $3a^1$ and $3b^1$ remain at rest. Viguier (1898) for *Tethys* describes the initial division of all the four quartet cells as "suivant des plans sensiblement radiaux", the resulting two cells in each quadrant being equal. Later cleavages of this quartet in *Fiona* will be considered under the discussion of gastrulation and secondary mesoderm formation. Bilaterality appears late in the cleavage of *Trochus*. The first divisions of this nature do not occur until the ninety-seven-cell stage, and are concerned with the cells $2c^{11}$ and $2a^{11}$. This is the first violation of Sachs-Hertwig's law of alternatingly perpendicular cleavages. The cleavages of the third quartet are very tardy in this Prosobranch, for when there are as many as one hundred and fifty cells present this quartet consists of but four cells in each quadrant.

Gastrulation.

With the beginning of gastrulation, marked differences appear in the cleavages of the quadrants and the radial symmetry of the egg as a whole gives place to a more and more distinct bilaterality. In the posterior region, particularly among the cells of the second quartet, great divisional activity and growth takes place; while the same series in A, C and B quadrants show relatively slight increase when compared with the derivatives of 2d. It has been impossible to follow the lineage, except in particular instances, from the time these cleavages begin, as most of the cells of the gastrula of *Fiona* are so similar in size and appearance and the number becomes so great that individual identification is limited to special cases. However, by continued observation of successively developing stages one becomes familiar with the cell groups which will later give rise to various organs and, aided by a few landmarks, may in most cases follow the organogeny with approximate if not absolute certainty.

An examination of figs. 69 and 70 will show that $2b^{1212}$ and $2b^{2112}$ have divided again, and shortly afterward cleavage occurs in a number of other cells, $2b^{22}$, $2b^{2111}$, etc. The upper cells of the third quartet in the anterior quadrants lie at first well toward the upper surface, but as invagination proceeds these move around toward the lower side, while an increasing number of second quartet elements are found separating the first from the third quartet at the anterior as well as the posterior end of the gastrula. Meanwhile the second quartet cells in the median posterior region (derivatives of 2d) have multiplied very rapidly, and by causing increase in the surface area of the gastrula in this region have pushed the apical pole several degrees forward. Not only have the posterior second quartet cells increased in numbers but also in size, marking out at an early period the region from which the shell gland will develop. The second quartet groups which lie laterally below the ends of the lateral arms of the cross also grow in extent and numbers, this being more particularly true of those which abut upon the enlarging cells of the same series in D quadrant.

The history of the third quartet has thus far been followed to a stage when its members in each anterior quadrant number six, of which four are large and two small cells, while in each posterior quadrant the group comprises seven cells, three of which are small and four large. By approximately horizontal cleavages of the upper cells in the two anterior quadrants four cells of equal size are formed in each quadrant, and as the blastopore continues to narrow these cells migrate as a group in each of the two anterior quadrants, approaching the blastopore and slipping over the cells $3b^{211}$ and $3b^{221}$, $3a^{211}$ and $3a^{221}$, which lie between them and the smaller cells of the same series (Pl. XXIX, figs. 68, 69). During this period the third quartet blastomeres of the posterior quadrants remain as before.

The blastopore thus becomes entirely surrounded by the second and third quartet elements, of which the third are much more numerous, having the small cells $2a^{22}$–$2d^{22}$ or their derivatives wedged in between them on the median and transverse line. The gastrula, taken as a whole, is much flattened dorso-ventrally and is at first shorter in its longitudinal than transverse axis. The blastopore assumes a slit-like form, its longitudinal axis corresponding to the future longitudinal axis of the embryo.

The next important change to be observed is the origin of the

Ecto-Mesoblast.

As the cells $3a^{111}$, ^{112}, ^{121}, ^{122} and $3b^{111}$, ^{112}, ^{121}, ^{122} continue to move toward the blastopore, the cells which they are covering over $3a^{211}$, $3a^{221}$ and $3b^{211}$, $3b^{221}$, sink downward into the segmentation cavity. As this occurs they all four divide, giving rise externally and in the direction of the blastopore to four small cells, $3a^{2112}$, $3a^{2212}$ and $3b^{2112}$, $3b^{2212}$, while the larger daughter cells continue to retreat beneath the overgrowing ectoderm (fig. 74). These larger cells, $3a^{2111}$, $3a^{2211}$, $3b^{2111}$ and $3b^{2211}$, are the source from which the secondary mesoderm is derived. They later divide, as may be seen in fig. 78, and begin at once to form two bands of several cells each, which lie in the antero-lateral region of the gastrula and later in the anterior head region of the larva.

Since the discovery by Lillie in 1895 of mesoderm which arose from the ectoderm in the Lamellibranch *Unio*, various other cell-lineage workers have arrived at similar conclusions concerning other forms. As is well known, Lillie found that the larval musculature of the Glochidium arose from a cell of the second quartet, 2a, which in cleavage gives rise to a cell toward the segmentation cavity, the descendants of which are mesodermal in fate. Conklin's results, published in 1897, gave evidence that in the Gasteropod *Crepidula* ectodermal mesoderm arose in three quadrants, in this case also from the second quartet (2a, 2b and 2c), but appearing much later then the "larval mesoblast" of Lillie, so late, in fact, that the exact cell origin could not be traced.

In 1897 Wierzejski showed that in the sinistral Pulmonate *Physa* secondary mesoblast arises from certain derivatives of the third quartet (3c and 3b), and similar conclusions were reached in the same year for *Planorbis* by Holmes. 3c and 3b here also giving rise to cells which sink into the segmentation cavity.

The formation of the secondary mesoderm in *Fiona* is strikingly similar to its manner of origin in *Planorbis*, as described by Holmes. The following diagram (text-figure 2), showing the cleavage history of the ectomesomeres of the two forms, indicates how close a comparison is possible.

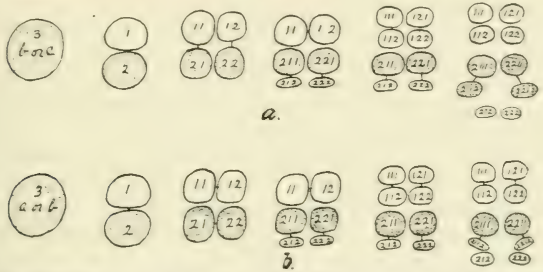

Fig. 2.—Diagrams showing the manner of formation of secondary mesoderm in (*a*) *Planorbis* (Holmes) and (*b*) *Physa* (Wierzejski) and *Fiona*. The cells containing secondary mesoderm are stippled.

It will be noted that four cells of each anterior quadrant are mesodermal in *Planorbis*, while in *Fiona* only two have this fate, the smaller cells, $3a^{2112}$, ^{2212}, and $3b^{2112}$, ^{2212}, of *Fiona* remaining in the ectoderm. For *Physa* Wierzejski came to similar conclusions, but here there is even closer correspondence, for the cells $3b^{2112}$, ^{2212} and $3c^{2112}$, ^{2212} of *Physa* remain in the ectoderm exactly as they do in *Fiona*. According to the nomenclature used by these two investigators secondary mesoblast arises from quadrant B and C, while in the dextrally cleaving egg of *Fiona* it comes from quadrant A and B. Holmes and Wierzejski have attempted to use the same sequence of lettering for sinistral forms as that commonly employed for the dextral, and have thus been led into error, Holmes particularly arguing for a non-homology of cells upon this score. When the dextral or clock-wise sequence is employed for a sinistral form this difference in designation necessarily results if the cell which is to give rise to the entomesoblast be labelled D. The more natural and logical method is to label the cells of a sinistral form in an anti-clock-wise sequence, as Crampton (1894) has very wisely done for *Physa*. Robert (1903), in his excellent paper on the development of *Trochus*, which has just reached this laboratory, calls attention to the above and confirms opinions which had already been embodied in this paper. Animals which are sinistral, or reversed in their larval and adult stages, develop from eggs which are likewise reversed in their cleavage, and the designation of the blastomeres of the egg should coincide with the condition of the adult, if any homology of cells exists. The eggs of sinistral Gastropods have probably at an early stage in their ovarian development undergone complete cytoplasmic and nuclear inversion, for only by such a process can the reversed condition of the larvæ and adults be understood or the reversal of direction of the cleavage spindles be explained, and if such an inversion be postulated, corresponding reversal of sequence in nomenclature must ensue.

Meissenheimer (1901) describes in *Dreissensia* a cell lying in the cleavage cavity just under the First Somatoblast derivatives, but which, he says, does not come from this group, though he is sure it is of ectodermal origin. It later divides and forms muscle fibers. Similar conditions appear to be present in *Cyclas* (Zeigler, 1885). In the fresh-water Prosobranch *Paludina* teloblastic pole cells are not found. Scattered mesenchyme cells occur, and Tönniges (1896) states that these have been produced from cells which lie in front of the blastopore. If this be the case, the formation of mesoderm in *Paludina* is similar to that of the secondary mesoderm of other Mollusks.

In *Dinophilus* (the cleavage of which is, from work now being done in this laboratory by Dr. J. A. Nelson, typically annelidan in character) Schimkewitsh (1895) appears to have recognized ecto-mesoblast, for he says: "Gleichzeitig (with the proliferation of Urmesodermzellen) aber findet auch eine Immigration der Ectodermzellen in der Vordertheil des Embryos statt, und es wird durch diese Zellen eine Mesemchymanlage gebildet".

In the Annelid *Aricia*, Wilson (1897) discovered mesoderm arising from the two posterior quadrants which could not be derived from the pole cells, and which he located as coming from "either the second or third quartet" (*i.e.*, from c^3 and d^3 or from c^2 and c^3). These conclusions were strengthened by a preliminary account of Treadwell (1897) on the cell lineage of *Podarke*, in which he derives secondary mesoblast from the third quartet (3a, 3c and 3d), and these results are confirmed in a later and more elaborate paper (1901). The account of the mesoderm formation given by Eisig (1898) for *Capitella* differs widely from the results of most workers on annelidan and molluscan embryology.

Here the definitive mesoblast is said to arise from 3c and 3d, which would be in correspondence with Wilson's "ecto-mesoblast," while what Eisig considers "larval" or "secondary" mesoblast comes from that portion of 4d which Wilson and Treadwell found in *Nereis* and *Podarke* to form part of the wall of the enteron. These results have, it seems justly, been called in question, though the careful investigation from which they spring certainly gives credence to their accuracy. Treadwell (1901) has called attention to certain figures (Pl. XXXIX, fig. 42, to Pl. XL, fig. 49) of Hatschek on *Eupomatus*, which show "scattered muscle cells in the upper hemisphere of the larva, which could hardly have come from the feebly developed mesoderm bands at the posterior end of the body", and suggests that they are of secondary origin; and he likewise calls attention to the figures of Drasche (1884) for *Pomatoceros* which show similar conditions, though neither of these investigators appears to have realized their significance. In a preliminary paper on the development of the mesoblast in *Thalassema*, Torrey (1902) derives ecto-mesoblast from all three quartets. "In all there are at least twenty primary cells of this character, but of them only ten, arising from the first and third quartets, develop into functional mesenchyme, while at least ten degenerate and are finally absorbed by the entoblasts." The greater part of the functional ecto-mesoblast comes from three cells of the third quartet (3a, 3c and 3d) which correspond closely to those which produce secondary mesoblast in *Podarke*. All of the cells arising from the second quartet and which sink into the segmentation cavity are rudimentary and in the end entirely degenerate, thus recalling Wilson's similar conclusions regarding the "rudimentary" cells of the definitive mesoblast of *Aricia* and *Spio*. At least six derivatives of the seven ecto-mesoblast cells which Torrey derives from the first quartet have a similar fate.

The mesoderm of Platodes, Annelids and Mollusks has of late years been subject to much study, and various theories have been propounded regarding the significance of the manner of formation of the middle germ layer of these groups. Without entering into a prolonged discussion with regard to this question, a few of the more general points may be mentioned. The results above tabulated and my own observations lead to the conclusion—which is, of course, not here stated as new—that the primitive mesoderm of these groups is represented by that which arises from the ectoderm, and which is alone found in the Polyclad (Wilson). The suggestion of Wilson that upon this hypothesis ecto-mesoblast might well be found arising from all three quartets of ectomeres has just been verified by the work of Torrey, and shows that in this respect *Thalessema* presents an ancestral condition similar to that of the Polyclad, though this does not necessarily imply close genetic relationship. Moreover a descending series may be formed both among Annelids and Mollusks of forms in which the presence of ecto-mesoblast gradually merges into conditions in which it has totally disappeared, showing that in these groups ectodermal formation of mesoderm is on the decline. The increasing number of cases reported in which ecto-mesoblast is larval in fate tend also to support this conclusion, nor do the results of Meyer, showing that much of this building material is used for adult structures, offer a serious objection, since it is a well-known fact that nature is not prodigal of the living substance on which it works, and the secondary application of ancestrally obsolete material is a fact of almost universal occurrence. Nor can I see that the later origin of ecto-mesoblast necessarily indicates its late phylogenetic appearance, as some have argued, since the early origin of ento-mesoblast, if associated with the future elongation of the animal, might well be supposed to be directly explained by the precocious segregation of this layer in those forms in which its development is so intimately connected with future growth and development. The early appearance and teloblastic growth of ento-mesoblast in the posterior region of Annelids and Mollusks has directly led to decrease of the radially appearing mesoblast. The Polyclad, which shows no endo-mesoblast, has failed to develop such a formation, though a tendency in that direction may be appearing, being marked by the bilateral division of one of the endodermal derivatives (Wilson). The fact that ecto-mesoblast as well as ento-mesoblast has been shown among Annelids to arise from the same quadrant (*Aricia, Podarke, Thalassema*) argues, it seems to me, conclusively for an entirely separate mode of origin of the two.

Closure of the Blastopore.

With the segregation of the secondary mesoblast changes appear in the form of the gastrula. Heretofore its shape has been broadly oval, the antero-posterior axis being the shortest, but at this period two regions of growth become manifest leading to marked change of form. The multiplication and growth of cells of the second quartet in the posterior region increase in activity, ever pushing forward the apical pole area, while at the same time the region just anterior to the apical pole is seen to be rising from the surrounding surface, forming a pointed projection, the summit of which lies at the anterior end of the forward arm of the cross (Pl. XXX, figs. 78, 79).

Synchronously with these changes the blastopore continues to decrease in size, being narrowed by overgrowth of cells in that neighborhood. It will be seen by the examination of fig. 78 that the large cells of the third quartet in the anterior quadrants ($3a^{111}$, ^{112}, ^{121}, ^{122} and $3b^{111}$, ^{112}, ^{121}, ^{122}) are all encroaching farther upon the smaller cells of the same series, which have been crowded beneath them at the edge of the blastopore. Posteriorly, derivatives of the third quartet have completely surrounded the blastopore by the division and migration backward of the small cells $3c^2$ and $3d^2$, while more laterally the remaining small cells of this quartet and their neighboring larger cells are crowding around the depression. The second quartet cells, $2a^{22}$ and $2c^{22}$, or their derivatives, yet lie in the lateral corners; but as closure of the blastopore proceeds they are crowded from this position by encroachment of the third quartet both from before and behind, which finally (fig. 79) join each other on the sides. In the anterior median plane, however, a cleft yet remains between the large third quartet cells, and after the inner of these large cells have divided, as shown in fig. 79, cells of the second quartet, represented by the derivatives of $2b^{22}$, still occupy the space between them and there bound the blastopore. Throughout this process the greatest extension of the third quartet is manifest in the area covered by the posterior third quartet groups, and this is doubtless connected with the disappearance from the ectoderm in the anterior groups of the secondary mesoblast. The blastopore closes from behind forward, to which process the larger number of third quartet cells in the ectoderm of the posterior region conduces.

The posterior surface of the gastrula is now covered by large cells of the third quartet, and in the median region by second quartet elements. On the right posterior surface (left when seen from ventral surface, fig. 79) may be seen one very large cell, Ex. ($3c^{1111}$), which will later become the principal excretory cell of the larva. The region anterior to the blastopore has been formed from the second quartet cells of B quadrant which have been pushed backward by posterior and apical growth, space being left for them through the shifting of the large cells of the third quartet already described. The second quartet cells of B quadrant have shown comparatively little division or growth, and thus appear to occupy a relatively smaller space than previously.

The blastopore of *Crepidula* (Conklin) is surrounded by second and third quartet cells, all quadrants contributing. The same is true for *Ischnochiton* (Heath). In *Trochus* (Robert) third quartet cells are mainly concerned in the closure of the blastopore, though the derivatives of $2a^{22}$–$2d^{22}$ also bound the narrowing opening. *Planorbis* (Holmes) shows a very similar condition, with the exception that $2d^{22}$ is crowded out. In *Fiona* all second quartet cells but a few at the anterior edge of the blastopore are excluded before the opening closes.

Organogeny.

The Velum.

In its earlier stages the velum of *Fiona* is so ill-defined on the upper surface of the developing larva that its study has proved most difficult, and though more time has been spent upon this region than any other portion of the developing organism the results have not been as satisfactory as could be wished. Living material would have been of great value, and the lack of it has been a source of much regret. After the breaking up of the cross the whole external surface of the gastrula, and particularly the anterior end, is characterized by cells of small and nearly equal size, among which there appear scarcely any cells whose size would give them prominence, or cell rows or distinctly marked groups.

In the last stage described under the discussion of the development of the first quartet the area covered by this series of micromeres represents nearly the whole upper surface of the flattened gastrula (fig. 75). The four arms of the cross are split transversely, while in the angles between them lie the four groups of turret cells, each group consisting of four cells of equal size. In axial relation the anterior and posterior arms correspond to the direction of the median plane, while the lateral are respectively right and left. The whole first quartet area is completely surrounded and separated from the third by derivatives of the second. By an increased growth of D quadrant of this series the apical pole and its surrounding area is moved forward in the direction of the blastopore, while at the same time growth of first and second quartet elements in the neighborhood of the tip of the anterior arm of the cross causes that region to become raised, until somewhat later the pointed anterior end so characteristic of many Opisthobranch larvæ is produced (figs. 78, 79, 96). The visible cause of the evagination of the ectoderm at this point may be found in the directions taken by spindles of the dividing cells which produce it, as in most cases they are radially or diagonally directed toward the point of greatest elevation. At this time the archenteron is roughly triangular in outline, the anterior point of the triangle being marked by the large cell $4b^2$, which remains for a long time in this position and is closely pressed up into this anterior cone. It may thus be possible that the pointed anterior end of the larva is caused by the shape of the enteron, upon which the outer layer is moulded.

At first the terminal point of elevation corresponds in position to the tip of the anterior arm, and is thus formed by derivatives of $2b^{11}$ and neighboring cells. At a somewhat later period the continued growth of the shell gland area pushes the whole apical region forward, so that eventually (figs. 95, 98, 100) this point is carried farther downward on the anterior surface. At the same time continued growth has increased the extent of the whole apical region, so that the anterior end becomes more rounded than pointed, and finally (figs. 101, 102), when the veliger stage is just being approached, a broad rounded contour characterizes the anterior as well as the posterior end of the larva. It is while these changes are taking place that the first evidence of a distinct velar area appears. Early in this period of forward movement the anterior trochoblasts may be seen to the right and left of the anterior end of the forward arm, being distinguished from the derivatives of the second quartet by their smaller size and compact arrangement. They thus, with the tip cell and two other cells behind them (probably $1b^{1221}$, $1b^{1222}$, derived by transverse splitting of the middle cell), form an irregular row across the anterior edge of the first quartet area (fig. 76). Laterally the posterior ends of this semicircle are joined by cells in the region of the tips of the lateral arms and thus meet the posterior trochoblast groups. These latter have grown larger than their corresponding cells in the anterior quadrants, and so are almost indistinguishable from second quartet elements which lie beneath them. On this account it soon becomes impossible to separate them from these cells, and so at a later period, when the velum in this region becomes marked, I am unable to state how much of it is derived from the trochoblasts, though the little evidence at hand indicates that they form the largest portion of it. With change of axis the anterior end of the velum is carried forward (Pl. XXXVII, figs. 95, 98), and the forward end comes upon a level with the antero-ventral surface. A lateral view (fig. 98) shows an irregular row of nuclei (cell outlines are usually indistinct) running downward and backward from the anterior median point, and becoming lost as it continues posteriorly. This row, which has arisen from the anterior trochoblasts, derivatives of the middle and tip cells of the anterior arm and probably tip cell derivatives of the lateral arms, will be designated V^1. Below this band of cells another irregular row may be distinguished composed entirely of second quartet cells which have lain nearest the first quartet area, and this row, the first appearance of which is indicated in figs. 97 and 98, will be designated V^2, since it corresponds in general to the same cells in *Crepidula* which are designated by that term. Unfortunately the cells in this region have for some time presented no distinguishing marks, without which exact derivation is precluded by their number, but from their positions these lower cells probably correspond to derivatives of $2b^{121}$, ^{122}, ^{211} in the anterior group, and similar cells in the lateral. At a later period (fig. 101) these rows tend to unite to form an irregular line several cells in breadth, distinguishable only by their nuclei. As the stomodæal invagination progresses the velar rows are drawn forward and downward in that direction, and by the growth of the head vesicle they are also pushed downward laterally. It is probable that elements of the second quartet which lie still lower than those already mentioned become involved in the preoral velar area, either functioning directly as ciliated velar cells or taking part in the development of the underlying region of the expanding velar ridge. At the period represented in fig. 103, two irregular rows of nuclei may be observed in the anterior cephalic region above the stomodæum, and these correspond in origin to the rows V^1 and V^2 above mentioned. The postoral velar area is but faintly demarkated in the preparations studied and crosses the ventral region just behind the stomodæum. The cells comprising it are doubtless, in the median region, derived from the third quartet, to which are added second quartet elements more laterally where the postoral velum joins the preoral.

A portion of the velum does not in *Fiona* curve sharply toward the apical pole, as in the case of *Crepidula,* where an anterior branch is formed, but the whole extends backward around the head vesicle, so that this part corresponds in position to the posterior branch of *Crepidula.* This difference will be evident if a comparison is made between figs. 78 and 82 of *Crepidula* and fig. 108 of *Fiona.* In the latter instance it will be seen that the apical pole lies far forward from the posterior ends of the velar edge, while in *Crepidula* the anterior branch curves inward toward the apex, while the posterior branch continues backward around the whole head vesicle, as does the entire velum of *Fiona.*

In *Crepidula* Conklin (*Supplementary Note,* p. 204) finds that the median anterior portion of the first velar row (V^1) probably arises from the divided tip cells of the anterior arm, while laterally this row is continued by the trochoblasts and cells at the ends of the lateral arms. The second row in its mid-ventral region is probably "derived from the cell identified provisionally as $2b^{22}$, which lies just beyond the median cells of the first row", and he adds, "I have not been able to determine whether any part of the second velar row arises by subdivision of cells of the first; if not this row may include a few of the third quartet ($3a^{111}$ and $3b^{111}$, fig. 56) at the points opposite the anterior turrets". It also seems probable (*Supplementary Note*, page 204) that the cells $2b^{12211}$, $2b^{12212}$ lie outside the first velar row. Fig. 79 shows two large cells between the first and second velar rows, and they appear to represent the major portion of these cells. Smaller derivatives from them may join $2b^{22}$ in forming the median part of the second velar row (V^2). Conklin thus finds that the preoral velum arises from "a few cells of the first quartet, many of the second and possibly a few of the third". I do not believe that the third quartet becomes involved in the preoral portion of the velum of *Fiona*, though doubtless cells from this series are closely connected with it in the stomodæal region and help in the formation of the postoral velum. It will be remembered that in *Crepidula* secondary mesoblast is derived from the second quartet, while in *Fiona* it is furnished by the anterior groups of the third, and in this process the large cells of this series, which have hitherto lain well up on the sides of the gastrula, migrate over the underlying mesoblastic elements and thus become far removed from the region where the velum first appears. The formation of secondary mesoderm in the most anterior second quartet group of *Crepidula* has doubtless the same effect of lessening the external area of the quartet in that region, while the neighboring third quartet cells would lie relatively higher in this form than in *Fiona*. So when the second velar row forms in *Crepidula* it will lie relatively lower in the second quartet group ($2b^{22}$) and more probably involve third quartet cells, as Conklin states it probably does.

Regarding the lineage of the velum of *Planorbis*, Holmes says that "the tip cell (of the anterior arm) divides as far as I can determine, but once, and the two daughter cells become pushed apart by the cell $1b^{1211}$, which forms the median cell of the upper row. These cells extend to the anterior trochoblasts on either side, but in later stages they may sometimes be separated from them by cells which wedge in from below". The anterior trochoblasts follow these cells posteriorly, but Holmes states that the tip cells of the lateral arms "do not form a part of the prototroch but enter into the formation of the head vesicle". In this *Planorbis* differs from *Fiona*. Blochmann states that the right and left tip cells enter the velum of *Neritina*. The lower cells in the prototroch Holmes derives from the second quartet, though he adds that at a later period cells are joined to the prototroch from below, the lineage of which is obscure.

In *Ischnochiton*, the larva of which is, in its velar aspects, remarkably like the trochophore of Annelids, Heath finds that the prototroch is composed of trochoblasts, of "accessory trochoblasts" (derived from the original basal cells of the molluscan or intermediate girdle cells of the annelidan cross) of the tip cells in the anterior and lateral arms, while in the posterior arm the tip cells go into the ventral plate, the gap in the trochal ring being there bridged by derivatives of the median cell of that arm of the cross. Thus in this annelid-like form of larva none but derivatives of $2a^{11}$, $2b^{11}$ and $2c^{11}$ from the second quartet form the trochal ring.

The prototroch of *Trochus* (Robert) is composed of twenty-five cells, sixteen of which comprise the trochoblasts, six represent the divided tip cells of A, B and C quadrants, while the other three are the cells 2a, b, c^{12111}. A very exact and close comparison may here be made with the prototroch of the Annelids *Amphitrite, Arenicola* and *Clymenella*, particularly with the former, for, as Robert says, "Vingt-deux ont indetiquement la même origine et la même disposition que celles de *Amphitrite;* le trois autres (2a, b and c^{12111}) sont des derives des cellules correspondantes de la même *Annelide*."

Among Annelids Wilson has found that the prototroch of *Nereis* arises entirely from twelve of the sixteen primary trochoblasts, there being no contribution from the second quartet. All sixteen of the primary trochoblasts enter the prototroch of *Amphitrite* and *Clymenella* (Mead), as is also the case with *Arenicola* (Child) and *Podarke* (Treadwell). Regarding the close resemblance between the trochophore of *Ischnochiton* and those of the Annelids, Heath says: "The origin, development and fate of these cells (primary trochoblasts) is precisely similar to the primary trochoblasts in *Ischnochiton.* The second quartet in *Amphitrite, Clymenella* and *Arenicola* furnishes three cells in each quadrant except the posterior, which enter the prototroch. Two of the three are homologues of the divided tip in *Ischnochiton*, while the third corresponds to a post-trochal cell".

If now we compare the derivation and ultimate structure of the annelidan prototroch with the typical molluscan velum some interesting causal relations appear. At the time of its functional activity the prototroch of Annelids is apparently a radially symmetrical structure. Among the Mollusks we find, as a rule, a velum strongly developed anteriorly, with a considerable area of weakly ciliated ectoderm between the ends of its posterior arms. There are numerous exceptions to this typical molluscan velum, *Ischnochiton* and *Trochus* for examples, in which the trochal ring is as complete as among the Annelids. Returning now to the developmental history of the two groups certain variations are found which, when viewed in the light of functional larval structure, appear as a natural result of the divergent forms of the larvæ, these variations having been precociously thrown backward upon the cleaving cells of the ovum. In *Amphitrite, Arenicola* and *Clymenella* among the Annelids, and *Ischnochiton* and *Trochus* representing the more primitive Mollusks, all the primary trochoblasts ($1a^{211}$, ^{212}, ^{221}, ^{222}, etc.) in all quadrants go into the prototroch, while in *Nereis* the same occurs with the exception of four, which may for all four quadrants be designated $1a^{221}$; these are not functional in this manner, but are pushed inward and form part of the cephalic vesicle. In *Crepidula* only the anterior trochoblasts help form the preoral velum ($1a^{22}$, $1a^{21}$, $1b^{22}$, $1b^{21}$), and the same is true of *Planorbis* and possibly also of *Fiona*. Accessory trochoblasts ($1a^{1221}$, $1a^{1222}$, etc.) form a part of the prototroch of *Ischnochiton* in all quadrants, while in *Podarke* the cells $1a^{1222}$, $1b^{1222}$, $1c^{1222}$, corresponding to three of the above series, aid in the formation of the prototroch ("secondary trochoblasts" of Treadwell). In *Planorbis* Holmes finds that the cell $1b^{1211}$ is the "anterior median" cell of the prototroch, but does not find similar conditions in any other quadrants. None of these elements which are, of course, derivatives of the annelidan outer intermediate or molluscan middle cells (with the exception of $1b^{1211}$ of *Planorbis*, which comes from the inner basal) are found in the antero-lateral portion of the prototroch of *Amphitrite, Arenicola, Clymenella* and *Nereis*. In all the above forms except *Nereis* elements from the second quartet are also added to the prototroch, and these may be designated with Treadwell "tertiary trochoblasts". In *Amphitrite, Arenicola* and *Clymenella* the prototroch is increased in A, B and C quadrants by the cells $2a^{111}$, $2a^{112}$, $2a^{121}$, etc. In *Podarke* $2a^{112}$ and $2a^{121}$ in A quadrant, and similar cells in B and C, function in like manner, while *Ischnochiton* shows the same, for $2a^{111}$, $2a^{112}$, etc., enter the prototroch from the anterior and lateral quadrants ("secondary trochoblasts" of Heath). Of *Hydroides* Treadwell says: "Cells are added from the lower hemisphere". For the prototroch of *Trochus* Robert derives the three cells from the second quartet in A, B and C quadrants ($2a^{111}$, $2a^{112}$, $2a^{12111}$, etc.). Coming to those Mollusks which possess a typical veliger, more cells are found to be contributed by the second quartet, particularly in the anterior quadrants. In *Crepidula* the tip cells of the anterior and lateral arms go into the first velar row, while below numerous cells are added, so that the second row contains "probably a few cells of the first, many of the second and possibly a few of the third quartet". The velum of *Planorbis* is rudimentary in structure but shows the same general type of development as *Crepidula*, and here in like manner second quartet cells are added. The tip cells of the lateral arms, according to Holmes, do not enter the prototroch, but cells of the same series below them function in this manner. In the anterior region both tip cells and those lying beneath them from the second quartet enter into the prototroch.

From this short comparison of the lineage of the trochal area in Annelids and Mollusks, it will be seen that as in the functional larval form the typical molluscan velum shows greater anterior development than the prototroch of Annelids, so also cells taken from the segmented egg to complete the velum in this region exceed in number those destined to form a similar area of the annelidan trochophore. To do this the second quartet has become greatly encroached upon in furnishing necessary building material for this structure in those Mollusks whose larvæ show strong anterior velar development, and in *Crepidula* the third quartet also possibly becomes involved. It is natural to conclude, as indeed the facts show, that those Mollusks which in the structure of their larval prototrochs show great similarity to the homologous structure of the Annelid trochophore, will exhibit a similar lineage of the cells constituting the larval organs compared—examples, *Ischnochiton* and *Trochus*.

Later Velar Development.—With continued invagination of the stomodæum and constriction of the foot, the velar area, which has thus far been marked only by an irregular double row of cells extending around the anterior half of the head vesicle and losing itself in the posterior portion of that larval organ, becomes more prominent and takes on the bilobed outline so characteristic of the anterior end of veliger larvæ. At first the velar lobes are merely rounded swellings gradually rising from the upper sides of the head vesicle and curving around, downward and inward toward the stomodæum (fig. 105). The cells in this region do not as yet exhibit that differentiation which later marks the prominent ciliated margin from the underlying region. But as the lobes begin to constrict beneath and become more prominent (fig. 106), those cells which lie on their most peripheral surface show marked increase in size, and the ciliation which hitherto has been uniform and weakly developed becomes more prominent in these cells. They may now be observed lying in a row on the rounded edge of the expanding ridge, and though at first this series of cells is indistinctly marked, it continues to increase in definiteness and in the size of its component elements. Figs. 106, 107 and 108 (Pl. XXXV) show successive stages in the elaboration of these large heavily ciliated cells of the velar edge, and sections, as figs. 91 and 92 (Pl. XXXII) in particular, show the great increase in size which now marks them.

Coincidently occurs the expansion of the velar lobes to form the broad wings or velar folds which characterize the functional larva at the time it becomes free-swimming. As the velar area expands it becomes deeply notched below where the lobes of the opposite side rise to meet over the mouth, and this growth in length and breadth is marked on the dorsal side as well. Figs. 109 and 110, side and dorsal views of the same veliger, show the condition of development of the velum just before the larva breaks from the egg capsule, though in these drawings from fixed material the velum is of necessity considerably contracted. In fig. 110 it will also be noted that the region just above the mouth has grown out into a projecting process, and it is upon this area that the former apical point (animal pole) lies.

Head Vesicle.

The Head Vesicle of *Fiona* reaches its greatest prominence at a stage shown in fig. 104 and slightly older larvæ. Somewhat later (figs. 105, 106) it becomes actually larger, but relatively smaller when compared with the larva as a whole, and has also become greatly involved in the formation of the velar lobes. It is composed of cells of the first quartet lying within the trochoblasts and ends of the arms of the cross, and its greatest extent is covered by cells which lie posterior to the lateral arms. A posterior cell plate, such as is found in *Crepidula*, is not here developed, for though doubtless the same cells are present, they have multiplied to a much greater extent than in *Crepidula* or *Planorbis*, and form a layer of small cells which are scarcely distinguishable from those in front or at their sides. Neither is an apical cell plate demarkated in the region corresponding to the location of that structure in *Crepidula*, the cells in front of the apex being all of similar size and seemingly without regularity of arrangement, so that it is with the greatest difficulty that the apex can be located among the large number of small cells of equal size by which it is surrounded. As has been described before, the point of greatest forward extension lies first in the region of the tip of the anterior arm of the cross, but with continued growth the apical area becomes pushed forward so that it shortly occupies the point of greatest anterior extension, while the tip region of the anterior arm through which the velum runs lies ventral to the apex in the direction of the blastopore (figs. 95, 98). At the same time the head end becomes rounded by increased growth of the cephalic area.

The four original apical cells, as shown in figs. 75 and 76, divide soon after and again at a stage represented by fig. 95, so that this region, which in *Crepidula* is in the fully developed veliger still marked by four apicals ($1a^{1111}$, etc.), here comes to consist of at least twelve very small cells, among which no regularity of arrangement is sufficiently marked to be of value in orientation. These cells are extremely difficult to distinguish from numerous other cells of like form and structure which cover the anterior surface of the head vesicle. The apical group continues its forward migration in relation to the larva as a whole and, as it appears, pushes aside some of the cells which have arisen from divisions of the inner and outer basals of the anterior arm, for at a later period (fig. 108) the apical group lies close against the first velar row. Either such a shifting occurs or the basals become involved in the development of the velum. In fig. 108 a row of cells may be distinctly observed in which the nuclei are particularly large, extending laterally from the apical point. My first thought on seeing them was that they were a part of the velum, but after definitely locating the position of the apex and following the later history of the velum, it is clearly seen that this row never enters into the latter structure, but represents in its cell-lineage derivatives of cells of the lateral arms of the cross. No ciliation has been discovered in the apical area, and such structures are certainly not strongly marked, though without examining living material a denial of the possible presence of such structures would scarcely be conclusive.

Nerve and Sense Organs.

Cerebral Ganglia.—The cerebral ganglia arise at a stage about corresponding to fig. 105, though they do not become well marked until somewhat later (fig. 108). During this period cells may be seen proliferating inward from the ectoderm of the head vesicle in the two regions which lie lateral from the apical area. A row of cells with large nuclei are at this time plainly visible running laterally from the apex, and it is along the anterior side of these cells that the ganglia first arise. This row has been identified as coming from the lateral arms of the cross, and cells lying between it and the anterior portion of the first velar row are from the same source.

Later many of these large cells also divide and go into the ganglia. Thus it will be seen that the two cerebral ganglia arise from elements of the two lateral arms, the anterior rosettes, and probably also from some cells of the anterior arm which have been pushed laterally by the advance of the apex and lie in the region where the ganglia develop. The tip cells of the lateral arms certainly do not take part in the formation of the ganglia, as they lie too far laterally and probably go into the velum. Where no large cells, the definite lineage of which is known, are left as landmarks, it is obviously impossible to give absolute derivatives for the ganglionic rudiments. Comparing, however, the above approximate derivation with other Mollusks which have been studied in this connection similarities are evident. In *Crepidula* the ganglia "very probably arise from the lateral extensions of the anterior arms". Holmes has been able to state very definitely the manner of origin of these ganglia in *Planorbis*, as here they are surrounded by conspicuous cells. He says: "The tip cells of the lateral arms and the cells lying immediately above them do not enter into the formation of these masses; with the exception of these, two cells in each arm, all the cells in the lateral arms of the cross, the cells of the anterior arm, except the tip and basal cell, and the central region of the cross, except the four apicals, and the two cells lying in front of them, enter into the formation of these rudiments".

Otocysts and Pedal Ganglia.—The otocysts appear at a considerably earlier period than the ganglia which innervate them or the cerebral ganglia. They are first seen as slight invaginations on the sides of the foot slightly below the stomodæal invagination, and at a stage shown in figs. 103 and 104 have developed to deep pits, the openings of which have become much constricted. As these constrictions narrow, the two otic vesicles arise and are connected with the external ectoderm by strands of cells which resulted from the constriction of the outer portion of the invaginations. Somewhat later the pedal ganglia are seen slightly external to the otocysts in position. These ganglia arise in part from the strands which connected the otocysts with the ectoderm, and in part from other cells proliferated from the ectoderm in the same region. At first the cerebral ganglia are not connected with each other by a commissure nor with the pedal ganglia, but later cells grow out and meeting connect the cerebral ganglia together, while between cerebral and pedal ganglia like connectives arise, probably both ganglia contributing cells to their formation. These connectives are very large (fig. 94), and the whole cephalic nervous system is much concentrated. Behind the pedal ganglia and somewhat higher dorsally may be distinguished, particularly in older larvæ, the rudiments of the pleural ganglia, which also appear to have arisen by delamination of the ectoderm and lie in close association with cerebral and pedal ganglia. A very heavy commissural strand connects the two pedal ganglia, and the whole nervous system of the larva foreshadows in its compact structure the adult condition, individual ganglia being difficult to distinguish. Figs. 92 and 94 show sections through this region at a somewhat later period than figs. 88 and 89. Eyes have not developed to a functional condition in the oldest larvæ observed. Sections of these show pigment granules within cells lying close to the cerebral ganglia, and in some cases these cells lie around a slight invagination of the ectoderm—the first evidence of optic organs.

Excretory Organs.

The large excretory cell which lies on the right side of the larva and forms the chief member of a group of similar greatly vacuolated cells lying in that region arises from the third quartet in the C quadrant, and from its large size and conspicuous appearance its complete history is known. Returning to a segmentation stage, in which the egg contains about one hundred and twenty cells (fig. 70), it will be seen that the third quartet group in C quadrant contains seven cells. Divisions next occur in the three large cells, $3c^{1212}$, $3c^{1112}$ and $3c^{1211}$ (fig. 77). The cell $3c^{1111}$ does not divide with these, nor does it ever again divide, but continues its growth, soon becoming the largest element in the ectoderm. As gastrulation proceeds this large cell, $3c^{1111}$ (Ex.), the origin of which is thus established, appears at the right of the elongating gastrula (left of figs. 78., 79) and with the closure of the blastopore lies midway between dorsal and ventral surfaces, as shown in figs. 98 and 99. It has become much larger, when compared with its neighboring cells, both from lack of division and by actual growth. As the veliger takes form this cell becomes yet more marked (fig. 102), and when the shell gland has become prominent (fig. 104) it is seen lying in a slight depression surrounded by small cells which are in an active state of division. As the foot arises and the cephalic end of the veliger is differentiated from the body, the large excretory cells move upward along the body just posterior to the pedal groove, on the right side, this change of position being a natural sequence of the general torsion of that region (figs. 105, 106). The intestine has also become well developed by this time as a solid strand of cells connecting the posterior end of the enteric cavity with the ectoderm, and this latter point of contact is just below the large excretory cell. Fig. 88 shows a section through this region, showing the excretory cell to be much vacuolated and to lie for the most part below the ectoderm. At a considerably later stage (figs. 109, 110) its position and structure are shown just before the veliger escapes from the egg capsule. A large nucleus, which usually contains several small nucleoli and having the general appearance of nuclei in cells which have for a long time remained undivided, lies at the lower end of the cell. The cytoplasm is greatly vacuolated and at its peripheral end, where it meets the exterior, is seen a deep pit with constricted mouth. This appears to function as an intra-cellular duct, for it comes into connection at its inner end with the large vacuoles which fill the cell. Just above and anterior to the large cell is a group of smaller ones which contain darkly stained nuclei and pigment granules. One of these, the largest, also contains vacuoles and lies nearest the cell $3c^{1111}$. In somewhat older larvæ one or two of these smaller cells, which lie close to $3c^{1111}$, have increased much in size, become greatly vacuolated and appear to function as their larger neighboring cell. These smaller accessory excretory cells are also doubtless of ectodermal origin and, since they lie between the principal one and the blastopore, are doubtless derived from the same quartet.

In addition to the excretory cells above described others of a similar nature are found in the larva of *Fiona*. Sections (figs. 90, 91) of fairly well-developed veligers show two cells (Nph) nearly symmetrically placed on the two sides of the body just behind the constriction separating head from body region. These cells contain large nuclei and their protoplasm is clear and greatly vacuolated. In a slightly older stage (the oldest larvæ examined) yellowish-brown granules are very evident, lying in the meshwork of the vacuolated cytoplasm. The cell on the left side (fig. 91) lies just to the side of and slightly higher than the otocyst of that side, being closely associated with its ganglia, while the one on the right side (fig. 90) lies higher and is in close proximity to the smallest cells of the large excretory organ of that side. It may be distinguished from the cells of this organ by its clear cytoplasm and the color of the granules lying in it. In later stages another cell of similar nature may be seen beside the one on the right side, but only one has been observed on the left. The origin of these cells is not known. In earlier stages cells of slightly smaller size lie in the regions which they later occupy, but cannot be distinguished in structure from neighboring mesodermal elements. However they lie close to the ectoderm and may have come from that source. The later fate of these cells is unknown, but as they are increasing in size they probably function as important larval organs. They will here be designated "nephrocysts," for they correspond to cells of similar position and structure described by Trinchese (1881) for the larva of *Ercolania* and other Nudibranchs, by whom an excretory function was ascribed them. Older and living material is desirable before making definite statements regarding the nature and function of these apparently similar larval organs of *Fiona*.

Numerous investigators have seen and described with various interpretations the excretory organs of larval Opisthobranchs. As early as 1839 Lovén observed the anal kidney in Nudibranch larvæ, but did not recognize its function, though indicating that it was probably an undeveloped sexual organ. Likewise Sars (1840) described a similar structure in the veliger of *Tritonia*, which, together with the large endodermal cell which lies near it, he associated in common function with the liver lying on the opposite side of the enteron. In *Æolis* like structures were found. Later (1845) he distinguished the vacuolated excretory cell and its neighboring pigmented cells, classing the whole as a reproductive anlage. Reid (1846) observed a like structure in a number of Nudibranchs (*Doris*, *Polycera*, *Doto*, etc.), considering it to be probably the heart from contractions which he saw it undergo. In Vogt's very thorough paper on *Actæon*, appearing in 1846, the excretory organ is somewhat neglected, though his figures indicate its presence. Nordman in the same year described this organ in *Tergipes*, and referred a reproductive significance to it. Schneider (1858) also found it in *Phyllirhöe*, but assigned no definite function. Langerhans (1873), having observed in the living larvæ of *Doris* and *Acera* cells in the anal region which contained concretions, and from which drops were extruded considered the organ to be of an excretory nature. In 1875 Lankester found similar conditions in *Aplysia*, and considered the organ to have arisen either from intestinal cells near which it lay or from the ectoderm.

Trinchese (1881) described an "anal gland for *Ercolania* which is strongly pigmented and lies on the right side of the body". This he believed arises from three or four mesodermal cells which acquire pigment and by their division form the organ in question. The same was found in *Amphorina*, *Bergia* and *Doto*, in the last case being paired. In addition to the anal excretory organ, Trinchese also found in the above forms two "rini primive" in the dorsal region under the ectoderm, one right and the other left. These he described as vesicular, spherical or ovoid bodies having a lower part full of transparent liquid, in which lay concretions of a yellowish color. These he denominated "nephrocisti" (nephrocysts) and ascribed to them a mesodermal origin, since they have no connection with the exterior. Haddon (1882) found a mass of cells on the right side of *Jantheria* and *Philine*, near the anus in *Elysia* on the left side, and in *Pleurobranchidium* on both sides. In 1888 Rho found similar organs in *Chromodoris* which he stated arise from a few mesoderm cells containing numerous concretions and excreta which indicate their functional value. He concluded that this structure corresponds to the right Prosobranch kidney, considering the left to be rudimentary. Lacaze-Duthiers and Pruvot (1887), in a paper on Opisthobranch embryology, described the anal organ of *Aplysia, Philine, Bulla, Pleurobranchus, Doris* and members of the family Æolididæ, stating that in origin it is entirely ectodermal and that it was none other than an "anal eye." This eye, it was claimed, becomes strongly developed in the blind larvæ and later atrophies as true eyes appear. It stands in connection with a cell-mass, ganglionic in nature, the "asymmetrical centrum" of Lacaze-Duthiers.

Mazzarelli (1892) came to some very different conclusions from work on *Aplysia*. He believes the organ in question to have neither the structure nor function of an eye, and, moreover, it remains present in the larvæ after eyes are developed. From its position and structure it is doubtless a kidney. He derives it from paired rudiments which originally were closely associated with the endodermal elements of the aboral pole (mesentodermal cells) and which later, separating, wander into the blastocoel cavity and, after torsion begins, first the left and then the right come to lie in the neighborhood of the anus and together form a small cavity which acquires communication with the exterior. This unpaired kidney is homologous to the kidney ("niere") which in many Prosobranchs is found in the same place and, as is well known, forms the anlage of the definitive kidney. Mazzarelli, therefore, concludes that the anal kidney of the Opisthobranch larva is a secondary kidney ("secondare niere"), while the primitive kidney of these Mollusks is already known (the "nephrocisti" of Trinchese). The anal kidney is but the anlage of the definitive kidney, which in this case corresponds not to the right but to the left adult kidney of the Prosobranch.

Heymons (1893) has carefully described the conditions found in *Umbrella*. The excretory rudiment is here at first paired and arises from the cells $3c^{11}$, $3d^{11}$, which sink somewhat below the surface and divide several times, one cell in each group remaining large. Thus the excretory cells of *Umbrella* are ectodermal in origin. In further history Heymons finds that the large cell of the left side decreases in prominence and finally is indistinguishable from those surrounding it, while the right continues to enlarge and, with the torsion of the larva, is carried higher on that side. Later a second large cell appears by the side of this one, which Heymons thinks cannot represent the original left cell, as this would presuppose too great a migration, but rather one of those associated with the original right, the growth of which has been delayed. The function of a larval excretory organ is assigned only to this group of cells by Heymons.

In 1895 Mazzarelli, after a study of the development of a large number of forms (*Philine, Gastropteron, Actœon, Oscanius, Pleurobranchus, Tethys, Archidoris, Aplysia, Hermœa, Janus, Polycera* and *Haminea*), came to the conclusion that the anal organ of Lovén, Sars, Pruvot, Lacaze-Duthiers and others was not, as Lacaze-Duthiers, Pruvot and Heymons maintained, of ectodermal origin, but rather mesodermal, arising from two large and other smaller mesoderm cells which become pigmented and which by a slight ectodermal invagination acquire an external opening. In later development he finds these cells form a connection with the pericardium, which has arisen from a mesodermal mass closely connected with them. Therefore, he concludes that the anal kidney of the Opisthobranch larva is not homologous with the head kidney of the Prosobranchs, but from its origin, position and relation (particularly in connection with the pericardium) it is none other than the anlage of the definitive kidney of the adult And also, since it lies to the left of the rectum, it corresponds to the kidney of the Gastropods which possess but one, and to the left kidney of those with two. Viguier (1898) describes the anal kidney of *Tethys*, distinguishing an excretory lumen, around which are grouped several cells; he does not indicate its origin.

Among the Prosobranchs externally situated larval excretory organs appear to have been found generally. Salensky (1872) has described such bodies filled with concretions lying upon the side of the body in *Calyptræa* and *Nassa*. Bobretzky (1877) found the same in *Fusus*, these cells lying behind the velum and without an underlying ectodermal layer. This latter condition is placed in doubt by McMurrich (1886). Similar organs to the above were found in *Fissurella* by Boutan (1885), while in *Capulus* (v. Erlanger, 1893) a single large ectodermal cell, probably excretory in function, was found on each side of the body behind the velum. For *Crepidula* Conklin (1897) has minutely described a group of ectodermal cells lying laterally just behind the velum and probably arising from the second quartet; they become much vacuolated, filled with darkly stained granules and before metamorphosis separate from the ectoderm and are lost. Erlanger (1892) concluded that the larval kidney of *Bythinia* was partly ectodermal and partly mesodermal, and had no connection with the definitive kidney of the adult. The earlier results of Bütschli (1877) on *Paludina* as well as *Bythinia* were enlarged by Erlanger (1891–2), showing that in these fresh-water Prosobranchs the larval kidney was formed from inner mesodermal and outer ectodermal portions.

Rabl (1879) established a mesodermal origin for the primitive kidney of *Planorbis,* and Holmes (1900) in his late work confirms the same. Fol (1879) derived the larval kidney of *Planorbis* entirely from the ectoderm. Wolfson (1880) described the larval kidney of *Limnæa* as arising from a large velar cell on either side which migrates inward, retaining connection with the exterior through an intra-cellular duct. Meissenheimer (1898) says of *Limax,* we have "in der urniere ein rein ekto-dermales Gebilde vor uns, zu dem das Mesoderm auch nicht den geringsten Beitrag geliefert hat." From his figures and discussion it appears very evident that in this form the primitive kidney is purely ectodermal in origin. In 1899 Meissenheimer published his investigations on the "Urniere der Pulmonaten" (of the Basommatophora, *Ancylus, Physa, Planorbis, Limnæa,* and of the Stylommatophora, *Succinea, Helix, Arion, Limax*). In both these groups he shows the larval kidney to be entirely ectodermal in origin and similar in structure, the urinary tube of the latter group being many-celled, while in the former but four cells comprise it. In both a ciliated cell or cells closes the inner end of the tube, and for this reason Meissenheimer compares the primitive kidney of the Pulmonate with the end cells of the water vascular system of the Platyhelminthes.

Among the Lamellibranchs Hatschek (1880) describes the larval kidney of *Teredo* as probably both ecto- and mesodermal in origin. In the single left primitive kidney of *Cyclas.* Stauffacher (1897) found a similar though more complicated structure arising from both ectodermal and mesodermal elements.

Meissenheimer (1901) finds that in *Dreissensia polymorpha* the larval kidneys arise from ectodermal cells wholly, each of the two being formed from a few in-wandering cells. The structure is more simple than that of the Pulmonates and Meissenheimer suggests that it may be the ground type of the group. This might then be described as an ectodermal invaginating tube with the end closed by a vacuolated heavily ciliated cell.

From the above account of some of the more important observations and conclusions upon the nature and origin of the larval excretory organs of the Lamellibranchs and Gastropods (and of the latter more particularly of the Opisthobranchs), one is strongly impressed with the feeling that much more work must be done upon these organs of mulluscan larvæ before we are ready to come to definite conclusions regarding their mutual relations and homologies, if such exist. Nor has the investigation recorded in this paper brought forward facts which justify an immediate solution of the problem. The anal kidney of *Fiona* doubtless corresponds to the similar structure described for so many members of the Opisthobranchia, but its derivation is totally different from the results obtained by some of the more recent and careful workers in this group.

Mazzarelli's conclusions regarding its mesodermal origin, resulting from investigations upon a large number of closely related forms, are very different from mine. There is no point regarding the cytogeny of *Fiona* of which I am more certain than that the group of cells constituting the anal kidney is of ectodermal origin, and one member of the group (the largest, $3c^{1111}$) has been traced through every step of its history, from the initial cleavages which produce it to its functional condition upon the right side of the veliger larva at the time of hatching. In this respect my results are entirely in accord with those of Heymons for *Umbrella* and, except for the function assigned to the resulting organ, agree closely with Lacaze-Duthiers and Pruvot's derivation of the same structure from ectodermal cells. With regard to the fate of this organ, the work of Rho and Mazzarelli appears to show conclusively that it becomes metamorphosed into the kidney of the adult, and the latter's comparison of this organ with the adult kidney of those Gastropods which possess but one, or with the left of those with two, is in entire accord with the generally accepted opinion upon this subject. Unfortunately material has not been available for a study of the metamorphosis of *Fiona*. But on *à priori* grounds it should be similar in all essential features to the above-mentioned processes of development in closely allied forms. The metamorphosis of the anal kidney of the larval Opisthobranch into the definitive kidney of the adult might seem, at first sight, fair grounds on which to doubt its ectodermal origin, since the latter structure has generally been considered to be a mesodermal derivative. But if in this connection be considered the recent results of Meissenheimer, who derives the adult kidney and allied structures of *Limax* and *Dreissensia*, representing two distinct molluscan groups, from ectodermal rudiments, after an investigation which bears every evidence of care and accuracy, the possibility at least of a similar manner of formation among the Opisthobranchs must be granted.

So little is as yet known of the "Nephrocysts" of Trinchese that any discussion of their significance and possible homologies must of necessity be largely hypothetical. An exact knowledge of their derivation and structure would be of the utmost value. In *Fiona* when first seen they lie in the cleavage cavity, but whether they have wandered there from the ectoderm or are from the first mesodermal in character is yet an unsolved problem. Should they prove to be of ectodermal origin their position might justify a close homology with the Prosobranch larval kidney, and possibly also with those of the Pulmonates and Lamellibranchs, since Meissenheimer has indicated the larval kidneys of the two latter groups to be of ectodermal origin, and his work is supported by the earlier investigations of Wolfson and Fol. Should these nephrocysts prove entirely mesodermal there is yet a possibility of their similarity to the larval kidneys of the Prosobranchs, Lamellibranchs and Pulmonates, through the investigations of Bütschli and Erlanger for the Prosobranchs, Rabl and Holmes for the Pulmonates and Hatschek for the Lamellibranchs, who derived the primitive kidney of members of these groups in part or entirely from mesodermal elements. However, the structure of the nephrocysts of Opisthobranchs is very different from the primitive renal organs of the groups above cited, for, as far as is known, they appear wholly enclosed in the schizocoel with no external ducts. The fact of their very rudimentary structure suggests an explanation for the great development reached by the anal kidney. When we consider that in other groups possessing true larval excretory organs the anlage of the definitive kidney does not develop into a condition of functional activity until after metamorphosis, while among Opisthobranch larvæ, even before the time of hatching, certain cells of this structure are actively concerned in the work of excretion, the causal relation between rudimentary structures on the one hand and advanced development on the other is brought forcibly to mind. The nephrocyst of the Opisthobranch is not a prominent or well-developed structure, and with its phylogenetic decline precocious development has arisen in the rudiment of the definitive kidney, resulting in functional activity in a part at least of its formative elements long before development of the adult organ.

There is yet another possible explanation of the renal organs as found in Opisthobranch larvæ which will be stated but briefly, since a preponderance of hypothesis over fact is always to be regretted. It is generally conceded that whether the anal kidney be of mesodermal or ectodermal origin its rudiment is at first a paired structure, one part of which may fail to develop into a renal organ (Heymons) or unite with the other (Mazzarelli). The nephrocysts are paired structures, one lying close to the anal kidney, the other in an almost similar position on the opposite side of the body. It is possible that the nephrocyst of the right side is but a part of the anal kidney of that side, while that of the left represents the degenerate whole of the rudiment of that side. In this case, of course, true larval kidneys would be wanting.

The Enteron.

As the archenteron arises from the cleaving entoblast it presents, when viewed from the vegetative pole, an irregular depression, the bottom of which lies considerably below the edge of the blastopore. The macromeres, 5A, 5B, 5C and 4D, are at the bottom of this pit, with 5a, 5b and 5c lying peripherally from them, while above these and next to the ectoblast come $4c^2$, $4b^2$, $4a^2$ and the smaller cells $4c^1$, $4b^1$ and $4a^1$. In the posterior region are found the small cells E^1, E^2, e^1, e^2 (enteroblasts) which have arisen from 4d. The fifth quartet and all the macromeres are the next cells to divide, this resulting in enlargement of the wall area of the enteron, and by this division into smaller elements closer contact between the blastomeres results. Hitherto the entoblasts have been much rounded (except those meeting directly in the center), and have lain together in a very irregular manner, particularly after invagination began. With diminution in size and rearrangement of these cells a distinct cavity with closed dorsal wall arises (fig. 80). At the anterior end lies the large cell $4b^2$, while posteriorly and laterally are found the two large cells $4a^2$, $4c^2$; between and behind them are the enteroblasts. At first the enteron is longer on the right side (left of figures), the cell $4c^2$ lying more posterior than $4a^2$, this being the natural result of the division which early separated the large mesentomere from 4D of that side and the lack of growth and division in this latter cell for so long a period. But as development proceeds and the whole enteron grows in antero-posterior extent it will be noted that $4a^2$, which is a very large cell and easily distinguishable, gains in its backward course upon the opposite cell of like lineage ($4c^2$), comes to lie opposite to it and later more posterior (figs. 80, 81, 82). This process is the beginning of the torsion of the intestine, and is apparently to be explained in at least its first manifestations as the direct result of increase in growth of one side over the other. After $4a^2$ lies considerably more posterior than the derivatives of the large cell, which before lay opposite it ($4c^{21}$, $4c^{22}$, fig. 81), the cell $4b^2$ is seen to be undivided as yet and still at the anterior median point of the enteron, showing that the change of position of $4c^2$ relative to its opposite cell has been the result of greater increase in the area of the left over that of the right enteric wall.

During this process $4a^2$ has not been observed to divide and it maintains its large size throughout. On the opposite side $4c^2$ has divided into cells of equal size and divisions are continued in this region, resulting in the thinning of that portion of the enteric wall and an equalization of the size of the cells which compose it. With the continued growth of the enteron $4a^2$ is moved still more posteriorly and finally toward the right (left of figs. 82, 83). In fig. 84, which represents the enteron in optical section at a stage about corresponding to fig. 104, $4a^2$ is seen lying directly in the median line. Above, in the anterior median portion of the enteron, is a group of large yolk-ladened cells which have been derived from $4b^2$ and its neighboring cells. This group will soon shift somewhat to the left and become the rudiment of the liver.

As was seen before, the small cells E^1, E^2, e^1, e^2, which were separated from the anterior end of the mesentoderm, at first lie between $4a^2$ and $4c^2$. An actual section at this stage parallel to the ventral surface (fig. 85) shows that the inner of these cells are yet in contact with the enteric cavity. I am confident that the cells in this figure marked "enteroblasts" represent mesentoblastic derivatives. Their history, position, size and the structure of their nuclei, which are small and darkly stained, correspond to these cells. With the increase in extent of the left side of the enteron and, after the closure of the blastopore, by its continued growth, these enteroblasts, which may be distinguished from their neighbors by their darkly staining nuclei and their smaller size, become pushed from the median plane toward the right side as the large cell $4a^2$ advances around to a more and more posterior position (fig. 83). Finally, when $4a^2$ itself lies on the median line, these cells lie entirely to the right and are more posterior than those which have come from 4c and 5c. A slightly diagonal actual section, as fig. 86, shows the large cell $4a^2$ in the median plane. Just behind it and slightly to the right are shown in the section five small cells lying closely pressed between $4a^2$ and the shell-gland invagination behind. These cells correspond in position and in appearance to the small enteroblasts of fig. 85. If we now examine section fig. 87, which is taken through a veliger slightly older than that shown in fig. 104, the relation of the enteron to its surrounding structures may be observed. The large entodermic cell, $4a^2$, has been successively traced through preceding stages from its origin on the left side of the archenteron to its final position on the right of the enteric cavity, as is shown in the figure. Just posterior to this will be noted a mass of cells connecting the enteron with the ectoderm. The nuclei of these cells are compact and deeply staining, and the cytoplasm is decidedly clearer and contains less yolk than that of the cells directly surrounding the enteric cavity. Moreover, their position beside the large cell $4a^2$ and now, through the torsion which the enteron has undergone, their later position somewhat posterior to this cell, indicates the probability of their correspondence with the "enteroblasts" of fig. 86 (Pl. XXXI) and earlier stages, in which the identity of these cells is unquestioned.

It is proper in this place to consider again the results of Carazzi's work on *Aplysia* and its relation to the mesentodermal history of *Fiona*. It will be remembered that Carazzi's account of the lineage of 4d up to a stage when its derivatives number twelve cells exactly parallels my results on *Fiona*, but regarding the fate of these cells there is lack of agreement. The anterior small cells of *Aplysia* are believed to be purely mesoblastic, while at least four of them in *Fiona* appear, from the preceding account, to be entodermal in nature. Carazzi, however, derives endoderm from the two small posteriorly directed cells (e, e^1 of *Aplysia*) which correspond to z^1, z^2 of *Fiona*. These latter cells were last seen lying at the posterior end of the gastrula of *Fiona* closely pressed against the ectoderm. At a later period, when a large number of mesodermal elements lie in this region, the z^1, z^2 cells become indistinguishable from these. Sections of later stages (fig. 87) show two cells which are larger and clearer than the enteroblasts and which lie against the ectoderm where the intestinal mass touches it. They may represent the cells z^1, z^2, but of this there is no evidence except that given above. Anal cells are not a marked feature of the developing embryo of *Fiona*, but at this time sections in particular show two cells of somewhat larger size than the surrounding ectodermal elements, against which the forming intestine abuts and which are doubtless comparable to the anal cells of other forms (fig. 87, An.C).

It will now be seen that the portion of the enteron lying most posterior and close against the shell-gland invagination has been derived from the cells which formed the bottom and the left side of the original archenteric invagination (5B, 5b, 4C, 5C, 5c, 4D, 5A) while dorsally and anteriorly are seen more yolk-ladened elements whose origin may be traced to the large entoderm cell $4b^2$ and those around it. The stomodæal invagination breaks through at a much later period between the descendants of 5a and 4b and their neighboring cells, which have been turned in an anterior direction, while doubtless cells from 4c and 5b also push in upon this region with the closure of the blastopore. By the torsion which the enteron has undergone the upper mass of large yolk-ladened cells is moved more and more to the left, while in like manner $4a^2$ turns to the right. While this is occurring the invaginating shell-gland has pushed the anterior and posterior walls of the enteron very closely together, both enteric and cleavage cavities being practically obliterated (fig. 86). When this structure evaginates the enteron again opens out and has then lost its elongated form, being rounded with its wall cells in close contact (fig. 87).

In *Umbrella* as well as in *Fiona* $4b^2$ occupies the anterior end of the enteric mass pushing up into the pointed apex of the gastrula, and the same is true of *Aplysia* in which there are but two large blastomeres, though according to Blochmann's nomenclature such does not appear to be the case. In later stages the positions of the large cells of the fourth quartet of *Umbrella* and *Fiona* are identical. The intestine of *Umbrella* is said to be formed by C'' and D'' (5c and 5d), which, as Heymons did not take into consideration an entoblastic contribution from 4d, correspond fairly well to the conditions found in *Fiona*, where these cells lie just at the place of origin of the intestine and may well take part in its future development. The cell-lineage of the archenteron of *Crepidula* is given as follows: "The four macromeres form the roof of the archenteric cavity. The cells of the fifth quartet form its lateral boundaries, arching the cavity on all sides save the posterior. Here the archenteric cavity runs backward between the cells 5C and 5D (5c and 5d) nearly to the posterior boundary of the egg. The cells of the fourth quartet come together on the ventral side of the archenteron, forming its floor anteriorly and ultimately giving rise to some of the many small cells which form that part of the mesenteron, adjoining the stomodæum." The intestine arises from the posterior lower right region of the enteron as a tube-like evagination, formed from the enteroblasts derived from 4d and neighboring small endodermal cells and ending blindly against the ectoderm. Later it elongates and the end is carried somewhat upward along the right side by trosion of the larva. It contains a lumen from the first. As the stomach begins to enlarge it is seen to be bounded by large cells dorsally and anteriorly in its lower regions. As development proceeds it is elongated, its posterior end being ventrally directed and turned toward the right. The development of the liver of *Crepidula* comes later, being retarded by the great amount of yolk.

The next change in the development of the enteron of *Fiona* may be observed in fig. 105, which represents a veliger in which the alimentary canal is beginning to become differentiated into several parts. Anteriorly is seen the stomodæum, which has as yet not broken through but touches the wall of the enteron. Above and to the left of this point of contact is a decided lobing of the wall of the enteric cavity, formed of the large yolk-ladened cells which at an earlier period lay in the anterior region of the archenteron. This is the rudiment of the liver, and as development proceeds the invagination becomes larger and more constricted at its base, forming a rounded lobe upon the left dorsal wall of the enteric canal. Behind the rudiment of the liver the enteron has widened into a capacious sac which is larger at its upper anterior end, the walls of the whole being formed of rather small cells which are yet rich in yolk. This is the stomach, and it ends blindly against the intestinal mass behind and to the right. The intestine is yet a solid strand of cells connecting the posterior end of the stomach with the ectoderm. With the growth of the veliger this strand has become more slender, elongated and turned forward, its distal end lying well up on the side of the body behind the constriction which forms the foot. The huge excretory cell lies just dorsal to this point (figs. 106, 107). In figs. 90, 91, 92 and 93, which represent coronal sections of a veliger somewhat older than figs. 105 and 106, and slightly more mature than that of fig. 107, it will be seen that the intestine is still a solid strand of cells, and that the œsophagus is as yet not in open connection with the rest of the alimentary canal. An examination of a considerably older larva (figs. 109, 110) shows a very small lumen, just beginning to form in the center of the intestinal strand, but as yet no communication between œsophagus and enteric cavity.

Stomodæum and Mouth.

As the blastopore narrows (fig. 79) it becomes entirely surrounded, except at the anterior end, by third quartet cells. At the anterior point second quartet cells from $2b^{22}$ and $2b^{212}$ lie along the edge also. Figures of a later stage (as 97, 98) show the blastopore as a mere rounded opening, its edges and walls below thickly set with darkly nucleated cells, and when complete closure occurs a plug of these cells may be observed upon lateral optical section dipping down from the region of closure to the enteron beneath. These cells have come largely from the third quartet of all four quadrants, and represent the smaller cells of this quartet which lay nearest the open blastopore. This condition exists but for a short time, for soon a broad pit may be observed in this region occupying exactly the place where the blastopore closed. As it forms the cells which have been invaginated to form the blastopore-plug open out again so that a blind pit results, the lower surface of which is formed by those cells which were first pushed inward as the blastopore was closing, and correspond to the second and third quartet elements which are shown in fig. 79 surrounding the blastopore. The stomodæal invagination continues to increase in depth by growth and division of the cells which already form it and by further invagination of surrounding cells, so that, as the form of the veliger begins to appear (figs. 103, 104, 105, 106), second and third quartet cells from all the quadrants lying in the region probably become involved. At first the stomodæum is broad and shallow, but as it increases in depth it narrows and becomes more dorsally directed at its inner end. In section, fig. 90, and in drawings of the oldest veliger shown (figs. 109, 110), the stomodæal invagination has as yet not formed an open connection with the enteron, but shortly afterward this occurs, at which time the stomodæum is much elongated. Union is established with the stomach pouch just below the opening of the large liver lobe.

Fiona agrees with a large number of Mollusks in which the blastopore closes and the stomodæum forms at the same point. Among them may be named *Nassa* (Bobretzky), *Neritina* and *Aplysia* (Blochmann), *Elysia* (Vogt), various Æolididæ (Trinchese), *Doris* (Langerhans), *Crepidula* (Conklin), *Planorbis* (Holmes) and *Trochus* (Robert). In *Patella* (Patten), *Fusus* (Bobretzky), Pteropods and Heteropods (Fol) and *Limnæa* (Lankester) the blastopore is said to remain open and pass over directly into the mouth.

Shell-gland and Foot.

If one examines the segmenting egg somewhat later than such a stage as shown in fig. 73, it will be observed that the posterior has considerably outstripped the anterior region in extent and that, together with numerous divisions, the cells have also enlarged considerably in size. The area which lies along the median line, and so is derived from the second quartet, shows most plainly this rapid increase in extent, and it is here particularly that the cells themselves become greatly enlarged and prominent. This is the region of posterior growth, and from this area arise both the shell-gland and the foot.

Taking up first the history of the former of these two organs, it will be found that in a stage represented by figs. 95 and 98 the whole area between the blastopore and the end of the posterior arm of the cross shows karyokinetic activity, but particularly in the region marked Sh.G. the cells have increased considerably in size. As growth continues these cells upon the upper and posterior surface of the gastrula protrude above the level of the ectoderm, the area which they cover having the appearance of a rough cobble-stone pavement; but somewhat later they settle down and form a smooth surface. The center of this area, which now lies just opposite the region of the stomodæum, begins to invaginate, pushing the enteron before it and reducing its cavity, so that there results a deep pit which, growing in size below, constricts above, and around which are several rows of large granular cells (fig. 102). Such a condition lasts but a short time, for soon the invaginated area opens outward, the whole forming a large thick-walled cap upon the posterior end of the veliger, constricted around its edge and merging abruptly with the thin-walled ectoderm anterior to it (fig. 104). As growth proceeds the shell-gland spreads and becomes much thinner, while the larval shell appears as a secretion of the large cells which compose it. As the shell continues to extend over the veliger its outer edge is marked by several rows of large cells, which by their secretive activity lay down the substance which forms the shell (figs. 105, 106, 107). Almost from its origin as a distinct structure the shell-gland is slightly displaced to the left side of the body, and as it increases in extent this lack of bilateral symmetry becomes more marked (fig. 107).

The ventral prominence which develops into the foot arises somewhat later than the shell-gland, and the cells which go into it come from the second quartet of D quadrant and the third quartet of C and D quadrants. The large ectodermal excretory cell, which in the larva lies just behind the foot, serves as a guide to show that much of the foot, like this cell, arises from C quadrant of the third quartet; and though no such landmark is present on the other side, the early history of the two quadrants are so similar that we may reasonably suppose a like origin from the third quartet for the left side of the foot. Lillie has derived the foot of *Unio* from cells of the second quartet, and Conklin appears to have done the same for *Crepidula*. Holmes states for *Planorbis* that as the cells immediately behind the blastopore are of third quartet origin, probably the "median portion of the anterior end of the foot is derived from some of these cells". Robert describes a similar condition for *Trochus*. In *Fiona* not only the median portion but also much of the lateral area certainly comes from the third quartet. The foot here does not arise as a paired swelling as in *Patella* (Patten), *Fulgar* (McMurrich) and *Trochus* (Robert), but shows from the first a median protuberance which increases in size and later becomes broadened and flattened (figs. 103, 108, 110). Its upper surface is covered with numerous cells, but they are not arranged to form a conspicuous cell-plate as in *Crepidula*. Large cells mark its lower surface and they soon begin to secrete the operculum.

Larval Musculature.

It is particularly unfortunate that for a study of the muscles of the velum no living material has been available, as without this many points of interest must of necessity be lost. When the veliger breaks from its capsule it presents an appearance shown in figs. 109, 110, though it should be remembered that in fixed material, from which the drawings were made, the muscles must be much contracted. The whole posterior region is swollen into a huge transparent vesicle, at the anterior end of which lies the contorted alimentary canal. In dotted outline is represented the probable position of the cuticular-like shell before shrinkage. In a larva of such age one of the most characteristic features is a large dorsal retractor muscle, which has its posterior point of attachment well to the left of the dorsal side of the posterior vesicle. It runs forward and branches just before reaching the liver lobe, its two anterior ends becoming attached to the alimentary canal and the body wall in the region of the œsophagus. In structure it is composed of large spindle-shaped interlacing cells, which are flattened dorso-ventrally, giving the muscle a band-like form. In function this muscle doubtless acts as a retractor for the anterior and particularly the upper portion of the cephalic region. A dorsal view of the same veliger shows two lateral muscles, the right and left retractors of the foot, which arise about midway back on the sides of the posterior vesicle and extend forward through the lower part of the neck region, to end in branching fibers in the foot. That of the right side is larger than the left, and in earlier stages (figs. 105, 106) is much thicker than later and relatively larger. In figs. 105 and 106 is shown a small muscle (Vl.R.) extending from the dorsal neck region to the velar folds where it branches greatly. Other similar retractor muscles of the velar lobes extend from the walls of the alimentary canal and the body wall outward into the velar area branching extensively. Fine interlacing fibers are also found in the foot in older stages.

Returning to the period marked by fig. 105, the dorsal retractor muscle is seen to be a short thick strand of cells extending from the shell region to the enteron near the position of the liver. It is here already branched and runs along the sides of the alimentary canal. The right retractor of the foot is, as shown, a very heavy cell strand which unites the foot with the lower dorso-lateral portion of the shell. A view from the left side would show a muscle occupying a similar position, but in this case much thinner (fig. 107 shows their relative sizes at a slightly later stage). Even at this early period the dorsal retractor is posteriorly attached to the left of the median line.

Bearing in mind the distinction of Lillie and others between primary mesoblast (ento-mesoblast) and secondary mesoblast (ecto-mesoblast or larval mesoblast), the attempt has been made to distinguish between these two sources of muscular tissue in the developing larva of *Fiona*, with, however, but partial success. The velar retractors, which lie in the region of the head vesicle, are formed from secondary mesoblast. Those cells which we have seen cut off from the third quartet in the two anterior quadrants lie in the antero-lateral region of the gastrula, and may for some time be distinguished from the primary mesoblast cells. When at an early period spindle-shaped muscle fibers appear in this region, their origin from these cells can scarcely be doubted. The component elements of the dorsal retractor are hard to distinguish. When this muscle first appears at a stage about midway between figs. 104 and 105, several large cells lie wedged in between the rounded wall of the enteron and the ectodermal area in the upper region of the shell-gland. The evidence is strong that these cells at least are from the primary mesoblasts. At this time, however, other cells extend along the enteron, connecting the compact posterior group with the loosely lying spindle-shaped elements of the velar retractors. They doubtless help form the more anterior portion of the dorsal retractor and, lying as they do so close to where secondary mesoblast was formed, may be derivatives of it. The two retractors of the foot and the interlacing fibers of that organ itself are doubtless composed of cells which have come from 4d. From the above account it is seen that a true "larval mesoblast" is found in *Fiona*, since much at least of the musculature of the velum, a purely larval organ, is derived from this secondary mesoblast.

No organ in any way comparable to a larval heart is to be found in the oldest veligers which I have studied.

Change of Axis and Form of the Developing Organism.

The egg at the time of laying is spherical. With the division into four cells the primary egg axis, running between the centers of the animal and vegetative poles, becomes shorter than the diameter of the equatorial plane. As segmentation proceeds this relation persists (fig. 14), and with continued division the formation of a large cleavage cavity becomes more pronounced. Until the cleaving egg reaches a stage of over sixty cells its surface, when viewed from either pole, appears almost perfectly rounded, but shortly after this its antero-posterior axis becomes shorter than the lateral (figs. 45, 56, 74), this relation holding until increased growth in the posterior and anterior quadrants causes elongation in that direction. Until about a stage shown in fig. 74 the primary egg axis, running from the center of the animal to the center of the vegetative pole, follows a straight line. Immediately after this, accentuated growth of the posterior region initiates a bending of this axis, which finally results in its complete folding upon itself, or a rotation through 180 degrees. A sharply pointed anterior projection arises (fig. 78), while at the same time the posterior dorsal region is rapidly increasing in extent and changing the embryonic axis. As the gastrula elongates the apical pole is moved forward, and by the time the first velar row becomes distinct the original polar axis has become so bent upon itself as to form an angle of nearly 90 degrees (figs. 95, 98). With the continued multiplication of cells in the head region that portion of the larva changes from its originally pointed shape into a rounded though not prominent head vesicle, while at the same time the opposite end is rounded by continued growth of second and third quartet elements (figs. 100, 101). The original polar axis will be seen in these figures to have moved through about 135 degrees. In the next stage, represented by figs. 102 and 104, the head vesicle has reached its largest relative size when taken in connection with the veliger as a whole. Comparing these figures with those which have gone before, a marked increase will be seen in the antero-posterior depth, and if this be considered in connection with the great change of axis the enormous growth of the posterior region will be evident. It is generally conceded that the head vesicle of molluscan and annelidan larvæ is of functional importance in serving as a float. In *Fiona* the head vesicle is never large and prominent and a substitute may reasonably be expected. With the differentiation of the velar lobes and foot the shell-gland may in figs. 105, 106 and 107 be seen to be rapidly spreading over the posterior region. As this is being accomplished it also grows greatly in size, producing the enormous posterior vesicle which in figs. 109 and 110 extends far behind the internal organs of the body. The importance of such an organ must be considerable and, taken in connection with the early decrease in size of the head vesicle, strongly suggests that its functional value is similar in kind to that usually ascribed to the anterior or head vesicle of other larvæ.

In all older veligers figured the original polar axis has become completely bent upon itself, a rotation of 180 degrees having occurred. With regard to the median plane of the future embryo, the first cleavage plane is obliquely transverse to this plane. When the mesoderm is formed it is thrown over toward this median plane, and from the first is approximately bilateral in position (figs. 24, 31, 34). The elements of both entoblast and ectoblast, which in late stages of cleavages lie on the median plane, appear to be derived from cells of the early cleavages which occupied similar positions. Little rotation, if any, is apparent other than a certain amount of irregularity found in all portions of eggs with equal or nearly equal cleavage.

Conklin describes for *Crepidula* an entire rotation of the ectoblastic cap at the time when the anterior and lateral cells of the fourth quartet arise. Heymons shows a similar rotation in *Umbrella.* Such a change of axis in the germ layers does not occur in *Fiona,* nor is there necessity for it. The large macromeres of *Crepidula* and *Umbrella* are here represented by small cells, which do not modify the positions of the germ layers at the time of their origin nor necessitate supplementary rearrangement.

Abstract.

Maturation begins at the time of laying. Two polar bodies are given off, the first of which may or may not divide. The unsegmented egg of *Fiona* is rich in yolk, the spherules being comparatively small. In shape the egg is round, but slightly flattened in the direction of its polar axis. One to three eggs are found in a roomy egg capsule.

The early cleavage is strictly spiral after the dextral sequence. The first quartet of micromeres are much smaller than the macromeres, but with succeeding divisions the cleavage becomes equal in character. After the four macromeres are formed they give rise to successive quartets of micromeres. The first three quartets contain all the ecto-

blast. The mesoblast arises in part from the fourth quartet cell of D quadrant. The remaining fourth quartet cells and all the macromeres are entoblastic, as is also the case with a small portion of 4d.

The first quartet of ectomeres give rise to the trochoblasts and ectoblastic cross. To the latter structure are added as "tips" the upper cells of the second quartet in all quadrants. The cross is radially spiral in symmetry, and does not increase in breadth by transverse splitting of its arms until a comparatively late period. Cells from the first quartet form the head vesicle, cerebral ganglia and eyes, and a portion of the first velar row.

The second quartet has a similar cleavage history in all four quadrants until a stage of about 150 cells. In later development the elements of this quartet in D (posterior) quadrant show great increase in size and divisional activity, initiating the posterior point of growth, with resulting bending of the embryonic axis. Cells from this area form the shell-gland and median portion of the foot. A large number of second quartet cells from the anterior and lateral groups aid in the formation of the velum. The more ventral elements of B quadrant help to close the blastopore.

In the third quartet bilateral cleavages first appear in the posterior quadrants (cells $3c^1$ and $3d^1$). Secondary mesoblasts arise from the anterior quadrant groups of this quartet (cells $3a^{2111}$, $3a^{2211}$ and $3b^{2111}$, $3b^{2211}$). The large anal excretory cell ($3c^{1111}$) and its associated cells are derived from C quadrant of this quartet. Third quartet cells surround the blastopore as it closes, with the exception of a small anterior portion; much of the stomodæum and the lateral portions of the foot come from third quartet elements.

The mesoblast of *Fiona* is derived from two sources, ento-mesoblast from 4d and ecto-mesoblast from the third quartet in A and B quadrants. The greater amount comes from 4d and forms teloblastic bands in the posterior region of the gastrula. The secondary mesoblast (ecto-mesoblast) is largely "larval" in fate, since much of it goes to form the muscles of the velum. From the history of 4d it appears that this cell contains both mesoblastic and entoblastic derivatives, the latter taking part in the formation of the intestine.

As is the case with many Opisthobranchs, the gastrula is sharply pointed anteriorly, the apical point at first lying at the end of the anterior arm of the cross.

The blastopore at the time of closure is surrounded by third quartet cells, except at its anterior edge, where second quartet cells are present. The stomodæum later forms at the point where the blastopore closed.

The shell-gland at first forms a deep invagination, which later opens out and covers the posterior end of the veliger with a cap of large cells which soon begin to secrete the shell. From the first the shell is slightly shifted toward the left, and this asymmetry becomes more marked with continued growth. With the enlargement of the shell a conspicuous posterior vesicle results.

The foot arises as an unpaired swelling below the stomodæum. Its under surface later secretes an operculum.

The first velar row is formed from the anterior trochoblasts (A and B quadrants), the tips of the anterior arm of the cross, and possibly from other cells of the first quartet in this region. The second velar row is derived from underlying cells of the second quartet. A post-oral velar area is but slightly marked. In later development the velum becomes bilobed and broadly expanded.

A prominent head vesicle is not present in the older veligers, and with this may be correlated the development of a large posterior vesicle. No apical sense-organ has been found, nor are distinctly marked apical plates present. The cerebral ganglia appear in the angles between the anterior and lateral arms of the cross. Otocysts are formed by invaginations of the ectoderm upon the sides of the foot, and pedal ganglia appear closely associated with them. The eyes are late in appearing and are intimately connected with the rudiments of the cerebral ganglia.

The anal kidney of the larva is derived from the ectoderm, coming from $3c^{1111}$ and associated cells. With the torsion of the larva this group is shifted farther to the right, and eventually lies well up on the right side of the veliger above the anal opening. Primitive excretory cells are also found lying in the body cavity laterally behind the velum.

The enteron is formed by invagination of the entomeres, which at first form an elongated sac; with the evagination of the shell-gland this becomes rounded. The liver is derived from large yolk-ladened cells lying at the anterior end of the enteron, and later the rudiment of this organ becomes turned toward the left side. Torsion of the enteron results from lengthening of the left side and is caused by increased growth of that region. The intestine is at first a solid thick cell-strand and is composed largely of entoblasts from 4d; it later elongates and acquires a lumen.

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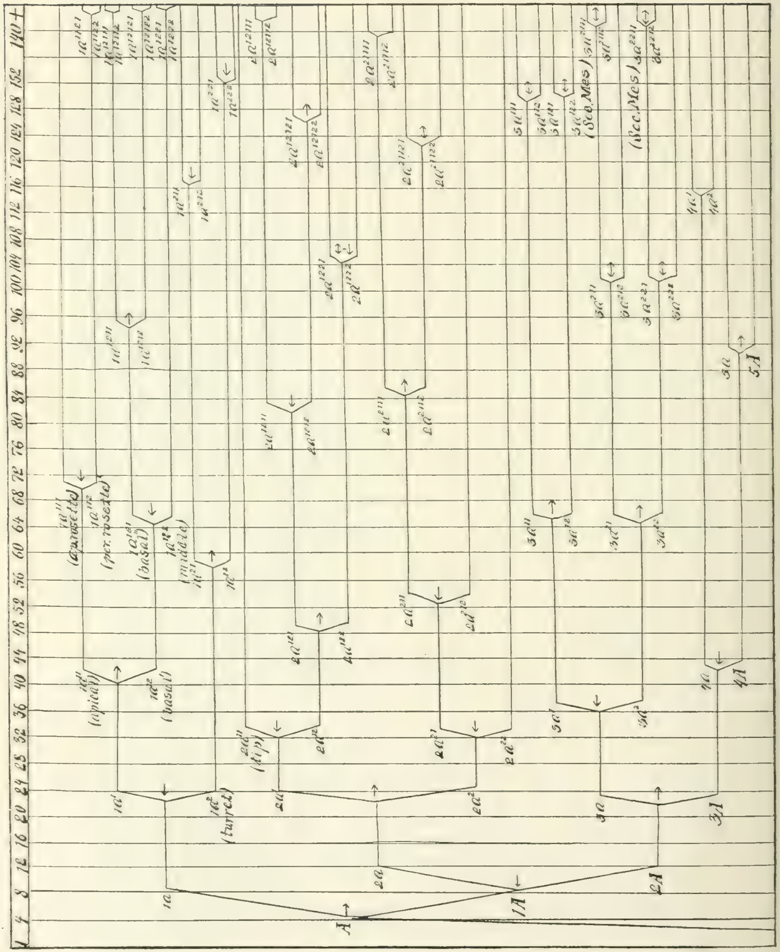
Table of Cell-Lineage.

A. Quadrant.



Arrows pointing to right, dexiotropic direction of cleavage; to left, læotropic; double-headed arrows, horizontal; double-headed bent arrows in history of 4d, bilateral cleavages with relation to cells of opposite side.

Table of Cell-Lineage.

B. Quadrant.

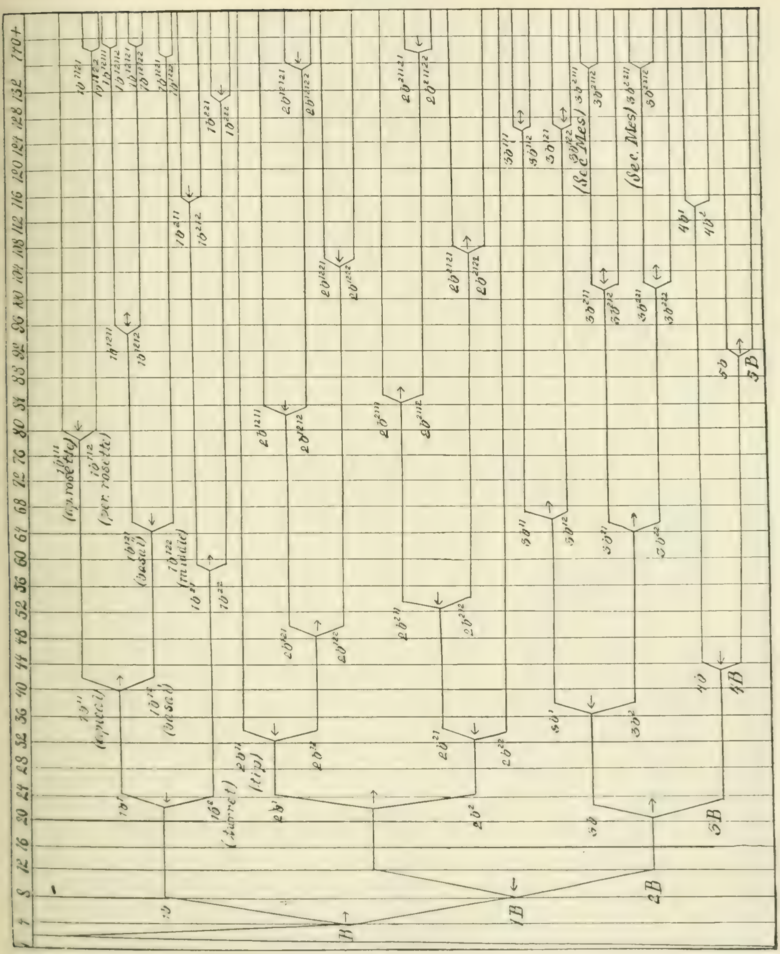


TABLE OF CELL-LINEAGE.

C. QUADRANT.

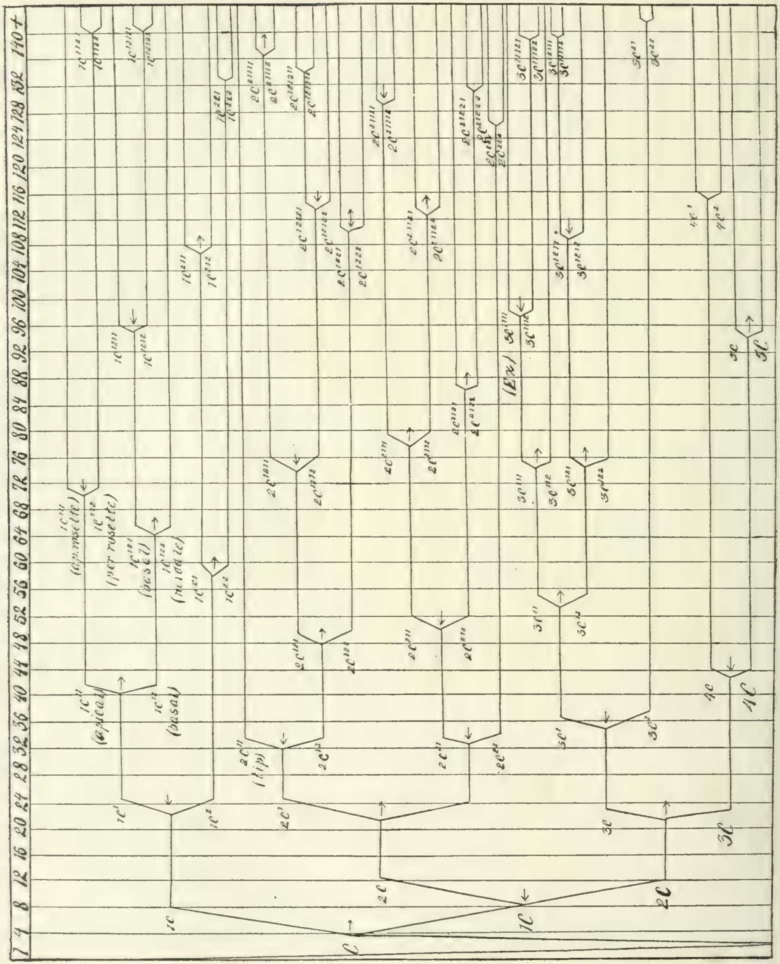
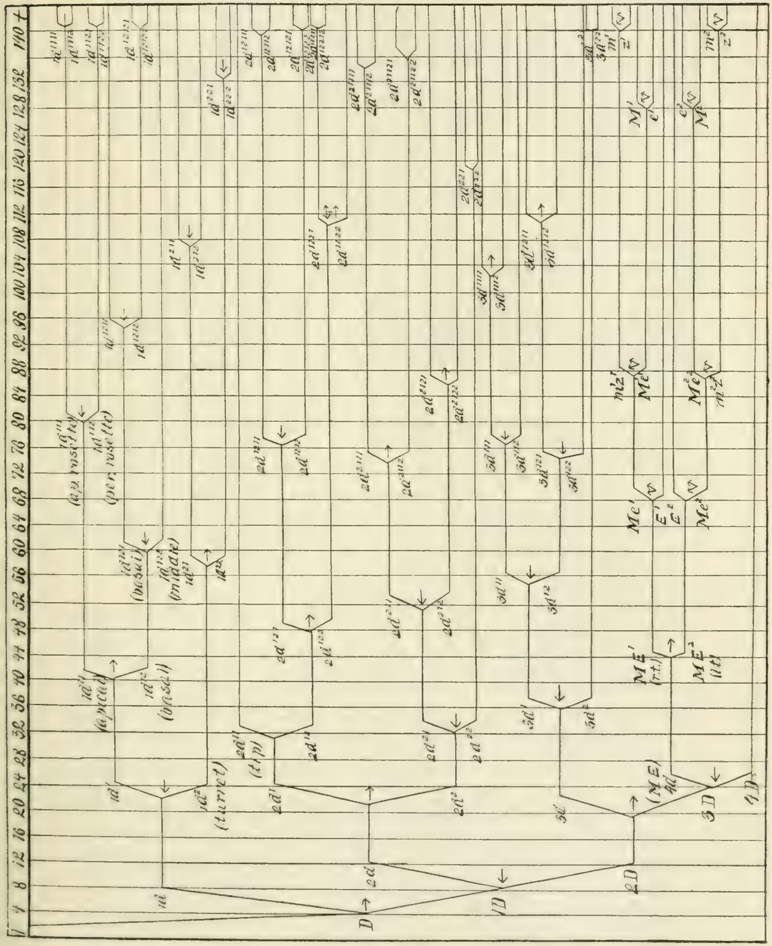


Table of Cell-Lineage.

D. Quadrant.



Reference Letters.

Ap	Apical point.
An.C	Anal cell.
Bl	Blastopore.
C.G	Cerebral ganglion.
Dr.R	Dorsal retractor muscle.
Ebl	Enteroblasts.
E.C	Large enteric cell.
En	Enteron.
Ex	Large anal excretory cell.
Ft	Foot.
Int	Intestine.
L	Liver.
Lt.R.Ft	Left retractor muscle of foot.
Mo	Mouth.
M.F	Muscles of foot.
Nph.L	Left nephrocyst.
Nph.R	Right nephrocyst.
Oes	Œsophagus.
Op	Operculum.
Ot	Otocyst.
P.B	Polar Body.
P.C	Pedal Commissure.
P.G	Pedal ganglion.
Rt.R.Ft	Right retractor muscle of foot.
Sec.M	Secondary mesoderm.
Sh.E	Edge of shell.
Sh.G	Shell-gland.
St	Stomodæum.
Stom	Stomach.
Tel	Teloblast.
V^1	First row of velar cells.
V^2	Second row of velar cells.
Vl.L	Velar lobe.
Vl.R	Retractor muscle of velum.

Note.—In the drawings the trochoblasts are represented with stippled nuclei; upper pole views show the ectoblastic cross in heavy outline. Plates I–XI, XIII, and Figs. 101–104 of Pl. XIV are reduced $\frac{1}{3}$ from original drawings, the remaining figures $\frac{1}{2}$. Figs. 7, 36, 39, 46 and 55 have been omitted from Plates.

Explanation of Plates XXI–XXXV.

Plate XXI, Fig. 1.—Section of egg of *Fiona marina*, showing first maturation spindle.

Fig. 2.—Section. First polar body being given off. Sperm nucleus with astral rays below.

Fig. 3.—Section. Rise of second polar body. Enlargement of sperm nucleus and astral rays.

Fig. 4.—Lateral view of entire egg. Approach of male and female pronuclei.

Fig. 5.—First cleavage; figure seen from side.

Fig. 6.—Completion of first cleavage, as seen from above. The two polar bodies lie between the nuclei.

Fig. 8.—Completion of second cleavage, seen from upper pole. A polar furrow is present at the vegetative but not at the animal pole.

Fig. 9.—Upper pole view, showing spindles which institute third cleavage.

Plate XXII, Fig. 10.—Dexiotropic turning of spindles of the first quartet, with constriction and rounding out of these cells. Lateral view.

Fig. 11.—Same egg as fig. 10, seen from above.

Fig. 12.—Lateral view of slightly older egg than Fig. 10, showing compact grouping of blastomeres after division.

Fig. 13.—Completion of fourth cleavage, læotropic in direction, by which the second quartet is separated from the macromeres.

Fig. 14.—Lateral view of same egg as fig. 13.

Fig. 15.—Læotropic division of first quartet, by which the "turret cells" (trochoblasts), $1a^2$, $1b^2$, $1c^2$, $1d^2$, arise. In following figures the turret cells and their derivatives are indicated by stippled nuclei.

Fig. 16.—Lateral view of same egg as fig. 15.

Fig. 17.—First cleavage of the cells of the second quartet (dexiotropic). The macromeres are about to give off the third quartet by dexiotropic cleavage.

PLATE XXIII, Fig. 18.—Slightly later stage (lateral view) than fig. 17. Division of the second quartet is about completed.

Fig. 19.—Animal pole view of egg, in which the divisions shown in figs. 17 and 18 are fully completed. 24 cells.

Fig. 20.—Vegetative pole view of egg slightly older than fig. 19, showing spindle which initiates the separation of 4d.

Fig. 21.—Transition stage between 25 and 33 cells (seen from animal pole). All eight cells of the second quartet are dividing læotropically, the upper four forming the "tip" cells of the cross ($2a^{11}$, $2b^{11}$, $2c^{11}$, $2d^{11}$).

Fig. 22.—Same egg as fig. 21, seen from vegetative pole. The læotropic division of 3D, forming 4D and 4d (ME), is completed.

Fig. 23.—Animal pole view of egg containing 41–44 cells. $1a^1$–$1d^1$ have divided in a dexiotropic direction the "apicals" ($1a^{11}$–$1d^{11}$) and the "basals" ($1a^{12}$–$1d^{12}$) of the" ectoblastic cross."

PLATE XXIV, Fig. 24.—Same egg as fig. 23, seen from vegetative pole. All the third quartet cells have divided læotropically. The macromeres, 3A, 3B, 3C, are dividing in a similar direction to complete the fourth quartet.

Fig. 25.—View of vegetative pole of egg slightly older than fig. 24. The formation of the fourth quartet is completed and the mesentomere 4d (ME) has divided into right (ME^1) and left (ME^1) halves.

Fig. 26.—Lateral view from B quadrant of an egg same stage as fig. 25.

Fig. 27.—Lateral view of an egg, D quadrant, same stage as fig. 25.

Fig. 28.—Animal pole view of an egg showing, (1) dexiotropic divisions of $2c^{12}$, $2a^{12}$, $2b^{12}$; (2) læotropic division of $2b^{21}$; læotropic to horizontal division of $2c^{21}$. The trochoblasts, $1c^2$, $1d^2$, are also beginning to divide.

Fig. 29.—Same egg as fig. 28, seen laterally from B quadrant.

Fig. 30.—Same egg as fig. 28, lateral view of C quadrant; $3c^1$ is cleaving in a dexiotropic direction.

Fig. 31.—Vegetative pole view of same egg as fig. 28, showing bilateral divisions of $3c^1$, $3d^1$.

PLATE XXV, Fig. 32.—Lateral view D quadrant, slightly older stage than fig. 28, showing bilateral divisions of $3c^1$, $3d^1$.

Fig. 33.—Upper pole view of same egg as fig. 32, showing cleavage in three of the "basal" cells of the cross. $1b^{12}$ is dividing in a læotropic direction; in $1c^{12}$ the spindle is dexiotropic to radial in position; in $1a^{12}$ læotropic to radial spindle. The turrets, $1a^2$ and $1b^2$, show dexiotropic cleavage. About 60 cells.

Fig. 34.—View of vegetative pole of somewhat older stage than fig. 31; $3a^1$, $3a^2$, $3b^1$ and $3b^2$ have all divided in a dexiotropic manner.

Fig. 35.—Same stage as fig. 34, lateral view of C and D quadrants.

Fig. 37.—Lateral view of A quadrant, showing dexiotropic division of $3a^2$.

Fig. 38.—Upper pole view, showing completion of cleavage forming "basals" ($1a^{121}$–$1d^{121}$) and "middle" ($1a^{122}$–$1d^{122}$) cells of cross.

Fig. 40.—Slightly older stage than preceding, showing completed cleavage of $3b^1$.

Fig. 41.—Same egg as fig. 40, A quadrant.

PLATE XXVI, Fig. 42.—View of vegetative pole of egg with about 68 blastomeres. ME^1 and ME^2 are dividing bilaterally.

Fig. 43.—Lateral view, A and D quadrants of egg with about 75 blastomeres, showing dexiotropic cleavage of $2a^{211}$ and læotropic divisions in $3d^{11}$, $3d^{12}$.

Fig. 44.—Same egg as fig. 43, seen from C quadrant. $3c^{11}$ and $3c^{12}$ are dividing dexiotropically.

Fig. 45.—View of vegetative surface of egg with about 80 cells. The mesentomeres have divided into two small cells, E^1 and E^2, and two large, Me^1 and Me^2.

Fig. 47.—Same egg as fig. 45, lateral view of D quadrant.

Fig. 48.—Same egg as fig. 45, lateral view of C. quadrant.

Fig. 49.—Lateral view of D quadrant in egg of about 86 cells. $2d^{121}$ is dividing læotropically; $2d^{211}$ and $2d^{212}$ have divided dexiotropically.

Fig. 50.—Lateral view of same egg as fig. 49, showing A quadrant.

Plate XXVII, Fig. 51.—D quadrant, a lateral view. Me^1 and Me^2 all dividing bilaterally.

Fig. 52.—Lateral view, B quadrant of same egg as fig. 49.

Fig. 53.—Upper pole view of egg of about 86 cells. The "apical" ($1a^{111}$–$1d^{111}$) and "peripheral" ($1a^{112}$–$1d^{112}$) rosettes have been formed by læotropic cleavages.

Fig. 54.—Same egg as fig. 51, seen from side (C quadrant).

Fig. 56.—Upper pole view of an egg of approximately 106 cells. The basal cells, $1a^{121}$, $1b^{121}$, $1c^{121}$, have divided; $1d^{121}$ is dividing with spindle transverse to posterior arm of cross. The two inner posterior trochoblasts ($1c^{21}$, $1d^{21}$) are dividing bilaterally.

Fig. 57.—Vegetative pole view of same egg as fig. 56. Completed division of Me^1, Me^2 into M^1e^1, M^2e^2 and m^1z^1, m^2z^2.

Fig. 58.—Same egg as fig. 56, showing A and D quadrants on lateral view.

Fig. 59.—Same egg as fig. 56, principally B quadrant.

Plate XXVIII, Fig. 60.—Same egg as fig. 56, lateral view of C quadrant.

Fig. 61.—Lateral view, D quadrant, same egg as fig. 56.

Fig. 62.—Upper pole view of egg slightly older than last series (over 115 cells). All the interior trochoblasts have divided, and the completed transverse division of the basal cell of the posterior arm of the cross is shown.

Fig. 63.—Same egg as fig. 62, showing A quadrant on lateral view.

Fig. 64.—Lateral view, same egg as fig. 62, B quadrant.

Fig. 65.—Lateral view, same egg as fig. 62, C quadrant.

Fig. 66.—Lateral view, same egg as fig. 62, D quadrant.

Fig. 67.—Egg of about 125 cells, lateral view, C quadrant.

Plate XXIX, Fig. 68.—Same egg as fig. 67, lateral view of A quadrant.

Fig. 69.—Same egg as fig. 67, lateral view of B quadrant.

Fig. 70.—Slightly later stage than fig. 67, lateral view of C quadrant.

Fig. 71.—Entomeres and mesomeres from egg of over 150 cells, seen from vegetative pole.

Fig. 72.—Entomeres and mesomeres of egg about stage of fig. 71.

Fig. 73.—Entomeres and mesomeres, seen from vegetative pole of egg slightly older than the two former stages.

Fig. 74.—Vegetative pole view of about same stage as fig. 73, showing the overgrowth of the "secondary" mesoblasts (ecto-mesoblasts, $3a^{2111}$, $3a^{2211}$, $3b^{2111}$, $3b^{2211}$) by other cells of the third quartet.

Fig. 75.—Upper pole view, about the same stage as fig. 74, showing transverse splitting of the arms of the cross and division of outer trochoblasts.

Plate XXX, Fig. 76.—Upper pole view of somewhat later stage than fig. 75, showing increase in breadth of cross area.

Fig. 77.—Lateral view of stage similar to fig. 75, showing large excretory cell ($3c^{1111}$) and neighboring cells.

Fig. 78.—Vegetative pole view of gastrula with closing blastopore, showing pointed anterior end and complete overgrowth of the ecto-mesoblast.

Fig. 79.—Somewhat older gastrula than preceding figure.

Fig. 80.—Optical section (parallel to ventral surface) of gastrula of about the stage shown in fig. 79.

Plate XXXI (*except figs. 81–2*), Figs. 81–84.—Optical sections, similar in direction to that of fig. 80, through successively older gastrulæ, showing torsion of the enteron through increase in area of the left side (right of figures). Fig. 84 represents a section taken through a young veliger about the stage of that shown in fig. 104.

Fig. 85.—Actual section through a gastrula similar in age to fig. 80 and in same plane.

Fig. 86.—Actual section (sagittal) through a gastrula about the age shown in fig. 95.

Fig. 87.—Actual section (about 30° to the right of the sagittal plane) through a young veliger slightly older than as shown in fig. 104.

Plate XXXII (*except fig. 94*), Figs. 88–89.—Actual sections (nearly horizontal) through a veliger about the stage shown in fig. 105, showing cerebral and pedal ganglia, pedal commissure and otocysts; also large excretory cell on right side of larva and large enteric cell on same side of enteron.

Figs. 90–93.—Four successive horizontal actual sections through a veliger slightly older than that shown in fig. 107.

Fig. 94.—Nearly horizontal actual section through veliger of same age as preceding series, showing nerve ring around œsophagus. On Pl. XXXI.

Plate XXXIII, Fig. 95.—Gastrula, seen from right side, showing first indication of the first velar row (V^1).

Figs. 96–97.—Upper and lower sides respectively of gastrula of the same age as shown in fig. 95.

Figs. 98–99.—Lateral (right) and lower sides of a veliger slightly older than that shown in figs. 96–97.

Fig. 100.—Left side of gastrula somewhat older than that shown in the two preceding figures.

Plate XXXIV, Figs. 101–102.—Anterior and right-lateral views of larva midway between gastral and veliger stages. The deep invagination of the shell-gland (Sh.G.) has formed and the stomodæal pit (St.) is well marked.

Figs. 103–104.—Anterior and right-lateral views of a young veliger. The shell-gland has opened outward, the foot (Ft.) is becoming evident and the velar lobes are just beginning to appear.

Fig. 105.—Veliger, seen from right side, somewhat older than the preceding one, showing further development of velar lobes and foot, developing shell, differentiation of enteron and larval musculature.

Fig. 106.—Slightly older veliger than fig. 105, seen from right side.

Plate XXXV, Figs. 107–108.—Dorsal and anterior views of the same veliger somewhat older than fig. 106. The shell and the velar lobes show considerable advance in development.

Figs. 109–110.—Right-lateral and dorsal views of the same veliger just before hatching. The dotted lines represent the probable shape of the posterior vesicle before shrinkage.

THE FOSSIL LAND SHELLS OF BERMUDA.[1]

BY ADDISON GULICK.

Last summer (1903), through advantages offered by the new Biological Station in Bermuda, I was able to collect the shells on which this paper is based. In the study of the material I owe much to Dr. H. A. Pilsbry, of the Academy of Natural Sciences of Philadelphia.

It will be necessary in the discussion of the fossils to compare them with the species that are now native, in the looser sense, to the islands. In drawing the line between these and the snails supposed to have been brought by commerce, I shall follow Dr. Pilsbry's latest paper on the "Air-breathing Mollusks of the Bermudas."[2] I shall also rule out all the littoral species, including *Truncatella*, because the fossil beds were not situated where such shells could be expected.

The most unsatisfactory feature of work on Bermudian fossil land shells is the difficulty in determining the ages of the various deposits. The rock of Bermuda is exclusively solidified dunes of calcareous sand, and the soil is the rust-colored residue of the weathered rock. In weathering, the surface of the rock becomes completely broken up into pockets and crevices packed with the earth. It is estimated[3] that every inch of earth must represent eight or nine feet of rock eroded, and thus when it is possible to judge of the average depth of soil formed over a deposit, that depth can be made an index of the age of the deposit.

Probably the oldest good fossiliferous deposit that I examined is collecting locality No. 807 (see Map No. 3) of the Bermuda Biological Station, at a hard-stone quarry on the west side of Knapton Hill, about midway between Hotel Frascati and "Devil's Hole." At this point a layer of eight or ten inches of red earth containing shells was covered by an ancient dune. The dune has become hard limestone, and its top has been eroded until now the red earth in its pockets must represent a layer averaging not less than six inches in thickness. The series of *Pœcilozonites* that we took from this bed is very incomplete, and the fossils of all the genera are poorly preserved, but notwithstanding this we are able to recognize at least eleven species and sub-

[1] Contributions from the Bermuda Biological Station for Research, No. 2.
[2] *Trans. Conn. Acad.*, Vol. X.
[3] A. E. Verrill, *Trans. Conn. Acad.*, Vol. XI, p. 490.

species. These are enough to identify its fauna with that of another deposit, locality No. 806 (see Map No. 2), where the shells are abundant and well preserved, but with no external evidence by which to estimate their age. This locality is another hard-stone quarry, where the excavations have uncovered a number of crevices and a cavern of considerable size. The shells are in stalagmitic conglomerate at the mouth of the cavern, and in the crevices, and also in the earth that fills certain of the pockets. They may represent a considerable period of time, but there is no way to distinguish any difference in age.

Another deposit at the same locality as the one last mentioned is a horizontal band of slightly reddish rock about half-way up the face of the quarry, and from two to three inches thick. This is part of the rock out of which the cave and pockets were eroded, so that the shells here are very much older than the others at No. 806; but here, again, there is no basis for a comparison with the date of No. 807. The remains here are obscure casts of *Pœcilozonites circumfirmatus* and of what appear to be *Vertigo* and *Carychium*.

I collected from three other beds in this neighborhood what seem to represent the same formation as the pockets of No. 806.

The first of these, locality No. 814, is a newly opened quarry just south from Coney Island. A red-earth pocket here contained a fine series of *Pœcilozonites nelsoni*, very large, but wanting the most extreme examples of both the elevated and the depressed variations. There are also fossiliferous conglomerates in caverns at this quarry, but they are composed of gravel too fine to contain *Pœcilozonites nelsoni*.

The best fossil specimens of *Pœcilozonites reinianus* came from locality No. 815, near Harrington House. They are noticeably larger than the recent specimens. No. 816, near 815, but on the shore of Castle Harbor, has large numbers of *Pœcilozonites bermudensis zonatus* and *Pœcilozonites reinianus*, the former associated with *Pœcilozonites nelsoni* in a conglomerate.

Bifidaria rupicola, found in the red earth of No. 806, may perhaps be an importation subsequent to the formation of No. 807, and *Strobilops hubbardi*, found at the same place, possibly may not have been a permanent resident; but we can safely assume that all the other species from the above localities belong to the epoch of the red-earth streak at No. 807. The remaining three deposits from which I collected are clearly much more recent than No. 807. These are in sand pits, in the nearly pure sand of partially solidified dunes. None of them have any clear signs of red earth, either about them or overlying them.

The shells at these places are so perfectly preserved that even the term "semi-fossil" seems a misnomer for them. Probably the sand preserves them by saturating the water with lime before it reaches them.

One of these shell deposits, locality No. 818, on the land of Mr. Benjamin Trott, in Tucker's Town, is only from 8 to 36 inches below the surface. The *P. nelsoni* were mostly in the upper foot of the deposit, where the bank is thoroughly solidified by the rain; but a few inches lower the sand is still loose enough to be scraped out with a strong hoe.

The two localities last to be mentioned, Nos. 808 and 809, are essentially alike. They face the Devonshire marshes on the northwest side—808 near the north end and 809 close to the barracks. The sand in these dunes appears to have drifted from near the present line of the north shore—a consideration which may yet give a clue to their age.

The following are my records of fossil and semi-fossil shells in these localities:

Locality 807.

Pœcilozonites nelsoni.
" nelsoni callosus.
" circumfirmatus, } Intergraded.
" discrepans.
Euconulus turbinatus.
Zonitoides minusculus.
" bristoli. One specimen.
Thysanophora hypolepta.
Succinea bermudensis.
Vertigo numellata.
" marki?
Carychium bermudense.

Casts in the Rock, Locality 806.

Pœcilozonites circumfirmatus.
Vertigo.
Carychium?

Cave and Pockets, Locality 806.

Pœcilozonites nelsoni. Both extremes in height of spire.
" bermudensis zonatus.
" reinianus.
" circumfirmatus.

PŒCILOZONITES CUPULA.
EUCONULUS TURBINATUS.
THYSANOPHORA HYPOLEPTA.
SUCCINEA BERMUDENSIS.
STROBILOPS HUBBARDI.
BIFIDARIA RUPICOLA. One specimen.
VERTIGO NUMELLATA.
" MARKI.
CARYCHIUM BERMUDENSE.

Locality 814.

PŒCILOZONITES NELSONI, } In one pocket.
" REINIANUS. }
" NELSONI. In crevices.
" BERMUDENSIS ZONATUS, }
" REINIANUS, } In stalagmitic conglomerate.
" CIRCUMFIRMATUS, }
EUCONULUS TURBINATUS. }

Locality 815.

PŒCILOZONITES BERMUDENSIS ZONATUS? Small fragments only.
" REINIANUS.

Locality 816.

PŒCILOZONITES NELSONI.
" BERMUDENSIS ZONATUS.
" REINIANUS. (None kept in the collection.)
EUCONULUS TURBINATUS.

Locality 818 (Sand Pit).

PŒCILOZONITES NELSONI CALLOSUS.
" REINIANUS.
" DISCREPANS.
EUCONULUS TURBINATUS.
ZONITOIDES BRISTOLI.
SUCCINEA BERMUDENSIS.
BIFIDARIA SERVILIS. One specimen.
CARYCHIUM BERMUDENSE.

Locality 808 (Sand Pit).

PŒCILOZONITES BERMUDENSIS ZONATUS.
" REINIANUS.

Pœcilozonites circumfirmatus.
Euconulus turbinatus.
Succinea bermudensis.
Bifidaria rupicola. One specimen.
Carychium bermudense.
(Polygyra microdonta? One immature specimen, which may have crawled into the sand in recent times. We shall give it no further notice.)

Locality 809 (Sand Pit).

Pœcilozonites bermudensis zonatus.
" reinianus.
" circumfirmatus. (None kept in collection.)
Succinea bermudensis. (None kept in collection.)
Carychium bermudense.
Pupoides marginatus. One specimen.

These lists include all the known fossils except *Pœcilozonites dalli.*

Outside of *Pœcilozonites,* the species that do not appear in deposit No. 807 are:

Strobilops hubbardi.
Bifidaria rupicola.
" servilis.
Pupoides marginatus.

The last two of these appear only in the sand pits, and are in all probability later importations. The first two, found at No. 806, may also have arrived after No. 807 was covered up, but the fossils at No. 807 are so poorly preserved that we cannot presume upon the absence of these species. Ignoring these doubts, we may combine and rearrange the lists from Nos. 807 and 806—the more ancient fossils—mentioning after each species the habitat of its nearest relatives in other countries, as follows:

Pœcilozonites nelsoni.
" nelsoni callosus.
" cupula.
" bermudensis zonatus.
" reinianus.
" circumfirmatus.
" discrepans.

EUCONULUS TURBINATUS. ZONITOIDES BRISTOLI. VERTIGO NUMELLATA. " MARKI. CARYCHIUM BERMUDENSE.	Eastern North America.

[4]ZONITOIDES MINUSCULUS. North America and West Indies.
[4]BIFIDARIA RUPICOLA. Florida, Cuba.
[4]STROBILOPS HUBBARDI. Florida, Jamaica.
THYSANOPHORA HYPOLEPTA. West Indies.
SUCCINEA BERMUDENSIS. West Indies.

Total, 17 forms, 14 of them probably peculiar to Bermuda. For comparison we have the following *recent* species, supposedly not imported by man:

PŒCILOZONITES BERMUDENSIS, " REINIANUS, " CIRCUMFIRMATUS, [5]ZONITOIDES MINUSCULUS, THYSANOPHORA HYPOLEPTA, SUCCINEA BERMUDENSIS, [5]BIFIDARIA RUPICOLA.	Remnant of the fossil fauna. Seven species.

[5]PUPOIDES MARGINATUS. North America, West Indies.

[5]THYSANOPHORA VORTEX, [5]POLYGYRA MICRODONTA, [5]BIFIDARIA SERVILIS, [5]BIFIDARIA JAMAICENSIS, HELICINA CONVEXA.	West Indies. Five species.

Total, 13 species, 6 of them probably peculiar to Bermuda.

Dr. Pilsbry's conclusion, from the anatomy of *Pœcilozonites*, that the oldest importations to Bermuda came from continental America, is thus confirmed by a large majority of the fossil forms. Bermuda, at the time of the No. 807 deposit, was characterized by not less than five genera of continental affinities, of which at least one had been resident long enough to have developed new generic characters and a respectable diversity of species. The abundance of the individuals, too, and the size and variability of some of the species, seem to show that the island was not inhospitable to continental genera at that epoch. There were not only the large extinct species *Pœcilozonites nelsoni* and *Pœcilozonites cupula,* but larger varieties also of *Pœcilozonites bermudensis* and

[4] Species not peculiar to Bermuda.
[5] Species not peculiar to Bermuda.

Pœcilozonites reinianus than are now living. The largest specimens even of *Pœcilozonites circumfirmatus* and *Succinea bermudensis* are among the fossils. These snails must have found more food than there is now on the uncultivated ground. There is also geologic evidence that they belonged to a more prosperous epoch than the present. Prof. Heilprin reports that in excavations for one of the docks, specimens of *Pœcilozonites nelsoni* were brought up from a peat deposit at a depth of forty feet below water. A rise of the land sufficient to put these shells ten feet above sea-level (see Map No. 1) would multiply the land area eight or ten times, changing it from a narrow ridge, hardly two miles wide at its widest, into an elliptical area, including, it is true, some large lagoons, but in all about ten miles across and more than twenty miles long. A large, protected interior valley would then receive the fertile soil that is now washed into the lagoon by every storm. It would not surprise me if the deposits at locality 807 should be shown to date from the period of this Greater Bermuda, but a person need hardly wait for this proof before supposing that the indigenous contemporaries of *Pœcilozonites nelsoni* were also characteristic of Greater Bermuda.

In spite of their evident prosperity, I do not think it could be proved that these snails lived under any densely shading vegetation. The humidity at Bermuda makes such a shade less necessary for snails than it is in many places. I have often seen *Succinea bermudensis* clinging to grass and to trunks of trees in such situations that I imagine an American summer day would have desiccated them. The tract about Prospect Hill (No. 809) must have been desolate, unshaded land when the hills were growing dunes, yet the sand here (localities 808 and 809) contains numerous well-developed specimens and quite a variety of species. These must either have lived where they are found, or else have been blown there from some place almost equally wind-swept.

The extinction of species that were able to prosper on those barren parts of the island seems to me a strange occurrence. If, as I believe is probable, the sand for these dunes came from near the present north shore, then the island must have had very nearly its present shape and size when these snails were alive. Thus when the Greater Bermuda sank, the change seems to have set new dunes in motion across this section of the Lesser Bermuda; and *Pœcilozonites zonatus, Carychium bermudense* and *Euconulus turbinatus* not merely survived the subsidence, but even formed a considerable population on the parts of the remaining island that were most damaged by the changing conditions. How many other species still survived in the less altered sections it is impossible to say. It is hardly possible to prove that even the set of fossils from No. 806 belong to any earlier date. Indeed we might draw an analogy between *Bifidaria rupicola* at No. 806, which may be one of the later arrivals, and *Bifidaria servilis* at No. 818 and *Pupoides marginatus* at No. 809, either of which we can hardly hesitate to treat as recent arrivals. But however this may be, the sand-pit deposits are against the supposition that the *Carychium* and its hardier associates were exterminated merely by the increasing barrenness of the island. We should be in a better position to discuss the other causes if we knew whether these species survived till after the West Indian arrivals had begun to take possession of the land. The West Indies snails, especially *Polygyra microdonta*, of Bahama, are at present much the commonest of the "native" snails, and it may be that their special fitness for the more barren land of the new Bermuda made them deadly competitors to the old species. The newer formations at the west end of the islands, which I had not the time to visit, may perhaps be the ones in which to look for evidence on this question.

Notes and Descriptions.

Thysanophora vortex Pfr.

Living animals quite abundant under stones; but I looked in vain for fossil specimens. Greater Antilles, Bahamas, Southern Florida.

Thysanophora hypolepta 'Shuttl.' Pils.

I found more examples of this than of *Z. minusculus* among the fossils, but among the living snails *Z. minusculus* seems to be far more abundant. It is supposed to be indigenous.

Polygyra microdonta Desh.

Excluding importations from Europe, this species is the one now most in evidence. It is partial to the coarse native grass, but is to be found almost everywhere. I was surprised not to find any indubitable specimens of this in the sand pits. I hope other collectors will look for it. Bahamas.

Strobilops hubbardi Brown.

An adult and an immature specimen, from locality 806. The adult is somewhat larger than the usual size on the continent. Alt. 1.2, diam. 2.8 mm. Habitat, the Gulf States and Jamaica.

Vertigo numellata n. sp. Pl. XXXVI, fig. 6.

Shell rimate, minute, elliptical or bluntly pupiform, yellowish-corneous, faintly striate, of 5 rather convex whorls; the diameter through the body whorl not much greater than that through the whorl preceding. A prominent, whitish, inflated ridge, appearing like a second peristome, occurs behind the peristome. Aperture proportionately more contracted than that of *V. ovata;* set with a parietal, an angular and a columellar lamella; and with two palatal and a basal fold. The palatal folds are prominent, the upper one slightly double-topped, the lower one more immersed and entering spirally. The parietal lamella is stout and blunt; the angular lamella smaller and thinner; the columellar lamella and the basal fold low and blunt. Peristome rather thin, expanded, and notched opposite the upper palatal fold, as in *V. ovata.*

Alt. 1.7, diam. .9 mm.

In one specimen there appears a slight suprapalatal denticle. A considerable number of smaller, more globose specimens seem to belong to this species. One of these from locality 806 measures 1.4 x .9 mm.

I have assumed that this species is more closely related to *V. ovata* than to any of the species reported from the West Indies.

Localities 806 and 807; the type from 806.

This is the common fossil *Vertigo.*

Vertigo marki n. sp. Pl. XXXVI, fig. 7.

Shell rimate, ovate, yellowish-corneous, faintly striatulate; whorls nearly 5, rather convex. Apex obtuse, but not rounded like that of *Vertigo numellata.* The inflated ridge inconspicuous, whitish, crowded close to the peristome. Aperture ovate, much longer than in *Vertigo numellata,* set with four denticles, of which the parietal lamella is the largest. The lower palatal fold denticular, smaller than that of *Vertigo numellata* and less immersed; the upper palatal fold minute; and the columellar lamella broad and low. The peristome is expanded, white, strongly thickened within, hardly notched at the upper palatal fold.

Alt. 1.9, diam. 1 mm.

Named in honor of Dr. E. L. Mark, of Harvard, Director of the Bermuda Biological Station for Research.

This species is somewhat suggestive of *V. tridentata,* but is a little slenderer, with a longer aperture, and a heavy white peristome.

Locality 806; doubtful specimens from 807.

Bifidaria rupicola Say.

One specimen each from localities 806 and 808, and several recent specimens. Dr. Pilsbry reminds us that the Bermudian form has a thicker lip than the others of this species. Cuba, Florida.

Bifidaria servilis Gld.

One specimen from locality 818, and a few recent. Cuba and other West Indian islands.

Bifidaria jamaicensis C. B. Ad.

The commonest of the recent Pupidæ, but I failed to find it fossil. Greater Antilles.

Pupoides marginatus Say.

I got one indubitable specimen from locality 809, but it went to pieces in my hands. I found only two or three recent ones. Mr. Owen Bryant, who was collecting at the same time, found a larger number. Eastern and Central North America, and some West Indian islands.

Carychium bermudense n. sp. Pl. XXXVI, figs. 11, 12.

Shell almost regularly tapering, corneous-white, imperforate, finely striate; whorls about 5, increasing regularly, those of the spire very convex, with deep sutures. Aperture quite oblique, obstructed by a small parietal and a very minute, deeply placed columellar lamella. Peristome broadly expanded and reflexed, thickened within by a white callus, with a slight groove on its front face, and developed inward to form a prominence slightly above the middle of the outer margin (near the position of the upper palatal fold in *Bifidaria*).

Alt. 1.8, diam. .9 mm.

This species is very dissimilar to the slender *Carychium jamaicense*. The shape of the aperture allies it more nearly to *Carychium exiguum* of North America, but its heavy peristome is quite its own.

It is one of the most abundant fossil species, occurring in the red earth of localities 806 and 807, and even in the sand that fills the larger shells in the sand pits.

Pœcilozonites nelsoni (Bld.).

Hyalina nelsoni Bld., Ann. Lyc. N. H. of N. Y., XI, 1875, p. 78.
P. nelsoni Pilsbry, Proc. Acad. Nat. Sci. Phila., 1888, p. 290.
P. nelsoni v. Mart., Sitzungsber. Ges. Nat. Freunde, Berlin, 1889, p. 201.

The typical form of this species is, I suppose, the large, moderately elevated form. This is represented among my specimens from locality 814, where the variation in dimensions is as follows:

Alt. 29	Diam. 39 mm.
28	37
27	41
27	40
26	35
25	39
23.5	36
23	41.5
23 (estimated)	35

The way these lay, piled together in a little pocket, compels the supposition that they lived at about the same time, and their variations in outline show what may occur in a single intergenerant colony. The specimens from locality 806 show even greater differences, of which the following are the extremes:

Alt. 34	Diam. 34 mm.
31	33
19	37
19.5	39

I should like to suggest the name *discoides*, merely as a convenient term by which to know the variation represented by the last two shells (Pl. XXXVI, fig. 4). I must say, however, that this suggestion would be unfortunate if it resulted in the division of the series obtained from locality 814. It seems to me, rather, that some physiological peculiarity has destroyed the diagnostic value of the elevation of the spire. The upper whorls differ less than the lower, and in the most elevated forms the suture of the later whorls is much below the keel of the preceding whorl, as if the slant of the spiral had been abnormally diverted downward.

Pœcilozonites nelsoni var. **callosus** n. var. Pl. XXXVI, fig. 5.

Shell smaller than the typical form, shiny, with heavy ribbed striæ, colored with a broad yellowish-brown peripheral band on a white ground. Whorls a trifle more than nine, increasing regularly and very gradually. The suture does not change its character nor become deflected from the peripheral line of the preceding whorl. The usual peripheral angle is almost obsolete. The base has a stronger angle about the umbilical perforation than is usual in the species. The peristome is greatly thickened on the inside from 1 mm. at the suture to fully 2 mm. near the columella. A prominent callosity covers the parietal wall of the aperture.

Alt. 24. diam. 33 mm.

The combination of small size and large number of whorls is characteristic. The ratio of height to diameter is more constant than in the typical form, and the tendency to produce the callosity is very marked.

Type from locality 818, others from 818 and 807.

The stability of the variety, occurring as it does in the oldest and the latest formations, is the most interesting thing about it. It is also my excuse for regarding such slight distinctions in a remarkably variable species.

I suppose the color patterns of *Pœcilozonites nelsoni* were essentially the same as those on the living *Pœcilozonites bermudensis*. For example, the type specimen of *callosus* probably had a dark brown band on a background of a yellowish cuticular color. The depressed specimen which is figured has traces of a subperipheral band, a supraperipheral line, and radial flaming above this line. This flamed pattern appears in several of the flat specimens.

Pœcilozonites cupula n. sp. Pl. XXXVI, fig. 2.

Shell solid, dome-shaped, with somewhat flattened base, perforate, strongly striate; pale, shiny-corneous, with subsutural and subperipheral bands of darker color, and faint traces of two narrow bands on the periphery. Whorls $7\frac{3}{8}$, a little convex, increasing slowly; the last vaguely angulate at the periphery. The aperture is somewhat quadrangular on account of the straight, vertical columella and the peripheral angle. The peristome is simple, thin, with the columellar margin reflexed.

Alt. 13 Diam. 16 mm.

Locality No. 806.

Other specimens measure:

Alt. 13.5	Diam. 16.5 mm.
12.5	17
13	19
13	20
15	15.5

The last specimen has $8\frac{3}{4}$ whorls.

The type was selected as the best-preserved specimen, not as the most representative example. The majority of the specimens have a more rounded base and periphery, giving the peristome a more oval contour. The height of the shell and the absence of a keel distinguish it readily from *P. bermudensis zonatus,* and the very round dome and less angulate periphery separate it from immature specimens of *nelsoni.*

Pœcilozonites dalli n. sp. Pl. XXXVI, fig. 1.

Shell elevated, with rounded apex and convex base, perforate. Its surface is polished, with incremental lines less pronounced than those of *P. cupula;* milky-white, with a yellowish-brown band below the periphery and a line above the periphery. The first four whorls are translucent whitish. Whorls $7\frac{1}{6}$; all but the final whorl are flat as if keeled, that one has a blunt peripheral ridge, below which it is deeply rounded. The aperture is quite oblique, round-lunate. The peristome is simple, except at the columella, which it joins without an angle, but the columellar margin is reflexed, partly covering the perforation.

Alt. 8.5 Diam. 7.3 mm.

Another specimen has the height 10, diam. 7 mm., and is composed of 9 whorls. It shows more of the brown and less of the white color.

The extreme variability of *P. cupula* leaves it debatable whether this may not be a dwarf race of that species.

No specimens of this form were found last summer, and it is through the courtesy of Dr. William H. Dall of the National Museum, that I am able to describe and figure it. The specimens came to him without labels, so that we are left to conjecture their age. The slender specimen is so glossy and brightly colored that Dr. Dall doubts whether it can be a fossil, but it seems to me the simpler hypothesis to suppose that it was preserved in the sand in the same manner as the type of *P. nelsoni callosus*, which it so closely resembles in color and polish. The shell sand seems to be a complete protection from destructive agents. On this hypothesis it had originally about the color of *Pœcilozonites bermudensis.*

Pœcilozonites bermudensis Pfr.

Pilsbry, Proc. Acad. Nat. Sci. Phila., 1888, p. 289; 1889, p. 85.

The typical variety seems to be of recent origin. It is distinguished from the fossil by a less rounded upper surface, less flattened apex, larger umbilical perforation, and usually smaller number of whorls. My largest specimen I found on Rabbit Island, Harrington Sound, buried under drift sand at some time previous to the cultivation of the island. It measures alt. 13, diam. 24.5 mm. The largest and smallest living mature shells measure as follows:

Alt. 14.5	Diam. 20. mm.
14	22
10	16.5

An average fully adult specimen measures:

Alt. 11	Diam. 20	Umb. 1.7 mm.

and has a trifle more than 7 whorls.

Pœcilozonites bermudensis var. **zonatus** Verr. Pl. XXXVI, fig. 3.

This differs from the type of the species in possessing an almost uniformly curved upper contour line, an almost flat apex, and a more constricted umbilicus. The keel is distinct, as in the recent form. Whorls $7\frac{2}{3}$. The aperture is surrounded by callous thickenings as in *P. nelsoni callosus.* Alt. 13.5, diam. 23, umb. 1 mm.

Specimens come from localities Nos. 806, 808, 814, 816 and 809.

The extremes from locality No. 808 are:

Alt. 16	Diam. 22.5 mm.	
15	25	
12.5	20.5	Umb. 1 mm. wide.

Thus the smallest adult is quite equal to the average recent shells. A few selected specimens of the fossil and recent shells can hardly be distinguished. Many of the fossils do not have the callosity.

Locality 816 has great quantities of these shells so firmly cemented together that most of them are worthless as specimens. They have the peculiar spheroidal upper surface, but the perforation is wider than in the series from locality 808—not so wide, however, as in the recent. Several specimens here occur below some fragments of *Pœcilozonites nelsoni* in stalagmite, apparently showing that they were there previous to the extinction of *nelsoni*.

Broken and immature specimens from locality 808 show that the umbilicus was not much narrower than that of the recent variety until the last whorl had commenced to grow. The peculiar contour is also less noticeable prior to the last whorl. Thus in their smaller number of whorls, their less rounded contour, and their larger umbilicus, the present snails seem like an undeveloped or degenerate race of the former species.

It is possible that this fossil variety is what Pfeiffer (*Monographia*, I, p. 80) mistook for *Helix ochroleuca* Fer.

Pœcilozonites reinianus Pfr.

Helix reiniana Pfeiffer, Malak. Bl., XI, 1863, p. 1.
P. reinianus Pilsbry, Proc. Acad. Nat. Sci. Phila., 1888, p. 290; 1889, p. 85.

I found this species in every deposit examined except No. 807. Further search would doubtless show it there also. At locality 815 many fine specimens were embedded in stalagmite. They show the typical color-pattern, with the dark marks changed as usual to reddish, and the lighter ground to ivory-yellow.

The largest specimen from No. 815 measured....	Alt. 7	Diam. 13	mm.
The largest from No. 808		12	
The largest from No. 806		11.5	
The largest from the pocket at No. 814		11	
The largest recent, lent by Mr. Bryant	6	11.3	
My largest recent	5	10.3	

From Town Hill (locality 819) come some good specimens of var. *goodei* Pils. Examples of these measure:

Alt. 4	Diam. 10	Umb. 4	mm.
3.5	9.3	3.4	
3.7	10	4	

The species is not so uniformly common as *Pœcilozonites circumfirmatus*, but is very abundant in some places, for example, near locality 806. It would be interesting to learn whether its place in the economy of nature is different from that of the following species.

Pœcilozonites circumfirmatus Redf.

Helix circumfirmata Redfield, Ann. Lyc. N. H. of N. Y., VI, p. 16.
Pœcilozonites circumfirmatus Pilsbry, Proc. Acad. Nat. Sci. Phila., 1888, p. 291.

The modern variety comes from both formations at locality 806, and from 814 and 808. Those from locality 808 are some of them more keeled than is now usual. A series of poor specimens from No. 807 seem to bridge the gap from these to var. *discrepans*.

This species has lost less in size than the others of its genus. My largest fossil, coming from locality 808, has alt. 7, diam. 12 mm. My largest recent shell has alt. 7, diam. 11.5 mm. I think the fossils average larger than the adults of the recent shells, but it is not easy to eliminate the immature of either.

Pœcilozonites circumfirmatus var **discrepans** Pfr.

Helix discrepans Pfr., Malak. Bl., 1864, p. 1.

Localities 807, 818 and two specimens of doubtful identity from 806. Some from 818 are extremely flat and carinate, one of them having alt. 4.8, diam. 10.5 mm. If this were the only locality that yielded the variety it would undoubtedly rank as a distinct species.

I should like to raise the question whether *Pœcilozonites discrepans* is not one of the extinct varieties. I believe it has not been treated as such heretofore, but none were found last summer any more recent than those from this sand pit.

Euconulus turbinatus n. sp. Pl. XXXVI, figs. 8, 9, 10.

Shell acutely conic, with contour very slightly convex; minutely perforate, thin, glistening yellowish-corneous, closely striate, and sculptured with microscopic spirals. Apex rounded off abruptly. Whorls $7\frac{1}{2}$, not convex, narrow, the last strongly angulate at the periphery. Suture simple, hardly impressed. Base rather flat, not excavated. Aperture almost quadrangular, but with the angle at the columella indefinite. Columella slightly curved, the columellar margin narrowly reflexed. Alt. 3.4, diam. 2.8 mm. (from locality 807); diam. 3 mm. (from locality 808).

From localities Nos. 807, 806, 814, 816, 808, and 818.

The above description is a composite. The general form is described from the specimen from locality 807, but the sculpture is that of the best specimen from 806, which should, perhaps, be considered the type, and the base and aperture are taken from the specimen from 808. From 814 comes the longitudinal section of one 3.8 x 2.8 mm., with an unusually convex contour.

The genus *Euconulus* is, of course, not wholly satisfactory for this species.

Zonitoides minusculus Binn.

Locality 807, and recent. Its abundance in the one deposit and absence in the others is a little surprising.

Zonitoides bristoli n. sp. Pl. XXXVI, fig. 13.

Shell resembling *Zonitoides minusculus* in general form, but much smaller, only moderately umbilicate, white, costulate, and densely sculptured with spiral lines ; composed of 3 convex whorls. Apex somewhat elevated. Aperture lunate, the outer and basal margin more uniformly curved than in *Zonitoides minusculus*, and the preceding whorl cutting out a greater arc. Peristome simple, thin. Costulæ regularly spaced, coinciding with growth lines. The spaces between them crowded with fine striæ. A close, regular, spiral sculpturing crosses these lines and gives the costulæ a slightly tubercular appearance.

Alt. .7 Diam. 1.17 mm.

Named in honor of Dr. C. L. Bristol, of New York University, Associate Director of the Bermuda Biological Station for Research.

One specimen from each of localities 807 and 818; the type from the latter place.

Succinea bermudensis Pfr.

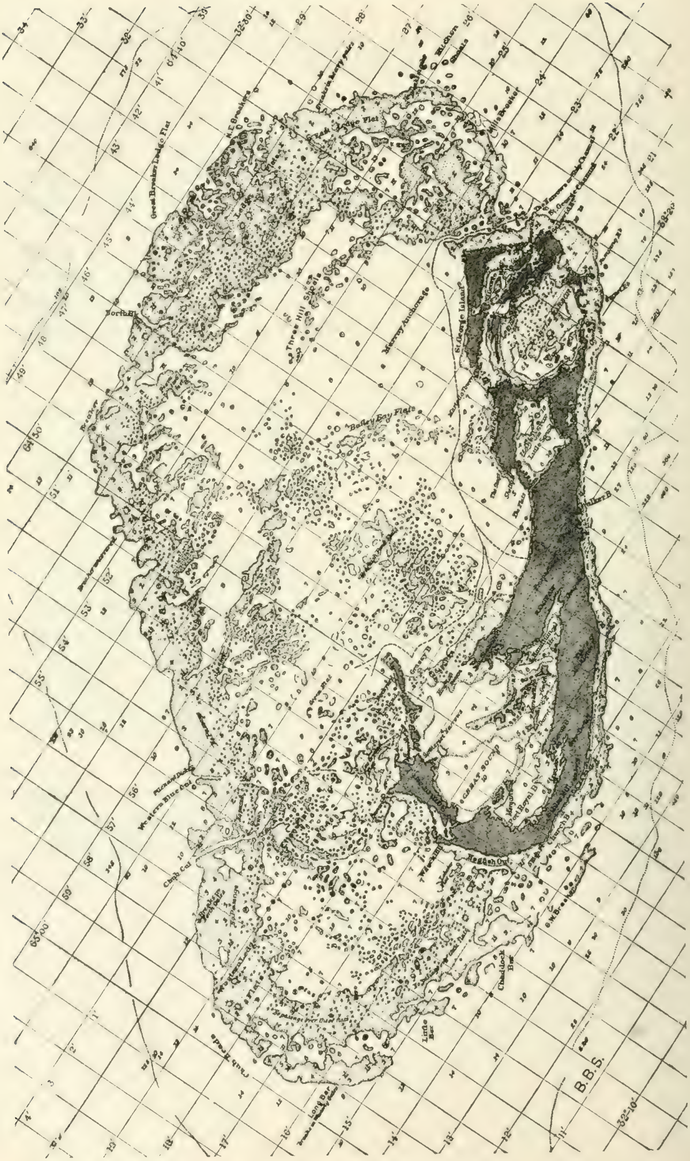
? *S. bermudensis* Pfr., P. Z. S., 1857, p. 110; Monographia, IV, p. 817.
S. barbadensis Pilsbry, Trans. Conn. Acad., X, p. 502.

Localities 807, 806, 818, 808, 809 and recent. In the absence of alcoholic specimens of *S. barbadensis* I have given up that name and returned provisionally to the name *bermudensis*. Its presence as a fossil makes it not unlikely that it may be proved distinct from *S. barbadensis*. This is another species that was formerly larger than now. The largest fossil, from locality 808, measures alt. 13, diam. 7 mm. The largest out of 30 recent specimens lent by Mr. Bryant has alt. 12, diam. 6.3 mm.

Helicina convexa Pfr.

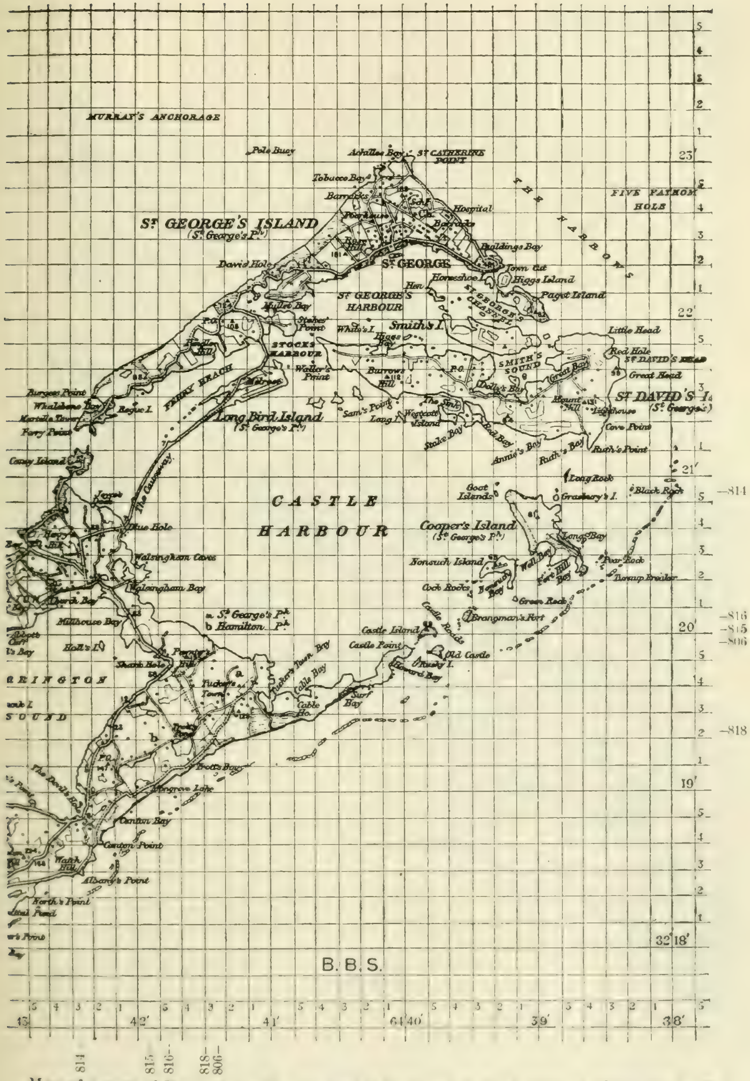
If this species were indigenous we could expect it to be as abundant formerly as it is now. Instead of that it seems to be entirely absent from the beds I examined. The evidence seems to me strong that its real home is elsewhere.

Map 1.



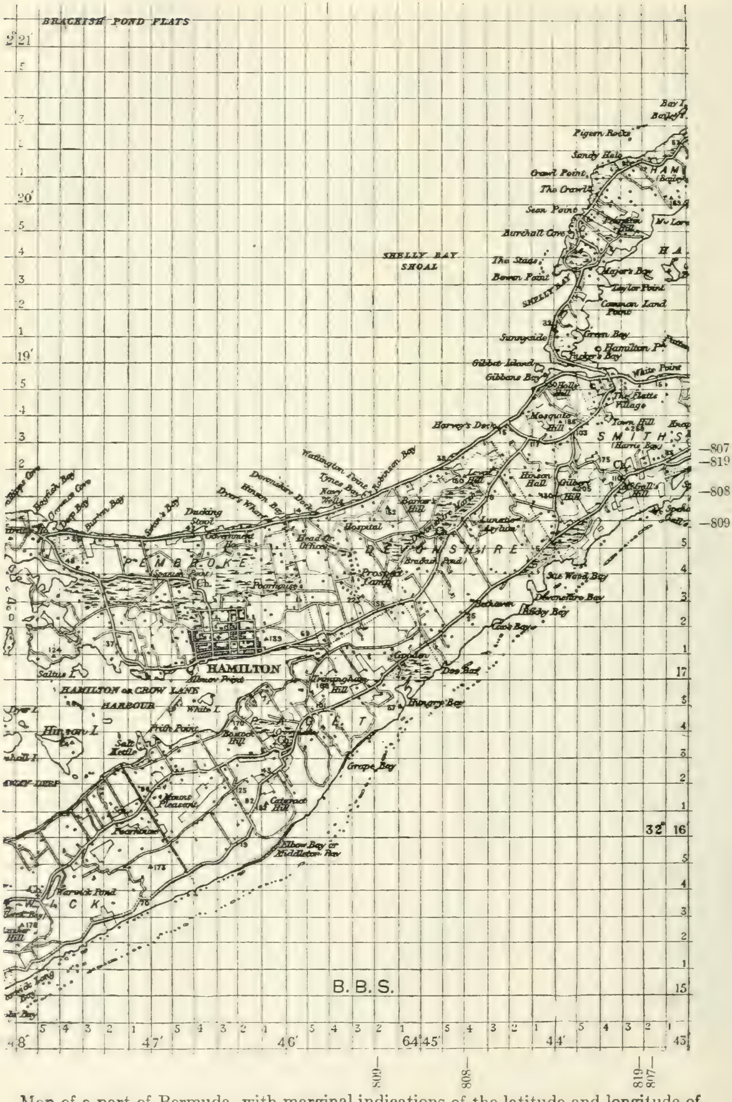
Bermuda Island.

Map 2.



Map of a part of Bermuda, with marginal indications of the latitude and longitude of collecting stations.

Map 3.



Map of a part of Bermuda, with marginal indications of the latitude and longitude of collecting stations.

Reference to Plate XXXVI.

Figures 2 to 5 are natural size; the others are variously enlarged.

Plate XXXVI Fig. 1.—*Pœcilozonites dalli.*
Fig. 2.—*Pœcilozonites cupula.* Locality 806.
Fig. 3.—*Pœcilozonites bermudensis zonatus.* Locality 808.
Fig. 4.—*Pœcilozonites nelsoni* form *discoides.* Locality 806.
Fig. 5.—*Pœcilozonites nelsoni callosus.* Locality 818.
Fig. 6.—*Vertigo numellata.* Locality 806.
Fig. 7.—*Vertigo marki.* Locality 806.
Fig. 8.—*Euconulus turbinatus.* Section from compact rock, locality 814.
Fig. 9.—*Euconulus turbinatus.* Locality 806.
Fig. 10.—*Euconulus turbinatus.* Locality 808.
Figs. 11, 12.—*Carychium bermudense.* Locality 806.
Fig. 13.—*Zonitoides bristoli.* Locality 818.

April 19.

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

Seventy-six persons present.

The deaths of Edwin Sheppard, April 7, and E. W. Clark, April 9, members, were announced.

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

"A Monograph of the Genus Dendrocincla Gray," by Harry C. Oberholser (April 8).

"Post-Glacial Nearctic Centers of Dispersal for Reptiles," by Arthur Erwin Brown (April 11).

Dr. E. G. Conklin made an illustrated communication on the earliest differentiations of the egg, with special reference to the mechanism of heredity and evolution. (No abstract.)

The following were elected members: Everett F. Phillips, Herbert Guy Kribs, Henry R. M. Landis, M.D.

The following were ordered to be printed:

A REVISION OF THE MAMMALIAN GENUS MACROTUS.

BY JAMES A. G. REHN.

During the preparation of this paper a series of one hundred and eighty-five specimens have been examined, seventy-six preserved as skins, the remainder being in alcohol. This interesting collection, representing the material of this genus preserved in the leading American institutions, was from the following collections: ninety-two from the Biological Survey of the U. S. Department of Agriculture, fifty from the U. S. National Museum, thirty-one from the American Museum of Natural History, five from the Field Columbian Museum, and the remainder from the collection of the Academy. The author wishes to thank Drs. C. Hart Merriam, J. A. Allen and D. G. Elliot, and Mr. G. S. Miller, Jr., of the above institutions, for their kindness in permitting the use of specimens, and also for replies to inquiries regarding the same.

MACROTUS Gray.[1]

1843. *Macrotus* Gray, Proc. Zoöl. Soc. London, 1843, p. 21. Type, *Macrotus waterhousii* Gray.
1855. *Macrotus* Wagner, Suppl. Schreber's Säugthiere, V, p. 639.
1858. *Macrotus* Baird, Proc. Acad. Nat. Sci. Phila., 1858, p. 116.
1859. *Macrotus* Baird, Rep. U. S. and Mexican Boundary Survey, Vol. II, Pt. ii, Mamm., p. 3.
1860. *Macrotus* Saussure, Revue et Magasin de Zoologie, 2e serie, XII, p. 486.
1864. *Macrotus* H. Allen, Monograph Bats N. Amer., p. 1.
1864. *Macrotus* Gundlach, Monatsb. K. Preuss. Akad. Wissensch., Berlin, 1864, p. 382.
1865. *Macrotus* Peters, Monatsb. K. Preuss. Akad. Wissensch., Berlin, 1865, p. 503.
1875. *Macrotus* Coues and Yarrow, Rep. Expl. Surv. W. 100th Merid., V, p. 80.
1878. *Macrotus* Dobson, Catal. Chiropt. Brit. Mus., p. 463.
1879. *Macrotus* Alston, Biol. Cent.-Amer., Mamm., p. 36.
1890. *Macrotus* H. Allen, Proc. Amer. Philos. Soc., XXVIII, p. 73.
1891. *Otopterus* Lydekker, in Flower and Lydekker, Mammals Living and Extinct, p. 673.
1894. *Macrotus* Allen, Monograph Bats N. Amer., 1893, p. 33.
1898. *Otopterus* Merriam, Proc. Biol. Soc. Wash., XII, p. 18.
1899. *Otopterus* Nelson, North American Fauna, No. 14, p. 18.
1901. *Otopterus* Elliot, Field Columb. Mus. Publ., Zool. ser., Vol. II, p. 419.
1904. *Macrotus* Miller, Proc. U. S. Nat. Mus., XXVII, p. 344.

[1] As the author does not consider that *Macrotis* Dejean invalidates this name, he has retained the term applied by Gray. The name *Macrotus* Leach (*Syst. Cat. Spec. Indig. Mamm. Birds Brit. Mus.*, 1816, p. 5) is a *nomen nudum*, and therefore has no standing. For discussion of the *Macrotus-Otopterus* question see True and Allen (Allen, *Monogr. Bats N. Amer.*, 1893, p. 33).

Generic Characters.—Head long; muzzle conical; nose-leaf simple, erect, lanceolate; nose-pad rounded; nostrils elongate, distinct; lower lip with a triangular pad bearing a longitudinal groove; ears large, united; tragus lanceolate; uropatagium large; tail long, projecting somewhat beyond the posterior margin of the uropatagium, which completely envelopes it but the free apex; calcanea short and stout. Skull with the rostrum moderately long, considerably lower than the brain-case. Dentition i. $\frac{4-4}{4-4}$, c. $\frac{1-1}{1-1}$, p. $\frac{2-2}{3-3}$, m. $\frac{3-3}{3-3}$. Median upper incisors chisel-shaped, long; lateral upper incisors weak.

Distribution.—Cuba, Haiti, Jamaica and a number of the Bahama Islands; Guatemala north to southern California and Arizona, but apparently not reaching the east coast of the mainland except in Yucatan.

History.—The genus *Macrotus* was founded by Gray on *M. waterhousii* from Haiti, and referred by him to the *Phyllostomina* close to the genus *Macrophyllum*. Wagner, in the supplement to Schreber's monumental work, placed Gray's genus in the *Megadermata* with *Megaderma, Rhinopoma, Nycteris* and *Nyctophilus*. In 1858 Baird described the Californian *M. californicus*, and, probably following Wagner, considered the genus a member of the subfamily *Megadermata*. Saussure, in 1860, in describing the Mexican *M. mexicanus*, referred the genus to the group *Phyllostomides*, but Harrison Allen, in 1864, followed Wagner and Baird, and considered it a member of the *Megadermatidæ*. Gundlach, in 1864, separated the small Cuban type as *M. minor*, while Peters, in 1865, considered the genus a member of his group *Vampyri*. Coues and Yarrow, in 1875, placed the genus in the family *Phyllostomatidæ*, in the section *Vampyri*, of which Dobson later placed it. In both of these papers *M. californicus, mexicanus* and *waterhousii* were considered identical. On the basis of several specimens from Guatemala, Dobson separated a species which he called *M. bocourtianus*. Harrison Allen, in 1890, separated a form of the genus from the State of Jalisco, Mexico, as *M. bulleri*, comparing it with *M. californicus;* the same author, in the 1894 edition of his *Monograph*, defended his statement made in 1864, that *M. californicus* was distinct from the West Indian *waterhousii*. Lyddeker, in 1891, believing that the name *Macrotis* Dejean invalidated *Macrotus* Gray, proposed the name *Otopterus* to replace Gray's term. This action was criticised later by True and Harrison Allen, who held that *Macrotis* was little used and in construction differed from *Macrotus*.

General Relations.—As little satisfactory material of the allied genera is available, no critical remarks as to the relationship of the genus can be made. It is without doubt a member of the present *Phyllostomatinæ*, but that it is not worthy of separation from some of the types of this division is not so certain. The genus *Lonchorhina* does not appear to the author to be as close an ally as Dobson's work would lead one to suppose; and taking the allied genera broadly, *Macrotus* appears to be a very distinct type, not differentiated as strongly by skull characters as by some external developments.

Key to the Forms.

a.—General size medium or large; skull with the interorbital region slightly and roundly depressed.
  b.—Ear medium or large (averaging 26 to 28 millimeters in length); skull with the rostrum rather heavy; interorbital region broad.
    c.—Foot quite robust, toes strong; West Indian forms.
      d.—General color ochraceous brown or pale umber.
        e.—First lower premolar subquadrate in basal outline; anterior width of the rostrum equal to the interorbital space.
          f.—Upper tooth-row heavy and strongly crowded; skull large, 26.8 mm. in length, *waterhousii* Gray.
          ff.—Upper tooth-row narrow and not strongly crowded; skull medium, not more than 24.5 mm. in length, *w. jamaicensis* n. subsp.
        ee.—First lower premolar elongate-elliptical in basal outline; anterior width of the rostrum less than the interorbital width, *w. compressus* n. subsp.
      dd.—General color dark umber or dark reddish-brown, *w. minor* (Gundlach).
    cc.—Foot rather slender, toes weak; Mexican and Central American forms.
      d.—Skull large (averaging 24.8 mm. in length); second upper premolar heavy, . *mexicanus* Saussure.
      dd.—Skull medium (averaging 23 mm. in length); second upper premolar rather weak and short, *m. bulleri* (H. Allen).
  bb.—Ear exceptionally large (averaging over 30 mm. in length); skull quite slender with the rostrum and interorbital region narrow, ... *californicus* Baird.
aa.—General size quite small; skull with the interorbital region very broad and strongly depressed, ... *pygmæus* n. sp.

Macrotus waterhousii Gray.

1843. *Macrotus Waterhousii* Gray, Proc. Zool. Soc. London, 1843, p. 21. [Hayti.]

1855. *M[acrotus] Waterhousii* Gray, Suppl. Schreber's Säugthiere, V, p. 640. [Hayti and Jamaica.] (Part.)

1865. *M[acrotus] Waterhousii* Peters, Monatsb. K. Preuss. Akad. Wissensch., Berlin, 1865, p. 503.
1878. *Macrotus waterhousii* Dobson, Catal. Chiropt. Brit. Mus., p. 464. [Haiti; St. Domingo; Jamaica.] (Part.)
1879. *Macrotus waterhousii* Alston, Biol. Cent.-Amer., Mamm., p. 38. (Part.)
1896. *Macrotus waterhousei* Elliot, Field Columbian Museum Publication, Zool. ser., Vol. I, p. 82. [San Domingo City, San Domingo.]

Type Locality.—Haiti.

Distribution.—Apparently restricted to the island of San Domingo and Haiti.

General Characters.—Size large; skull large; rostrum as wide anteriorly as the interorbital space; teeth rather heavy and robust, the first lower premolar thick, almost quadrate in basal outline; ears whitish basally.

Head.—Ears large, high; apex rounded yet with the angle apparent; internal margin with the lower half strongly arcuate, the upper half very slightly curved; internal ridge low, slight; external margin slightly arcuate, a slight incision separating a small basal portion; transverse plicæ distinct, but not strongly marked; tragus elongate-lanceolate, apex acute, internal margin straight with a slight apical emargination, external margin straight with a slight basal accessory lobule; connecting membrane distinct but not high. Eye medium in size. Nose-leaf moderately high, acute, the margins of the pad free and rounded; nostrils elliptical, directed inward and downward. Lower lip with the pad with a distinct division.

Limbs.—Forearm moderately long, considerably and evenly arcuate, thumb large and comparatively free. Femora, tibiæ and feet rather long and heavy.

Membranes and Fur.—Membranes rather heavy; propatagium rather large basally, extending to the thumb as a subequal strip of membrane with the margin totally free. Fur very long and silky, thin on the interscapular and abdominal regions and practically absent from the face, but otherwise regularly distributed; base of ears with a short growth of fine woolly hairs; muzzle with a number of long setiform hairs; volar membranes almost unhaired.

Color.—Above Prout's brown, the basal portion of the fur white, latter exposed on the thinly furred interscapular region; posterior margin and short fur on the basal portion of the ears white; below fawn color, with a silvery "bloom" caused by the silvery-white tips of the hairs. Volar and interfemoral membranes seal-brown; ears bistre.

Skull.—Robust and strongly built; brain-case rounded, moderately elevated; rostrum considerably constricted Brain-case evenly vaulted, the longitudinal curve low, sagittal crest distinct and sharp; interorbital region slightly constricted; zygomata prominent, slightly more expanded posteriorly than anteriorly. Rostrum attenuate, the anterior width (taken behind the canines) not less than the interorbital width, the dorsal outline continuing, but less distinctly, the regular descending course from the summit of the brain-case; palate slightly vaulted, posterior portion with parallel sides, the median cleft with a sub-truncate apex; pterygoids very slender apically, moderately flaring. Mandible rather heavy, the rami strong; ascending rami stout, the coronoid process acute-angulate, condylar process broad but low; angle strong, recurved, unguical in character, distinctly bent laterally.

Teeth.—Median pair of upper incisors slender, projecting, with a narrow cutting edge; lateral upper incisors small, low, crowded, the external face distinctly channeled; upper canines projecting anteriorly, slightly recurved; first upper premolar elongate-elliptical in basal outline, advanced upon and crowding the canine, cusp anterior, low and followed by a jagged cutting edge and distinct cingulum; second upper premolar oblong in basal outline, anterior section narrowed considerably, cusp distinct, subcaniniform; first upper molar subquadrate, the paracone-metacone ridge distinct and with the two arms distinctly acute at the metacone, protocone as a low blunt ridge, hypocone almost obsolete, cingulum very weak; second upper molar similar to the first in character, but larger, distinctly quadrate and with the paracone more apparent than in the first molar; third upper molar strongly transverse and equal to the other molars in width, paracone strongly developed. Lower incisors narrow, compressed, strongly crowded between the canines, cutting edges faintly bilobate; lower canines rather strongly recurved; first lower premolar subquadrate in basal outline, advanced upon and strongly crowding the canine, cusp rather low and broad; second lower premolar very similar to the first premolar in basal outline but smaller and narrower, cusp rather sharp and rectangulate, cingulum quite distinct; third lower premolar subquadrate in basal outline, broad posteriorly, equal to the second premolar in size, cusp and cingulum much as in the second premolar; lower molars all longitudinal in basal outline, the third smaller than the others, the para- proto- metaconid group less distinct in the first than in the others, the hypo-entoconid group weaker and less distinct in the third than in the other molars.

Measurements.—Adult male (from dried skin): Length of head and body 62 mm.; ear 25; tragus 8.1; forearm 52; thumb 14.5; third digit 92.5; tibia 21; foot 15.5; greatest width of ear 17.

Skull of adult male: Total length 26.8 mm.; greatest zygomatic width 12.3; interorbital width 4.9; height at base of second premolar 4; height of brain-case 9.3; breadth of brain-case above roots of zygomata 10; width of palatal constriction 2.3; length of palate from anterior foramina 11; width of palate including teeth 8.1; greatest length of mandible 17.3.

Remarks.—True *M. waterhousii* can readily be distinguished by the character given in the key. From the mainland forms the heavier posterior limbs and the stronger skull and teeth will distinguish it. From *w. minor* the Haitian form can readily be separated by the paler coloration as well as the much greater size; from *w. jamaicensis* by the larger size and heavier teeth; from *w. compressus* by the broader rostrum as well as the subquadrate first lower premolar.

Specimens Examined.—One skin and skull: San Domingo City, San mingo. (Field Columbian Museum.)

Macrotus waterhousii jamaicensis n. subsp.

1851. *Macrotus Waterhousii* Gosse, A Naturalist's Sojourn in Jamaica, p. 295, Pl. 6, fig. 2. [Jamaica.] (Not of Gray.)
1878. *Macrotus waterhousii* Dobson, Catal. Chiropt. Brit. Mus., p. 464. [Haiti; St. Domingo; Jamaica.] (Part.)

Type.—Adult ♀; Spanishtown, Jamaica. No. $\frac{8,553}{37,543}$, U. S. National Museum. Collected by William Thomas March.

Distribution.—The island of Jamaica, where according to Gosse (*vide supra*) it is one of the commonest bats. Osborn, in Dobson (*vide supra*), states that "when inhabiting houses these bats always live in the cellars below ground, they are never found in the roofs."

General Characters.—Similar to the Haitian *M. waterhousii*, but differing in the duller coloration, the smaller skull and narrower and weaker upper tooth-row.

Head.—Ear quite large, much as in *M. waterhousii*, but the size is greater, and the transverse plicæ more distinct;[2] connecting membrane rather high and with a distinct central emargination; tragus as in *M. waterhousii*, but the apex is blunter. Nose-leaf and nose-pad broad, the leaf acuminate with the apex rather broad and blunt. Lower lip with the pad trigonal, the median cleft deep and very distinct.

Limbs.—The forearm and tibia are structurally as in *M. waterhousii*, but of slightly larger size; the thumb and foot are, on the other hand, of smaller size. Calcanea short and stout. Tail distinctly projecting beyond the interfemoral membrane.

Fur.—Essentially as in *M. waterhousii.*

[2] This is hardly visible in the type skin, but quite distinct in alcoholic specimens.

Color.—Above Prout's brown, the hair with slightly more than the basal half white. Below between drab and wood brown, the hair with the basal half white. Ears and uropatagium Prout's brown, endopatagium, mesopatagium and the greater portion of the ectopatagium clove brown.

Skull.—Similar to that of *M. waterhousii*, but slightly smaller.

Teeth.—Similar to *M. waterhousii*, but narrower and not strongly crowded; second upper premolar separated from the first premolar by a distinct space.

Measurements.—Type: Total length 90.2 mm.; head and body 63.2; ear 23; greatest width of ear 16; tragus 8.5; forearm 54.5; thumb 14.1; third digit 92; tibia 23.5; foot 13; tail 27.

Average of series: Total length [10] 93.8 mm. (90.2–103); head and body [10] 60.6 (57–67); head [9] 26 (25.5–27.5); ear [10] 26.3 (23–29); greatest width of ear [10] 18.5 (16–20.5); tragus [10] 8.8 (8–9.5); forearm [10] 53.4 (52–54.5); thumb [10] 13.4 (12–15); third digit [10] 90.3 (88–94); tibia [10] 22.3 (21.5–24); calcaneum [9] 10.4 (9.2–12); foot [10] 13.6 (12.2–16); tail [10] 33.1 (27–36).

Type skull: Greatest zygomatic width 12.2 mm.; interorbital width 4.3; height at base of second premolar 4.1; breadth of brain-case above roots of zygomata 9.5; width of palatal constriction 2.4; length of palate 11; width of palate including teeth 7.8; greatest length of mandible 16.5.

Average of three skulls: Total length [2] 24.3 mm. (24.2–24.5); greatest zygomatic width 12 (12–12.2); interorbital width 4.2 (4.1–4.3); height at base of second premolar 3.9 (3.7–4.1); height of brain-case [2] 9 (9–9.1); breadth of brain-case above roots of zygomata 9.4 (9.4–9.5); width of palatal constriction 2.2 (2.1–2.4); length of palate 9.9 (9.3–11); width of palate with teeth 7.9 (7.8–8); greatest length of mandible 16.1 (16–16.5).

Remarks.—This form requires comparison with but one other, true *M. waterhousii*, from which the compressed and spaced tooth-row will readily distinguish it. The external characters are also of service, the longer forearm and tibia and smaller foot being distinctive. From *M. w. compressus* and *minor* the characters given in the key will enable one to separate it without difficulty.

Specimens Examined.—Twelve; one skin, eleven alcoholic individuals.

Spanishtown, Jamaica. One [type]. (U. S. N. M.)

Kingston, Jamaica. One. (U. S. N. M.)

Jamaica. Two. (Biological Survey.)

Jamaica. Eight. (A. M. N. H.)

Macrotus waterhousii compressus n. subsp.

Type.—Adult ♀; Eleuthera, Bahamas. No. 122,484, U. S. National Museum. July 6, 1903. Collected by S. H. Derickson.

Distribution.—Specimens have been examined from Eleuthera, New Providence, Long Island and Conch Sound, Andros, Bahamas.

General Characters.—Similar to *Macrotus waterhousii* and *M. w. jamaicensis*, but differing in the quite narrow rostrum (which is anteriorly narrower than the interorbital region) and elongate-elliptical first lower premolar.

Head.—Similar to *M. w. jamaicensis*, except that the nose-leaf and nose-pad appear to be slightly narrower and slenderer. This character appears to be only an average one, however, as the series shows considerable variation.

Limbs.—Similar to *M. w. jamaicensis*, but the forearm, tibia, third digit and tail average smaller, while the foot averages larger. In the latter respect *compressus* approaches true *waterhousii*, as their respective distribution would lead one to suppose, from which the limbs show practically no differential characters.

Fur.—Essentially as in *M. waterhousii* and *M. w. compressus.*

Color.—Above Prout's brown, the hair with more than the basal half white; fur at the base of ears and along the internal margins whitish. Below the hair is white basally, ringed with pale drab, and tipped with silvery-white. Membranes sepia, the ears and uropatagium paler than the other portions.

Skull.—Similar to that of *M. w. jamaicensis*, but with the anterior portion of the rostrum narrower than the interorbital region. The skull of true *waterhousii* can readily be separated, as it is of considerably greater size. The mandible is also seen to be slenderer than in either the Haitian or Jamaican form.

Teeth.—Similar to *M. w. jamaicensis*, but with the first upper premolar narrower and more elongate, and the first lower premolar is distinctly elongate-elliptical in basal outline instead of subquadrate. The teeth are distinctly weaker than in *M. waterhousii*, the latter having a very heavy robust dentition.

Measurements.—Type: Total length 94 mm.; head and body 69; ear 24; greatest width of ear 18; tragus 8.5; forearm 52; thumb 13.5; third digit 85; tibia 21; calcaneum 11; foot 13; tail 25

Average of series: Total length [8] 96.7 mm. (88–98); head and body [8] 64.5 (59–69); head [4] 25 (24–26); ear [8] 26 (23–29.5); greatest width of ear [8] 18.8 (17–21.5); tragus [8] 8.9 (7.5–10); forearm [8] 52.1 (49.5–54); thumb [7] 13.9 (12.8–16); third digit [7] 88.7 (84–106);

tibia [7] 21.2 (20–23.5); calcaneum [7] 10.4 (9.3–11); foot [8] 14.4 (13–16.8); tail [8] 30.9 (25-33.5).

Skull of type: Total length 25 mm.; greatest zygomatic width 10.6; interorbital 4.3; height at base of second premolar 4.1; height of brain-case 8.6; breadth of brain-case above roots of zygomata 8.5; width of palatal constriction 2.3; length of palate 11; width of palate (including teeth) 7.6; greatest length of mandible 17.

Average of four skulls: Total length 25 mm. (25–25.1); greatest zygomatic width 11.6 (10.6–12); interorbital width 4.3 (4.2–4.5); height at base of second premolar 4 (4–4.1); height of brain-case 8.3 (8–8.6); breadth of brain-case above roots of zygomata 9 (8.5–9.5); width of palatal constriction 2.2 (2.1–2.3); length of palate 10.6 (10.5–11); width of palate (including teeth) 7.5 (7.5–7.6); greatest length of mandible 16.9 (16.8–17).

Remarks.—The Bahaman form in general appearances approaches closer to true *waterhousii* than to *w. jamaicensis*, but the skull and teeth are decidedly different from the Haitian type and approach the Jamaican form. Taken as a whole, however, the Bahaman race is quite distinct from any other form of the genus.

Specimens Examined.—Nine; five skins, four alcoholic specimens.

Eleuthera, Bahamas. One [type]. (U. S. N. M.)

Gregorytown, Eleuthera, Bahamas. Two. (U. S. N. M.)

Georgetown, Eleuthera, Bahamas. Three. (U. S. N. M.)

Nassau, New Providence, Bahamas. One. (U. S. N. M.)

Conch Sound, Andros, Bahamas. One. (A. M. N. H.)

Long Island, Bahamas. One. (U. S. N. M.)

Macrotus waterhousii minor (Gundlach).

1864. *Macrotus minor* Gundlach, Monatsbr. K. Preuss. Akad. Wissensch., Berlin, 1864, p. 382. [Cuba.]

1873. *M*[*acrotus*] *Waterhousei* Gundlach, Anales Soc. Españ. Hist. Nat., I, cuad. 3, p. 239. [Cuba.] (Not of Gray.)

1878. *Macrotus waterhousii* Dobson, Catal. Chiropt. Brit. Mus., p. 464. (Part.)

1904. *Macrotus waterhousii* Miller, Proc. U. S. Nat. Mus., XXVII, p. 344. [Guanajay, El Cobre, Cuba; Nueva Gerona, Isle of Pines.] (Not of Gray.)

Type Locality.—Cuba. From remarks made by Gundlach in a later paper (*vide supra*) we learn that his material was from western Cuba.

Distribution.—Cuba and the Isle of Pines. Gundlach says it is a common species in some warehouses and caves, where individuals pass the day side by side suspended by the hind limbs.

General Characters.—A member of the *Macrotus waterhousii* group but readily separated by the smaller size and the deeper coloration. The Cuban form is such a distinct type, with small light skull and weak teeth, that it hardly requires comparison.

Head.—Essentially as in *M. waterhousii jamaicensis.*

Limbs.—As in *M. w. jamaicensis,* but slightly smaller.

Fur.—As in the other forms of the *waterhousii* group, except that the furring of the base and proximal part of the internal margin of the ear is more marked than in any other form.

Color.—Apparently two extreme types of coloration exist in this form, which may be sexual, but the available material is not in condition to justify any statement beyond the fact that the two phases exist. The one extreme is a deep brown, while the other (represented by but one skin) is a rather dark ferruginous. Two specimens have a slight tendency toward the ferruginous type, the upper surface being slightly suffused with that tint while the lower surface is that of the brown form. Brown phase: Above seal brown, the hair with slightly more than the basal half white, region between the ears and posterior to the connecting membrane blackish; below the hair is white basally, then conspicuously annulate with drab and rather obscurely tipped with silvery; membranes blackish-brown. This type is distinctly darker, both above and below, than any of the other West Indian forms. Red phase: Above and below dull ferruginous, the hair unicolor; patch between the ears blackish; membranes black. In one of the apparently intermediate specimens mentioned above, the hair of the upper surface is whitish basally with a median annulation of smoke gray.

Skull.—Of the general type of *M. waterhousii,* but distinctly smaller than any of the related forms. As specimens from the eastern part of Cuba approximate slightly toward the Jamaican type, a slight difference in size is noticed in comparing the skulls of individuals from the two extremes of the island.

Teeth.—Essentially as in *M. w. jamaicensis,* but the first upper premolar is slightly narrower and the lower premolars are distinctly more longitudinal and compressed. This latter character alone will immediately demonstrate the fact that while specimens from the eastern part of the island slightly approach *jamaicensis,* they are inseparable from typical *minor* from western Cuba, when the dentition is considered.

Measurements.—Average of twelve specimens: Total length 90.7 mm. (84.5–96.5); head and body 59.9 (55.5–65); head 25.1 (25–30); ear 26.3 (21.5–30); greatest width of ear 17.3 (15–19); tragus 8.6 (7.8–10); forearm 51.4 (49–54); thumb 14.1 (12.5–15); third digit 85.1 (81–88); tibia 21.2 (19–22.5); calcaneum 10.9 (8.5–12.3); foot 13 (10.5–15.5); tail 30 (20–37).

Average of five skulls: Total length 23.8 mm. (23.5–24.3); greatest zygomatic width 11.3 (11–12); interorbital width 3.9 (3.5–4.1); height at base of second premolar 3.8 (3.5–4); height of brain-case 8.3 (8–8.8); breadth of brain-case above roots of zygomata 9.1 (9–9.2); width of palatal constriction 2.1 (2–2.2); length of palate 9.7 (9.2–10); width of palate (including teeth) 7.3 (7–8); greatest length of mandible 15.4 (15–16).

Remarks.—The Cuban form *minor* is quite distinct from any of the related forms except the Jamaican *Macrotus waterhousii jamaicensis.* The specimens from eastern Cuba somewhat approach this latter race, as already noticed by Gundlach (*vide supra*), but the general characters of the race are retained and the smaller size and weaker teeth, as well as the deeper coloration, will serve to distinguish the two races.

Specimens Examined.—Twenty-eight; four skins, twenty-four alcoholics:

Guanajay, Pinar del Rio, Cuba. Three. (U. S. N. M.)

Nueva Gerona, Isle of Pines. Three. (U. S. N. M.)

El Cobre, Santiago, Cuba. Two. (U. S. N. M.)

Santiago de Cuba, Cuba. Twenty. (U. S. N. M.)

Macrotus mexicanus Saussure.

1860. *Macrotus mexicanus* Saussure, Revue et Magasin de Zoologie, 2e ser. XII, p. 486. [Cuautla, near Yautepec, Morelos, Mexico.]
1865. *M[acrotus] mexicanus* Peters, Monatsb. K. Preuss. Akad. Wissensch., Berlin, 1865, p. 504.
1876. *Macrotus bocourtianus* Dobson, Ann. and Mag. Nat. Hist., 4th ser., XVIII, p. 436. [Vera Paz, Guatemala.]
1878. *Macrotus waterhousii* Dobson, Catal. Chiropt. Brit. Mus., p. 464. (Part.)
1878. *Macrotus bocourtianus* Dobson, Catal. Chiropt. Brit. Mus., p. 467 [Vera Paz, Guatemala.]
1879. *Macrotus waterhousii* Alston, Biol. Cent.-Amer., Mamm., p. 38 (Part.)
1879. *Macrotus bocourtianus* Alston, Biol. Cent.-Amer., Mamm., p. 38 [Vera Paz, Guatemala.]
1898. *Otopterus mexicanus* Merriam, Proc. Biol. Soc. Wash., XII, p. 18 [Morelos, Mexico.]

Type Locality.—Cuautla, near Yautepec, Morelos, Mexico.

Distribution.—From Colima, Michoacan, and Morelos, Mexico, south to Vera Paz, Guatemala.

General Characters.—Size large; ears rather large; limbs robust; skull heavy, the rostrum not narrower than the interorbital region; teeth heavy, the first upper premolar moderately compressed, the third lower premolar somewhat crowded.

Head.—Ear, when stretched forward, extending beyond the muzzle a distance not exceeding the length of the nose-leaf; internal margin strongly arcuate basally, gently so apically; apex rather narrowly rounded; external margin slightly curved, basal notch distinct, basal lobe rather low; tragus lanceolate, apex acuminate, external basal lobe low; internal connecting membrane rather high, with a slight median emargination. Nose-leaf acute; nose-pad with the inferior margin more or less free; nostrils crescentic. Pad on the lower jaw trigonal, median incision of varying depth, but usually rather broad and shallow.

Limbs.—Forearm long and heavy, with a distinct and even arcuation. Posterior limbs moderately robust (for the genus), femora and tibiæ of equal length; foot about half the length of the femur, rather heavy; calcaneum thick and flattened. Tail rather long, one or one and a half terminal joints free.

Membranes and Fur.—Essentially as in the *waterhousii* group.

Color.—Two color phases are present in the series examined—one dark brown the other of a more rufescent type—between which two extremes are a number of intermediate specimens. Dark brown phase: Above bistre with a slight overlying silvery "bloom," the basal three-fifths of the hair white; below wood brown, the hair with the basal section as above, the whole with the tips of the hair white; hair at the base of the ears and the auricular hairs whitish; membranes bistre. Rufous brown phase: Above cinnamon, slightly more than the basal half of the hair white; below the hair white basally, then ringed with cinnamon, and tipped with ecru drab, thus producing a paler color than that of the upper surface; hair at the base of the ears and auricular hairs whitish; membranes mummy brown.

Skull.—Similar to *M. waterhousii,* but slightly smaller, with the interorbital region more depressed and the rostrum slightly slenderer.

Teeth.—As in *M. waterhousii,* except that the canines are distinctly weaker, the first upper premolar is more compressed, the second upper premolar slightly longer, and the lower tooth-row more compressed.

Measurements.—Average of four Cuernavaca specimens: Total length 93.1 mm. (87–101); head and body 59.8 (56.5–64); head 24; ear 25.2 (24–27); greatest width of ear 17.7 (17–18.5); tragus 9.2 (9–9.6); forearm 49.6 (47.5–51.5); thumb 12.5 (11.5–13); third digit 87.1 (85.5–90); tibia 21.2 (21–21.5); calcaneum 10.3 (9–11.3); foot 12.7 (11.8–13); tail 33.5 (30–37).

Average of eight Tehuantepec skins: Total length [1] 100.5 mm.; head and body 60.9 (57–69); head [1] 29.2; ear 26 (24–28.5); greatest width of ear [3] 18.8 (17.9–19.5); tragus 8.5 (8–10); forearm 52.5 (51–53.5); thumb [7] 12.3 (12–13.5); third digit [5] 87.8 (87–89); tibia 22.2 (20–23.5); calcaneum 10 (9–11); foot 13.1 (13–13.5); tail [1] 31.5.

Average of eight skulls from Tehuantepec and Reyes, Oaxaca: Total length 24.8 mm. (24–25.5); greatest zygomatic width 12 (11.5–12.5);

interorbital width 4.1 (3.9–4.5); height at base of second premolar 3.7 (3.5–3.9); height of brain-case 9 (8.1–9.5); breadth of brain-case at roots of zygomata 9.2 (9–9.6); width of palatal constriction 2.2 (2–2.5); length of palate 9.4 (9–9.8); width of palate (including teeth) 8 (7.9–8.2); greatest length of mandible 16.4 (16–17.6).

Remarks.—The *Macrotus mexicanus* group is closely related to the West Indian *waterhousii* group, from which, however, it can be distinguished by the characters mentioned above. The slenderer build, larger ears and lighter skull will at once separate *M. californicus* from this form, while the race *bulleri* is a smaller type of the *mexicanus* character quite easily recognized.

Dobson's *Macrotus bocourtianus* is, no doubt, simply the extreme development of this form, and his measurements are almost identical with those of the type of *mexicanus* given by Saussure. Specimens from Tehuantepec average larger than Morelos specimens, but some specimens in the same series are smaller than Cuernavaca individuals, and as no other characters appear to be at variance, they should be considered extreme *mexicanus*. Many of Dobson's measurements of *bocourtianus* are smaller than the average of four Cuernavaca specimens examined, and in several cases are actually smaller than the same measurements of Saussure's type.

Specimens Examined.—Nineteen; eleven skins, eight alcoholic specimens:

Colima, Colima. Two. (Biol. Surv.)

La Salada, Michoacan. Five. (Biol. Surv.)

Cuernavaca, Morelos. Four. (Biol. Surv.)

Reyes, Oaxaca. One. (Biol. Surv.)

Tehuantepec, Oaxaca. Seven. (A. M. N. H. and Field Columbian Mus.)

Macrotus mexicanus bulleri (H. Allen).

1889. *Macrotus californicus* J. A. Allen, Bull. Amer. Mus. Nat. Hist., II, p. 166. [Bolaños, Jalisco, Mexico.] (Not of Baird.)

1890. *Macrotus bulleri* H. Allen, Proc. Amer. Philos. Soc., XXVIII, p. 73. [Bolaños, Jalisco, Mexico.]

1894. *Macrotus bulleri* H. Allen, Monogr. Bats N. Amer., p. 41. [Bolaños, Jalisco, Mexico.]

1898. *Otopterus mexicanus* Merriam, Proc. Biol. Soc. Wash., XII, p. 18. [Maria Madre, Tres Marias Islands.] (Not of Saussure.)

1898. *Otopterus bulleri* Merriam, Proc. Biol. Soc. Wash., XII, p. 18. [Bolaños, Jalisco, Mexico.]

1899. *Otopterus mexicanus* Nelson, North American Fauna, No. 14 p. 18 [Maria Madre, Tres Marias Islands.] (Not of Saussure.)

Type Locality.—Bolaños, Jalisco, Mexico.

Distribution.—From Guadalajara north to Durango and southern Chihuahua, also including the Tres Marias Islands.

General Characters.—Similar to *M. mexicanus*, but smaller, with the dentition more crowded, and the second upper premolar shorter and somewhat weaker.

Head.—As in *M. mexicanus*, except that the ears are larger.

Limbs.—As in *M. mexicanus*, but rather slenderer, the foot and calcaneum distinctly weaker.

Membranes and Fur.—As in *M. mexicanus.*

Color.—This race occurs in two phases, one of which appears to be that of immaturity. The dark brown type, which is apparently the immature coloration, is connected by intermediates with the dull rufescent brown type. Brown phase: Above bistre, the hair with the basal half white; base of ears and auricular hairs whitish; below drab, the hair white at the base and tipped with silvery-white; membranes clove brown. Red phase: Above between chestnut and hazel (Ridgway's *Nomenclature of Colors*, pl. iv), the hair light and rather vinaceous basally; base of ears and auricular hairs of the under color of the upper surface; below dull pinkish vinaceous; membranes between chestnut and liver brown. The intermediate specimens have the upper surface cinnamon rufous, while of this type has the extreme base of the hair smoke-gray, thus making the hair triannulate—smoke gray, white and cinnamon rufous. The original series of this race was composed entirely of immature individuals and accordingly all are of the dark brown type.

Skull.—Very similar to that of *M. mexicanus*, but distinctly smaller, with the rostrum, for its size, heavier.

Teeth.—As in *M. mexicanus*, but the second upper premolar is without the produced anterior shoulder noticed in *mexicanus*, and the inferior premolars are comparatively shorter and broader.

Measurements.—Average of five alcoholic topotypes: Total length 87.6 mm. (84.5–92); head and body 55.1 (53.5–56.5); head 23 (22.5–23.5); ear 28.5 (27–30.5); greatest width of ear 19.2 (18.5–20.5); tragus 9.5 (9–10); forearm 49.2 (48.5–50.5); thumb 12.6 (12–13.2); third digit 83.8 (81–87); tibia 20.2 (19–21); calcaneum 10.6 (10–11.2); foot 12.4 (12–13); tail 32.5 (30.5–35.5).

Average of eleven topotypic and Guadalajara skulls: Total length 23 mm. (22.5–23.5); greatest zygomatic width 10.8 (10.5–11.1); interorbital width 4 (4–4.2); height at base of second premolar 3.6 (3.3–4); height of brain-case 8.2 (8–9); breadth of brain-case above roots of zygomata 8.6 (8.3–9); width of palatal constriction 2 (2–2.3); length of palate 8.6 (8.3–9); width of palate (including teeth) 7.4 (7–7.8); greatest length of mandible 15 (14.6–15.5).

Remarks.—This well-marked race of *mexicanus* can be easily recognized by the smaller size, the weak second upper and distinctly crowded third lower premolars. The Tres Marias specimens appear to be inseparable from the mainland form.

Specimens Examined.—Fifty-two; twenty-seven skins, twenty-five alcoholic individuals:

Near Batopilas, Chihuahua. Four. (Biol. Surv.)

Chacala, Durango. Five. (Biol. Surv.)

Bolaños, Jalisco. Twenty-one. (A. M. N. H., Biol. Surv., and Field Columb. Mus.)

San Pedro, near Guadalajara, Jalisco. Five. (A. M. N. H.)

Ameca, Jalisco. Six. (Biol. Surv.)

Maria Madre, Tres Marias Islands, Tepic. Eleven. (Biol. Surv.)

Macrotus californicus Baird.

1858. *Macrotus Californicus* Baird, Proc. Acad. Nat. Sci. Phila., p. 116. [Fort Yuma, California.]
1859. *Macrotus californica* Baird, Rep. U. S. and Mexican Boundary Survey, Vol. II, Pt. 2, Mamm., p. 4, Pl. 1, fig. 2. [Fort Yuma, California.]
1864. *Macrotus californicus* Allen, Monogr. Bats N. Amer., p. 3, figs. 2 and 3. [Fort Yuma, California; Cape St. Lucas, Lower California.]
1865. *M[acrotus] californicus* Peters, Monatsb. K. Preuss. Akad. Wissensch., Berlin, 1865, p. 504.
1875. *Macrotus waterhousii* Coues and Yarrow, Rep. Expl. Surv. W. 100th Merid., V, p. 80. (Not of Gray.)
1878. *Macrotus waterhousii* Dobson, Catal. Chiropt. Brit. Mus., p. 465. [Cape St. Lucas, Lower California.] (Part.)
1879. *Macrotus waterhousii* Alston, Biol. Cent.-Amer., Mamm., p. 38. (Part.)
1894. *Macrotus californicus* Allen, Monogr. Bats N. Amer., p. 34, Pls. 1 and 2. [Fort Yuma, California; Cape St. Lucas, Lower California; near Tucson, Arizona.]
1901. *[Otopterus] californicus* Elliot, Field Columb. Mus. Publication, Zool. ser., II, p. 420.

Type Locality.—Fort Yuma, San Diego county, California.

Distribution.—Arid region of the southwestern United States, Lower California and Sonora. Specimens have been examined from as far east as Tombstone, Cochise county, Arizona, west as far as De Luz, San Diego county, California, and from as far south as Camoa, Rio Mayo, Sonora, and Cape St. Lucas. Cape St. Lucas and Sonoran specimens are slightly smaller than topotypes, but are otherwise indistinguishable.

General Characters.—Size large; form slender, ears extremely large, subovate in outline; limbs very slender; skull slender, rostrum narrow; teeth weak; colors usually pale.

Head.—Elongate, slender; rostrum rather attenuate; brain-case moderately elevated. Ear very large, elliptical, when stretched forward, exceeding the muzzle by a third the entire length of the appendage; internal border arcuate, strongly so basally; apex blunt rectangulate; external margin very slightly curved, almost straight; basal lobe low, but separated by a distinct notch; transverse plicæ weak, separated; internal ridge narrow, rather inconspicuous; interauricular membrane moderately high with a rounded median emargination; tragus lanceolate, greatest width not more than a third of the length, apex attenuate, internal margin moderately arcuate at the base, external margin with a pair of slight accessory lobes at the base. Eye of medium size. Nose-leaf blunt lanceolate, higher than the width of the pad; nostrils crescentic; nose-pad with the margins free to a greater or less extent. Lower jaw with the pad triangular and of medium size, divided more or less distinctly.

Limbs.—Forearm moderately robust, slightly bowed; thumb long and slender. Posterior limbs slender and weak, the feet narrower and with the toes strongly compressed. Tail slender, exceeding the apical margin of the interfemoral membrane by the length of one or one and a half vertebræ.

Membranes and Fur.—Membranes thin and rather weak; propatagium deep proximally, very narrow distally, but with the margin free to the thumb; uropatagium large, apical margin subtruncate; endopatagium with the nerves extending parallel to the humerus and femur; mesopatagium with the nerves with a general antero-posterior trend. Fur thick and long, rather silky in texture, uniform in distribution except on the interauricular region of the head, which is partially bare; ear with the posterior and internal bases as well as the anterior margin very distinctly haired, the anterior margin with the hair long and scattered.

Color.—Upper surface ranging from pale drab to mars brown, the basal two-thirds of the fur white, which shows through distinctly at the nape and on the crown, at which latter point the brown tips are almost absent in some specimens. Under surface ranging from ecru drab to broccoli brown, the hair white basally and with silvery tips, the latter being more marked in some individuals than in others. Hair at base and on the margin of the ears whitish. Membranes and muzzle appendages Prout's brown.

Skull.—Slender, elongate, rostrum produced and moderately acuminate. Brain-case slightly compressed, evenly arched; sagittal crest low and weak; interorbital constriction distinct, not or very slightly wider than the width of the rostrum at the canines; zygomata with the greatest width posterior, not arched. Rostrum at the orbits twice as wide as at the canines, gently acuminate and passing into the brain-case without any abrupt depression; palate with the posterior portion rather broad, subequal. Mandible rather slender; ascending rami low, coronoid process rather sharp, condylar process broad but compressed, angle recurved, deflected laterally to a considerable extent.

Teeth.—Central pair of superior incisors slender, compressed, distinctly projecting forward; lateral upper incisors of about the same basal area as the median pair, but very low, not one-fourth the height of the median pair. Upper canines slightly flaring, subreniform in basal outline; first upper premolar elongate, strongly compressed, cusp low and placed anteriorly; second upper premolar touching and slightly overlapping the first, elongate pyramidical in basal outline, the apex interior and deflected toward the internal margin of the tooth-row, cusp moderately high; first upper molar narrowed anteriorly, metacone inconspicuous and pressed against the hypocone-metaconule ridge; second upper molar quadrate, cusps regularly placed; third upper molar strongly transverse. Lower incisors small, compressed, edges very faintly bilobate; lower canines slightly recurved; first lower premolar oblong in basal outline, the internal margin slightly rounded, cusp obtuse and low; second and third lower premolars similar in basal outline, oblong, the third not more crowded than the second; first lower molar smaller than the second, cusps similar in character except that the entoconid is distinctly stronger in the second than in the first tooth; third lower molar with the meta-paraconid section very slight and weak in strong contrast to the distinct and heavy ento-metaconid fold.

Measurements.—Average of series of five alcoholic topotypes: Total length 88.6 mm. (84.5–92.5); head and body 54.7 (50–58); head 23.8 (22.5–25); ear 30.7 (28–33); greatest width of ear 21.2 (20.5–22.5); tragus 10.9 (10–12); forearm 50.5 (49.3–51); thumb 11.9 (10.8–12); third digit 79.9 (77–83); tibia 21.7 (21–22.2); calcaneum 11.5 (10.2–12.8); foot 11.5 (11–12.5); tail 33.9 (30–37).

Average of six skulls: Total length 23.5 mm. (23–24.1); greatest zygomatic width 11.5 (11–12); interorbital width 3.9 (3.8–4); height at base of second premolar 3.5 (3–3.9); height of brain-case 8.1 (8–8.8); breadth of brain-case above roots of zygomata 8.7 (8.4–9); width of palatal constriction 2.2 (2–2.5); length of palate 9.5 (9.2–10); width of palatal constriction 7.3 (6.9–7.9); greatest length of mandible 15.7 (15.2–16).

Remarks.—This species can be distinguished from the *waterhousii* group by the slenderer structure of the whole body and skull the longer ear and the weaker dentition.

From *M. mexicanus* and *M. bulleri, californicus* can be distinguished by the characters given in the key.

The Cape St. Lucas specimens are slightly differentiated from the typical Yuma specimens, but the differences are so extremely slight that they would not justify the separation of the Cape series.

Specimens Examined.—Fifty-nine; twenty-one skins, thirty-three alcoholic individuals:

Yuma, Arizona. Five. (Biol. Surv.)

Thirty-five miles east of Yuma, Arizona. Two. (U. S. N. M.)

Parker, Yuma county, Arizona. One. (U. S. N. M.)

San Xavier, Pima county, Arizona. One. (U. S. N. M.)

Arizona. Five. (A. M. N. H.)

Tombstone, Cochise county, Arizona. Two. (Biol. Surv.)

Vallecito, San Diego county, California. Seventeen. (Biol. Surv. and U. S. N. M.)

De Luz, San Diego county, California. Two. (Biol. Surv.)

Indian Wells, San Diego county, California. Four. (U. S. N. M.)

Ortiz, Sonora, Mexico. One. (Biol. Surv.)

Camoa, Sonora, Mexico. Eleven. (Biol. Surv.)

Cape St. Lucas, Lower California. Eight. (A. N. S. Phila. and U. S. N. M.)

Macrotus pygmæus n. sp.

Type.—Adult skin and skull; Izamal, Yucatan. No. 12,756|11,043, American Museum of Natural History. Collected by George F. Gaumer.

Distribution.—Known only from the type locality.

General Characters.—Size extremely small (for the genus); skull with the interorbital region very broad and distinctly flattened; teeth large and strongly crowded.

Head.—Ear rounded; internal margin evenly arcuate; apex rounded with but a slight trace of an angle; external margin evenly arcuate, basal notch very slight, basal lobe subobsolete; transverse plicæ distinct; interauricular membrane distinct and moderately high; tragus lanceolate, apex rather blunt, external margin with a slight basal accessory longitudinal lobule. Nose-leaf high, lanceolate, with the nose-pad over twice as high as the width of the pad; apex rather acute; nostrils slightly crescentic. Extremity of lower jaw with the triangular pad bearing a shallow median depression.

Limbs.—Forearm short, robust, evenly arcuate. Thumb rather long, enveloped in membranes for more than half its length. Third digit moderately long. Posterior limbs heavy; feet strong and but moderately compressed; calcanea long, stout and compressed.

Membranes and Fur.—Membranes thick and leathery; propatagium broad. Fur long, silky above, woolly below; skin of the head at the base of the ears and the interorbital region bare; base of ears and greater part of the internal margin of the ear clothed with long hair; muzzle with a number of long setiform hairs.

Color.—Above mars brown, the hair grayish white basally; below ecru drab, the hair unicolor; flight membranes clove brown; ears and nasal appendages Prout's brown; auricular hairs the color of the upper surface.

Skull.—Light and rather fragile; brain-case strongly elevated above the rostrum. Brain-case when viewed from the posterior aspect subtectate, evenly arched longitudinally; sagittal crest distinct; zygomata rather evenly arched, but greatest width posterior; interorbital region broad, depressed, curving evenly toward the rostrum and the brain-case. Rostrum moderately produced, rather low, width at canines considerably less than the interorbital width; palate rather narrow, shallowly excavated, posterior extension rather broad with the cleft acute-angulate with the apex blunt; pterygoids strongly divergent. Mandible rather long; ascending ramus low; coronoid process blunt; condylar process broad transversely; angles blunt, divergent.

Teeth.—Median pair of upper incisors narrow, cutting edges entire; lateral upper incisors very small, low and without a distinct cusp or other structure; upper canines rather heavy, slightly divergent; first upper premolar subelliptical in basal outline with a distinct median constriction, cusp rectangulate and low; second upper premolar crudely pyramidical in basal outline, the internal posterior margin bearing a distinct rounded shoulder; molars of the type usual in the genus. Lower incisors narrow, compressed; lower canines rather heavy, divergent, projecting slightly forward; lower premolars subquadrate in basal outline, the first and third more longitudinal than the second, cusp of the first tooth rectangulate, of the second and third acute; first lower molar with the para-proto-metaconid group much less sharply defined than in the other lower molars; third lower molar with the hypo-entoconid group reduced as in the other members of the genus.

Measurements.[3]—Total length 79.3 mm. (Gaumer); head and body 46; ear 17.2; greatest width of ear 13; tragus 7; forearm 35.5; thumb 10; third digit 65.5; tibia 14.9; calcaneum 9; foot 10.5; tail 28 (Gaumer); nose-leaf and nose-pad, 7.2.

Skull: Greatest zygomatic width 9.2 mm.; interorbital width 4.2;

[3] From dried skin, unless otherwise credited.

height at base of second premolar 3.2; height of brain-case 7.6; breadth of brain-case above roots of zygomata 8; width of palatal constriction 2; length of palate 8; width of palate (including teeth) 6.5; greatest length of mandible, 12.8.

Remarks.—This diminutive species is so very distinct that no further comparison or special comment is necessary.

Specimens Examined.—One, the type.

A MONOGRAPH OF THE GENUS DENDROCINCLA Gray.

BY HARRY C. OBERHOLSER.

The purpose of the investigation whose results are set forth in the following pages is to clear up to such degree as may be possible the measurable uncertainty of identification attending the birds of the genus *Dendrocincla*. This Dendrocolaptine group is composed entirely of plainly attired species which present often but slight differentiating characters; and many of the original descriptions are both so short and so unsatisfactory that the determination of their positive identity is a matter sometimes of considerable difficulty. Individual color variation is very marked in a few of the forms, occasionally amounting to a greater degree of difference than that which distinguishes some entirely distinct species; and the sexes, though alike in color, frequently differ widely in size. The color of the bill, which some writers have relied on to furnish specific distinctions, seems to change with age, being darkest in immature birds.

The name *Dendromanes*[1] under which Dr. Sclater proposed to separate *Dendrocincla anabatina* and a few of the other small species, at first generically,[1] then subgenerically,[2] seems to have no standing other than as a simple synonym of *Dendrocincla*, since the alleged characters do not prove to be significant; furthermore, there are no other structural differences among the species of the genus, aside from some comparatively slight variations in length of tail, and none of these seem cause sufficient for even subgeneric division.

For the purposes of the present review there have been available examples of all the twenty forms here recognized, save two—the newly described *D. macrorhyncha* and the well-known *D. longicauda*—comprising altogether considerably over 100 specimens. In a difficult group like *Dendrocincla* the examination of types is of great value—in many cases of prime importance—and in this we have been fortunate enough to handle the original specimens of *D. tyrannina*, *D. atrirostris*, *D. o. lafresnayei*, *D. meruloides*, *D. rufo-olivacea*, *D. castanoptera* and

[1] SCLATER, *Proc. Zool. Soc. Lond.*, 1859, p. 382.
[2] SCLATER and SALVIN, *Ibid.*, 1868, p. 54.

D. olivacea anguina, thereby being able to elucidate some problems of doubtful relationship.

The most important papers dealing with the species of this genus appear to be as follows:

LAFRESNAYE, *Revue et Mag. de Zoologie,* 1851, pp. 465–468.
RIDGWAY, *Proc. U. S. Nat. Mus.,* X, 1888, pp. 488–497.
SCLATER, *Cat. Birds in Brit. Mus.,* XV, 1890, pp. 162–168.

Although the present writer's work began with the collection of the United States National Museum, including that of the Biological Survey, he is under great obligations to the authorities of the American Museum of Natural History, and of the Boston Society of Natural History, as well as to Mr. Outram Bangs, for the loan of material, without which, particularly the valuable type specimens, it would have been impossible to arrive at anything like satisfactory conclusions. To Mr. Glover M. Allen he is also indebted for the verification of some obscure references; and especially to Mr. Ridgway, whose constantly courteous assistance has contributed to make this paper much better than it otherwise would have been.

Genus **DENDROCINCLA** Gray.

Dryocopus Wied, Beitr. Naturg. Bras., III, 1831, p. 1111 (*nec* Boie) (type, *Dendrocolaptes turdinus* Lichtenstein).
Dendrocincla Gray, List Gen. Birds, 1840, p. 18 (type, *Dendrocolaptes turdinus* Lichtenstein).
Dendromanes Sclater, Proc. Zool. Soc. London, 1859, p. 382 (type, *Dendrocincla anabatina* Sclater).
Dendrocichla Sharpe, Hand-List Gen. and Spec. Birds, III, 1901, p. 74 (nom. emend. pro *Dendrocincla*) (type, *Dendrocolaptes turdinus* Lichtenstein).

Chars. gen.—Similar to *Dendrocolaptes*, but nares linear and somewhat operculate, instead of round and open; bill somewhat more compressed. Species mostly smaller and of plainer colors.

Type.—Dendrocolaptes turdinus Lichtenstein.

Geographical Distribution. — Southern Mexico; Central America; Tobago; Trinidad; and all of South America down to Bolivia and southern Brazil.

KEY TO THE SPECIES AND SUBSPECIES OF DENDROCINCLA.

A.—Wing over 115 mm.
  a.—Wing less than 135 mm.
    b.—Exposed surface of wing-quills decidedly tinged with olivaceous . . . . *ridgwayi.*
    b′.—Exposed surface of wing-quills clear chestnut.

c.—Under parts lighter, more olivaceous; pileum and jugulum more distinctly striated . . *tyrannina.*

c′.—Under parts darker, more rufescent; pileum and jugulum less distinctly striated . . . *brunnea.*

a′.—Wing more than 135 mm. . . . . *macrorhyncha.*

B.—Wing not over 115 mm.

a.—Outer webs of secondaries tawny, in sharp contrast to the dark brown upper wing-coverts.

b.—Darker . . . . *anabatina.*

b′.—Paler . . . . *typhla.*

a′.—Outer webs of secondaries chestnut or olive-brown, not in sharp contrast to the wing-coverts.

b.—Pileum with distinct pale buffy or ochraceous shaft stripes.

c.—Tail about equal to wing . . . . . *longicauda.*

c′.—Tail decidedly shorter than wing.

d.—A conspicuous ochraceous postocular stripe; exposed surface of wing-quills bright chestnut *atrirostris.*

d′.—No conspicuous ochraceous postocular stripe; exposed surface of wing-quills olivascent.

e.—Much more rufescent; throat and sides of head darker; shafts of rectrices brown *turdina.*

e′.—Much more olivaceous; throat and sides of head paler; shafts of retrices mostly black . . . . *enalincia.*

b′.—Pileum without distinct pale buffy or ochraceous shaft stripes.

c.—Pileum rufous-chestnut, decidedly contrasted with back.

d.—Back and lower parts more olivaceous . *ruficeps.*

d′.—Back and lower parts more rufescent.

e.—Smaller and paler . . . . *homochroa.*

e′.—Larger and darker . . . . . *acedesta.*

c′.—Pileum concolor with back, or more olivaceous.

d.—Exposed surface of secondaries decidedly less rufescent than tail.

e.—Larger and much more rufescent . *ridgwayi.*

e′.—Smaller and much more olivaceous.

f.—Darker . . . . *olivacea.*

f′.—Lighter . . . . . . *lafresnayei.*

d′.—Exposed surface of secondaries not decidedly less rufescent than tail.

e.—Feathers of throat with conspicuous pale shaft streaks . . . . . . *fuliginosa.*

e′.—Feathers of throat without conspicuous pale shaft streaks.

.—Chin rufous or olive-rufous, concolor with breast.

g.—More rufescent throughout *meruloides*.
g′.—More olivaceous throughout *aphanta*.
.—Chin whitish, pale grayish, or buffy, much paler than breast.
g.—Lower surface darker, chin more whitish . . . . . *merula*.
g′.—Lower surface lighter, chin more buffy . . . . . *phæochroa*.

Dendrocincla macrorhyncha Salvadori and Festa.

Dendrocincla macrorhyncha Salvadori and Festa, Boll. Mus. Zool. ed Anat. Comp. Torino, XV, 1899, No. 362, p. 27.

Type Locality.—Pun, eastern Ecuador.

Geographical Distribution.—Eastern Ecuador.

This recently described species is the largest of the genus, and may readily be distinguished by this character alone. In other respects it appears to be close to *Dendrocincla tyrannina tyrannina*, of which it may prove through further research to be but a subspecies.

Dendrocincla tyrannina tyrannina (Lafresnaye).

Dendrocops tyranninus Lafresnaye, Rev. Zool., 1851, p. 328.

Type Locality.—Bogota, U. S. Colombia.

Geographical Distribution.—United States of Colombia.

This is one of the large forms (wing 118–130 mm.), with the throat conspicuously pale-streaked. It appears to be confined to Colombia, as birds from western Ecuador belong under the next. The two types in the Lafresnaye collection measure as follows:[3]

Sex.	*Wing.*	*Tail.*	*Exposed Culmen.*	*Tarsus.*	*Middle Toe.*
?	127	111	28	27.5	17
?	128	117	29	26	18

Dendrocincla tyrannina brunnea (Salvadori and Festa).

Dendrocincla brunnea Salvadori and Festa, Boll. Mus. Zool. ed Anat. Comp. Torino, XIII, 1898, No. 330, p. 2.

Type Locality.—Nanegal, Ecuador.

Geographical Distribution.—Western Ecuador.

Similar to *D. tyrannina tyrannina*, but darker, more rufescent below; the throat deeper ochraceous; the foreneck and pileum less distinctly,

[3] All measurements in this paper are in millimeters.

even to scarcely striated. Specimens examined, including one from the type locality, and compared with the type and other examples of *tyrannina*, show *brunnea* to be an easily recognizable race, which its describers hastened unnecessarily to suppress.[4] There seems to be no doubt, however, of its being only subspecifically distinct.

Dendrocincla longicauda Pelzeln.

Dendrocincla longicauda Pelzeln, Orn. Bras., 1868, p. 60.

Type Locality.—Borba, Amazonas, Brazil.

Geographical Distribution.—Lower Amazon to British Guiana.

Evidently a very good species, though not seen, differing conspicuously from *Dendrocincla tyrannina* in its reduced size, and particularly by reason of its comparatively much longer tail.

Dendrocincla atrirostris (d'Orbigny and Lafresnaye).

Dendrocolaptes atrirostris d'Orbigny and Lafresnaye, Mag. de Zool., 1838, Cl. ii, p. 12.

Dendrocincla minor Pelzeln, Orn. Braz., 1868, p. 60 (San Vicente, Matto Grosso, Brazil.)

Type Locality.—Guarayos, Bolivia.

Geographical Distribution. — Eastern Bolivia and southwestern Brazil.

Apparently a very distinct species, as pointed out by Mr. Ridgway,[5] though for some time confused with *Dendrocincla olivacea lafresnayei*, but really much more closely allied to *tyrannina* and *longicauda* than to either *lafresnayei* or *olivacea*. From *D. tyrannina tyrannina* it differs principally in much smaller size; rather paler upper and much paler lower parts; very conspicuous postocular stripe; and the more ashy chin and cheeks. The two types in the Lafresnaye collection (Nos. 2,308 and 2,309) are the only specimens of this species that have been examined. Both are apparently not quite adult, though fully grown; one of them is considerably more olivaceous than the other, but this seems undoubtedly to be only an individual difference. They measure as follows:

Sex.	*Wing.*	*Tail.*	*Exposed Culmen.*	*Tarsus.*	*Middle Toe.*
?	97	90	22[6]	24	14
?	100	85	26	24	15

[4] Cf. SALVADORI and FESTA, Boll. Mus. Zool. ed Anat. Comp. Torino, XV, 1899, No. 362, pp. 26–27.

[5] *Proc. U. S. Nat. Mus.*, X, 1888, p. 493.

[6] Tip of maxilla broken.

The bird described by Pelzeln as *Dendrocincla minor*[7] from San Vicente, Matto Grosso, Brazil, which has hitherto remained unidentified, is undoubtedly the same as that previously called *atrirostris* by Lafresnaye. This is evident from a comparison of the original description of *minor* with the types of *atrirostris*, which shows a perfect agreement both in dimensions and other characters. Furthermore, San Vicente, the type locality of *minor*, is in southwestern Brazil, not far from Guarayos, Bolivia, whence came the first specimens of *atrirostris*. This species appears to have a limited distribution, being known from only eastern Bolivia and Matto Grosso, Brazil, for all citations of *atrirostris* from Ecuador and Colombia belong elsewhere.

Dendrocincla anabatina anabatina Sclater.

Dendrocincla anabatina Sclater, Proc. Zool. Soc. Lond., 1859, p. 54, Pl. CL.

Type Locality.—Omoa, Honduras.

Geographical Distribution.—Southeastern Mexico (Vera Cruz) and Guatemala to Panama.

One of the most conspicuous forms of the genus. In a general way it resembles *Dendrocincla atrirostris*, but may at once be distinguished by its immaculate buffy or ochraceous buff chin, in sharp contrast to the color of the breast; by the color of the outer webs of the secondaries, which is tawny or bright tawny-rufous, unique in the genus and strikingly different from the olive-brown of the wing-coverts or the dark fuscous of the tips of the wing-quills; by a much shorter tail; as well as by other less obvious characters. Birds from Panama are not distinguishable either in size or color from those of Nicaragua or even the States of Tabasco and Vera Cruz, Mexico; but those examined from Guatemala are rather paler, though not sufficiently so to warrant either their separation or their reference to *typhla*.

Dendrocincla anabatina typhla, subsp. nov.

Chars. subsp.—Similar to *Dendrocincla anabatina anabatina*, but decidedly paler throughout, particularly on the lower surface.

Geographical Distribution.—States of Yucatan and Campeche, Mexico.

Description.—Type, male adult, No. 167,499, U. S. N. M., Biological Survey Collection; Puerto Morelos, Yucatan, Mexico, March 12, 1901; E. W. Nelson and E. A. Goldman.

Upper parts deep reddish raw-umber brown of decidedly olive shade, rather more rufescent on pileum, where the darker edges of the feathers produce an obscurely squamate effect, paler on rump, and passing into

[7] Orn. Bras., 1868, p. 60.

deep rufous on the upper tail-coverts; tail chestnut; wing-quills chestnut along the shafts, dull rufous exteriorly, shading basally into buff on their inner margins, and broadly tipped with fuscous; superior wing-coverts rufescent olive-brown like the back; sides of head and neck olive-brown mixed with ochraceous, the lores paler, and a noticeable postocular stripe dull ochraceous; chin buff, shading gradually into the raw-umber brown of the remainder of the lower surface; jugulum with broad spots and shaft streaks of dull ochraceous; longest lower tail-coverts rufous; lining of wing ochraceous. Wing, 99, tail, 75, exposed culmen, 21, tarsus, 25, middle toe, 16.5.

A local form of rather restricted distribution, specimens of which have been examined from only Yucatan and Campeche, Mexico, those from the latter locality being, however, indistinguishable from Yucatan examples. The type of *Dendrocincla anabatina anabatina* came from Omoa, Honduras, and although this is not far from the eastern part of Yucatan, yet a specimen seen from La Puerta, Honduras, near the type locality, is decidedly different from *typhla*, and indistinguishable from those taken in Guatemala, while one from Santa Ana, Honduras, is still darker. This, therefore, fixes *anabatina* as the dark form, leaving the Yucatan bird to be supplied with a name, as above.

Dendrocincla fuliginosa (Vieillot).

> *Dendrocopus fuliginosus* Vieillot, Nouv. Dict. d'Hist. Nat., XXVI, 1818, p. 117.
> *Dendrocolaptes fumigatus* Lichtenstein, Abhandl. Kön. Akad. Wiss. Berlin, 1820, p. 203 (Cayenne, French Guiana).
> *Dendrocincla rufo-olivacea* Ridgway, Proc. United States Nat. Mus., X, 1888, pp. 490, 493 (Diamantina, Lower Amazon, Brazil).

Type Locality.—Cayenne, French Guiana.

Geographical Distribution.—Lower Amazonia, south to Bahia, north to British Guiana.

Similar to *D. atrirostris*, from which, however, it may readily be distinguished by its much more olivaceous coloration both above and below, as well as its lack of pale shaft streaks on the feathers of the pileum. Its olivaceous colors separate it from also *D. anabatina anabatina*, and in other respects it differs from this form much as *D. atrirostris* does. Mr. Ridgway's *Dendrocincla rufo-olivacea*,[8] which unfortunately he was unable to compare with authentic examples of *fuliginosa*, seems to be identical with *D. fuliginosus*, as some time ago considered by Sclater;[9] so that unless more abundant material should prove it a recognizable geographical race occupying the Amazon valley

[8] *Proc. U. S. Nat. Mus.*, X, 1888, pp. 490, 493.
[9] *Cat. Birds Brit. Mus.*, XV, 1890, pp. 165–166.

from the vicinity of Santarem westward, it must be relegated to synonymy. The type and two other specimens from Diamantina, together with one from Pará, Brazil, which represent the material at Mr. Ridgway's disposal when describing *rufo-olivacea*, have all been examined in the present connection, and these alone, although the only specimens now available, indicate a considerable amount of individual variation in *D. fuliginosa*. The type of *rufo-olivacea* and one other from Diamantina are evidently much paler, more grayish below than ordinary *fuliginosa*, and are quite different from the Pará specimen, with which, however, the third Diamantina example very closely agrees.

Dendrocincla turdina (Lichtenstein).

Dendrocolaptes turdinus Lichtenstein, Abhandl. Kön. Akad. Wiss. Berlin, 1820, p. 204, Pl. II, fig. 1.

Type Locality.—Bahia, Brazil.

Geographical Distribution.—Eastern Brazil (Bahia).

Resembling *D. atrirostris*, but apparently larger (wing 100–107 mm.); throat and sides of head more rufescent; exposed surface of wing-quills duller, more olivaceous, not so much contrasted with the color of the back; chin paler; ochraceous postocular stripe lacking. From *D. fuliginosa* it differs in very much more rufescent upper and lower parts; smaller bill; and conspicuously pale-streaked pileum.

In the Lafresnaye collection there are two specimens of this species marked as the types; but this is evidently not quite correct, for they were probably nothing more than the specimens used for description by Lafresnaye in his monograph of the genus *Dendrocolaptes*,[10] as the species was originally named by Lichtenstein,[11] and the real type is, or should be, in the Berlin Museum, where many, if not most, of Lichtenstein's types were deposited. Dr. Sclater records a specimen of *Dendrocincla turdina* from Rio, Brazil,[12] which is possibly to be referred to *D. enalincia*, though without examination this is of course impossible to determine. The decided variation in size among specimens of this form examined by Dr. Sclater[13] is undoubtedly merely sexual.

Dendrocincla enalincia, sp. nov.

Chars. sp.—Resembling *Dendrocincla turdina*, but upper and lower parts, including the wings, much more olivaceous; sides of head paler and more grayish, not so sharply defined against the light color of the

[10] *Rev. Zool.*, 1851, p. 465.
[11] *Abhandl. Kön. Akad. Wiss. Berlin*, 1820, p. 204, Pl. II, fig. 1.
[12] *Cat. Birds Brit. Mus.*, XV, 1890, p. 167.
[13] *Loc. cit.*

throat; exposed surface of closed wings, and the broad fuscous tips of the wing-quills darker; upper surface of the shafts of the rectrices mostly deep brownish-black, instead of reddish-brown, the fourth and fifth pair of tail feathers with a large blackish terminal area on the inner webs; mandible (in skin) less yellowish; lining of wing paler.

Geographical Distribution.—Southeastern Brazil.

Description.—Type, adult, No. 177,707, U. S. N. M., Baurú, Rio Feio, Sao Paulo, Brazil, 1901; E. Garbe.

Upper surface rufescent olive-brown, the rump decidedly paler, the longest superior tail-coverts chestnut, the feathers of pileum with tawny ochraceous shaft streaks which are most conspicuous anteriorly; tail chestnut, the upper surface of the shafts brownish-black, the fifth pair of tail feathers, counting from the outside, having the inner webs broadly tipped with blackish, the same existing though to a less degree on the fourth pair; inner webs of wing-quills basally chestnut, paler on their margins; outer webs of primaries and broad terminal portions on both vanes of primaries and secondaries fuscous, these tips largest on the primaries, more narrow and confined largely to the inner webs on the secondaries, almost absent on the tertials; remaining portions of exterior webs of secondaries reddish olive-brown; upper wing-coverts olive-brown like the back, though rather darker and duller; lores dull grayish-brown, with buffy shaft streaks; cheeks and auriculars of similar color, but somewhat darker and more rufescent, with buffy shaft lines, these most conspicuous on the auriculars; sides of neck like the back, but lighter and somewhat more grayish; chin wood-brown; under tail-coverts light chestnut; remainder of lower parts raw-umber brown, more grayish on the breast, lighter on the throat, the feathers of which have buffy shafts; color of the throat passing gradually into that of the paler chin and the darker sides of the head; lining of wing ochraceous-buff. Wing, 106; tail, 87; exposed culmen, 22; tarsus, 24; middle toe, 17.

In a considerable series of typical *Dendrocincla turdina*, exhibiting the usual amount of individual variation in depth and shade of color to which members of this genus are commonly subject, there is no specimen that can be considered intermediate between *turdina* and *enalincia*. In view of this, as well as of the fact that in *Dendrocincla* perfectly distinct species are often very much alike, *enalincia*, on account of its decided characters, has here been given full specific rank, although it may in time prove to be but the southern subspecific representative of *D. turdina*.

Dendrocincla merula (Lichtenstein).

Dendrocolaptes merula Lichtenstein, Abhandl. Kön. Akad. Wiss. Berlin, 1820, p. 208.
Dendrocincla castanoptera Ridgway, Proc. United States Nat. Mus., X, 1888, pp. 490, 494 (Diamantina, Lower Amazon, Brazil).

Type Locality.—Cayenne, French Guiana.

Geographical Distribution.—Valley of the Amazon, to eastern Peru; north to British Guiana and the Orinoco river, Venezuela.

This very distinct species resembles to some extent *D. turdina*, but is darker above; very much darker, more olivaceous below; the throat is more whitish; the pileum without pale shaft streaks; the wings are clear chestnut instead of tinged with olivaceous, being thus more contrasted with the color of the back; and the lining of the wing is darker.

The specimen of this species in the Lafresnaye collection, marked "type" (No. 2,304), is probably only the specimen used by Lafresnaye for descriptive purposes, as Lichtenstein's original example is still in the Berlin Museum. Mr. Ridgway's *Dendrocincla castanoptera*[14] is regrettably a synonym of *D. merula*, for the type and one other specimen now in the U. S. National Museum do not differ in any essential respect from two examples in the collection of the American Museum of Natural History, taken by S. M. Klages at Suapure, Venezuela, nor from the Lafresnaye specimen above mentioned. The two examples of *castanoptera* are considerably smaller than the Lafresnaye specimen of *merula* with which Mr. Ridgway compared them, but this is certainly but a sexual distinction. This sexual difference may easily be appreciated by reference to the following comparative measurements:

Sex.	*Locality.*	*Wing.*	*Tail.*	*Exposed Culmen.*	*Tarsus.*	*Middle Toe.*
♀	Diamantina, Brazil	92	73	23	23	16
♂	Suapure, Venezuela	98	75	24	24	17
[♂]	[15]	101	81	23	25	17

Dendrocincla olivacea olivacea Lawrence.

Dendrocincla olivacea Lawrence, Ann. N. Y. Lyc. Nat. Hist., VII, 1862, p. 466.

Type Locality.—Panama R. R., Atlantic side of Isthmus of Panama.

Geographical Distribution.—Panama to southern Honduras.

Similar to *D. fuliginosa*, but darker above and below; the exposed surface of wing-quills much more olivaceous than the tail, instead of being of the same color. From *D. merula* it differs in having the

[14] *Proc. U. S. Nat. Mus.*, X, 1888, pp. 490, 494.
[15] Lafresnaye Collection, No. 2,304, the reputed "type" of *Dendrocincla merula.*

notæum more olivaceous; wing-quills much washed with olivaceous; upper wing-coverts olive-brown in place of mostly chestnut; sides of head more ashy; throat less whitish; lower surface paler, rather more rufescent, and a slight ochraceous postocular stripe. It is very distinct from *Dendrocincla atrirostris* by reason of its decidedly darker, more olivaceous upper parts; olivaceous tinged wing-quills; more deeply colored, rather more olivaceous ventral surface; almost obsolete ochraceous postocular stripe; and lack of pale shaft streaks on the pileum.

Mr. Ridgway[16] was the first after Lawrence to recognize this species as distinct from *D. atrirostris*, although it is much more closely allied to *D. fuliginosa* and *D. merula* than to *D. atrirostris*. The specimens from Guayaquil, Ecuador, placed under this form by Mr. Ridgway.[16] belong, however, under *D. olivacea lafresnayei*, since true *olivacea* must be restricted to Central America. Birds from Panama are intermediate between *olivacea* and *lafresnayei*, but nearer the former.

Dendrocincla olivacea lafresnayei (Ridgway).

Dendrocincla lafresnayei Ridgway, Proc. United States Nat. Mus., X, 1888, pp. 489, 492 (Upper Amazon?).
Dendrocincla olivacea lafresnayi Allen, Bull. Amer. Mus. Nat. Hist., XIII, 1900, p. 156.
Dendrocincla olivacea anguina Bangs, Proc. Biol. Soc. Wash., XII, 1898, p. 138 (Santa Marta, Colombia).

Type Locality.—Upper Amazon River.

Geographical Distribution.—Ecuador and Colombia.

Like *Dendrocincla olivacea olivacea* in size; but in color lighter, more rufescent above and below, the lining of wing paler. From *D. atrirostris* it may be distinguished principally by lack of pale shaft streaks on the pileum; obsolescent or absent ochraceous postocular stripe; more olivaceous upper surface; and conspicuously more olivaceous wings.

As may thus easily be seen, *lafresnayei* is far more nearly related to *D. olivacea*, *D. fuliginosa*, and even *D. meruloides* than to *D. atrirostris*, although nearly all writers excepting Mr. Ridgway have, at least in part, confused *lafresnayei* with *atrirostris;* and all records of *atrirostris* or *olivacea* from Ecuador or Colombia refer undoubtedly to the present form. Examples from Ecuador seem to agree with the type, and those from Colombia are not separable from either. A series of some eleven specimens from the Santa Marta region, Colombia, including the type and original suite of Mr. Bangs' *D. olivacea anguina*,[17] exhibits a

[16] *Proc. U. S. Nat. Mus.*, X, 1888, p. 492.
[17] *Proc. Biol. Soc. Wash.*, XII, 1898, p. 138.

considerable amount of individual variation in the depth and shade of color, both on the upper and lower surfaces, which differences comprise all that appear to distinguish *anguina* from *lafresnayei;* in consequence of which *anguina* must be considered a synonym, as has already been indicated by Dr. Allen.[18]

The specimen in the Lafresnaye collection labelled as one of the types of *D. atrirostris*, and referred by Mr. Ridgway to *D. olivacea*,[19] is undoubtedly an example of *lafresnayei.* Specimens of *olivacea* from Panama, clearly intermediate between *olivacea* and *lafresnayei*, point conclusively to the necessity of using a trinomial for the latter.

Dendrocincla olivacea phæochroa (Berlepsch and Hartert).

Dendrocinda (*sic*) *phæochroa* Berlepsch and Hartert, Novit. Zool., IX, 1902, p. 67.

Type Locality.—Munduapo, Orinoco river, Venezuela.

Geographical Distribution.—Venezuela.

Very close to *Dendrocincla olivacea lafresnayei*, and in size and general color both above and below not distinguishable; but it has the chin and cheeks less grayish, as well as the chestnut of the wing-quills less washed with olivaceous. It differs more decidedly from true *olivacea*, however, in its lighter, more rufescent coloration, more ochraceous chin, and less olivaceous wing-quills. From *D. merula*, although of the same size, it may be readily distinguished by its paler, rather more olivaceous upper parts; much lighter, more rufescent or ochraceous ventral surface, the throat buffy or ochraceous instead of whitish or grayish; lighter lores; and a slightly evident ochraceous postocular stripe.

Three specimens in the collection of the American Museum of Natural History, collected by S. M. Klages in Venezuela—two from Suapure, one from La Unión, Caura—agree perfectly with Messrs. Berlepsch and Hartert's original description of *phæochroa*. These have been carefully compared with the type of *lafresnayei* as well as with the considerable series of that form at present available, with the result of demonstrating that *phæochroa* is at best but a subspecies of *olivacea*, since the only characters discernible to separate it from *lafresnayei* are shown to be not entirely constant; yet it still is probably quite entitled to stand as a geographical race on its merits as above said.

Dendrocincla ridgwayi, sp. nov.

Chars. sp.—Similar to *Dendrocincla olivacea lafresnayei*, but larger;

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[18] *Bull. Amer. Mus. Nat. Hist.*, XIII, 1900, p. 156.
[19] *Proc. U. S. Nat. Mus.*, X, 1888, p. 492.

chin, lores, cheeks, and auriculars less ashy; entire upper and lower surfaces, including the wings, much more strongly rufescent.

Geographical Distribution.—Costa Rica.

Description.—Type, adult male, No. 64,819, U. S. N. M.; Talamanca, Costa Rica, 1873; J. C. Zeledon.

Upper surface deep reddish mummy-brown, rather paler and more grayish on the pileum, lighter and somewhat more rufous on the rump, the longest upper tail-coverts chestnut; tail chestnut; wings chestnut, the exposed surface rather duller and slightly tinged with olivaceous, the tips of outermost primaries broadly fuscous, the inner margins of the quills basally ochraceous, all the superior wing-coverts mummy-brown, somewhat less rufescent than the back; a short, narrow, poorly indicated ochaceous postocular stripe; lores dull brownish-gray; sides of head dull mummy-brown, the auriculars with paler shaft streaks; chin dull grayish-brown, lighter than the remainder of the lower surface which, excepting the chestnut under tail-coverts, is dull, dark, rufescent tawny-olive brown; lining of wing tawny-ochraceous. Wing, 115; tail, 96; exposed culmen, 26;[20] tarsus, 25.5; middle toe, 18.

This new species appears to be undoubtedly most closely allied to *Dendrocincla olivacea lafresnayei.* From *D. olivacea olivacea,* whose territory it inhabits, it differs in much the same respects as from *lafresnayei,* but more strongly. The type and sole specimen has been for some years in the U. S. National Museum collection, and has been successively identified as *D. merula, D. olivacea* and *D. atrirostris!* It seems to be undoubtedly a distinct and hitherto undescribed species, for its peculiarities are not such as appear readily or satisfactorily explainable on grounds of individual variation. It bears its present name in honor of Mr. Robert Ridgway, as a slight token of the author's appreciative esteem.

Dendrocincla meruloides meruloides (Lafresnaye).

Dendrocops meruloides Lafresnaye, Rev. Zool., 1851, p. 467.
Dendrocincla merulina Cabanis and Heine, Mus. Hein., II, 1859, p. 34 (nom. emend. pro *Dendrocops meruloides* Lafresnaye).

Type Locality.—"Côte ferme" (= British Guiana).

Geographical Distribution.—British Guiana.

Similar to *D. ridgwayi,* but smaller and more brightly colored; cheeks and chin more rufescent; superior wing-coverts and wing-quills less inclined to olivaceous.

The type of this species, which is now in the Museum of the Boston Society of Natural History, along with the rest of the Lafresnaye col-

[20] Tip of maxilla broken.

lection, has been compared with specimens from British Guiana and found to be identical, from which the assumption is apparently safe that it hailed originally from that region, particularly as the birds from Venezuela prove to be different. It is evidently an adult female, and measures as follows: Wing, 95; tail, 73; exposed culmen, 20.5; tarsus, 24.5; middle toe, 14.5. All the specimens of true *meruloides* examined are females, and agree in size with those of the same sex of *D. meruloides aphanta*. The measurements of *meruloides* given by Mr. Ridgway[21] are also based on female examples, and are therefore too small. The name *Dendrocincla merulina* of Cabanis and Heine[22] is a mere puristic emendation of *D. meruloides*, and must therefore be considered identical in application.

Dendrocincla meruloides aphanta, subsp. nov.

Chars. subsp.—Like *Dendrocincla meruloides meruloides*, but chin and sides of head usually more grayish; entire upper and lower surfaces, particularly the former, much more olivaceous.

Geographical Distribution.—Tobago, Trinidad, and Venezuela.

Description.—Type, adult female, No. 74,883, U. S. N. M.; Tobago, West Indies, April, 1878; F. A. Ober.

Upper parts deep rufescent tawny-olive, darker on the pileum, where the feathers have dusky margins, paler and brighter on the rump, the longest upper tail-coverts chestnut; tail chestnut; wings chestnut, the inner margins of the quills basally ochraceous, the secondaries with terminal shaft streaks of dusky, the outer webs of the outermost primaries and broad tips of all fuscous, the superior wing-coverts like the back, save for those of the greater series, which are rather more reddish; lores dull brownish-gray; auriculars the same but darker; remainder of sides of head and neck brown like the back; under tail-coverts chestnut, but lighter than the tail; all the remaining lower surface rufescent tawny-olive, like the upper parts, but lighter, the chin and upper throat decidedly grayish; lining of wing tawny-ochraceous. Wing, 92; tail, 73; exposed culmen, 22.5; tarsus, 23; middle toe, 15.

[21] *Proc. U. S. Nat. Mus.*, X, 1888, p. 490.
[22] *Mus. Hein.*, II, 1859, p. 34.

The measurements of five adult males are as below:

Locality.	*Wing.*	*Tail.*	*Exposed Culmen.*	*Tarsus.*	*Middle Toe.*
Quebrada Secca, Venezuela	99	82	22	25	16.5
" "	105.5	87	22.5	24.5	15
Caparo, Trinidad	104	84.5	22	24.5	15.5
Princestown, Trinidad	105.5	85	24	24.5	16.5
" "	103	78	24	25	16
Average	103.4	83.3	22.9	24.7	15.9

This new race differs from *D. olivacea lafresnayei* in its decidedly more rufescent coloration both above and below; less ashy chin and cheeks, the former more uniform with the breast; and less olivaceous upper surface of the wings. It is much more rufescent throughout than *D. olivacea phæochroa*, with the chin not conspicuously different from the rest of the lower parts.

Specimens from Venezuela are apparently like the type; but a considerable series from Trinidad exhibits some individual color variations, while as a whole it is intermediate between *aphanta* and *meruloides*, though decidedly nearer the former.

Dendrocincla ruficeps (Sclater and Salvin).

Dendrocincla ruficeps Sclater and Salvin, Proc. Zool. Soc. Lond., 1868, p. 54.

Type Locality.—Panama City, Panama.

Geographical Distribution.—Panama.

Resembles *D. meruloides meruloides*, but is much darker throughout, particularly on the abdomen; the chin, however, is lighter, and decidedly contrasted with the breast; sides of head more rufescent; the pileum still more so, and conspicuously different from the distinctly olivaceous back.

A very satisfactory series of eleven specimens of *D. ruficeps*, while it evidences considerable individual difference in color, yet appears to establish beyond reasonable doubt the validity of the species; for none of these examples are so reddish on the back, rump, and lower surface as either *homochroa* or *acedesta*. When Mr. Ridgway wrote[23] he had no specimens of real *ruficeps*, and all the birds referred by him to this form, and upon which he predicated its subspecific relationship with *D. homochroa*, prove to belong without doubt to *Dendrocincla homochroa acedesta*. The localities from which specimens have been examined

[23] *Proc. U. S. Nat. Mus.*, X, 1888, p. 491.

by the present writer are Boquete and El Banco, Chiriqui, and the Panama Railroad, Panama.

Five adult males show the following dimensions:

Locality.	*Wing.*	*Tail.*	*Exposed Culmen.*	*Tarsus.*	*Middle Toe.*
Boquete, Chiriqui, Panama	101	74	24	25.5	16.5
" " "	102	76.5	24	26	17.5
" " "	100	74.5	23	25.5	17
Panama Railroad, Panama	106	78	25.5	27	18
" "	102	83	25	26	18
Average	102.2	77.2	24.3	26	17.4

Dendrocincla homochroa homochroa (Sclater).

Dendromanes homochrous Sclater, Proc. Zool. Soc. London, 1859, p. 382.

Type Locality.—Teotalcingo, Oaxaca, Mexico.

Geographical Distribution.—Southern Mexico (Oaxaca, Campeche, and Yucatan) and Guatemala.

In size like *D. ruficeps*, and otherwise similar, but of a lighter, brighter rufous throughout; the back, rump, and ventral surface less olivaceous; the pileum less trenchantly defined from the back. It resembles also *D. meruloides meruloides*, but in color is much brighter rufous; the pileum is rufous-chestnut, instead of olive-rufous, and is more contrasted with the back; the auriculars are rufous in place of olive-brown; the throat and sides of the head much more rufescent.

This is the brightest rufous of all the species of the genus. Birds from Yucatan and Campeche, Mexico, seem to be rather paler than those from Guatemala, but the difference is barely appreciable.

Dendrocincla homochroa acedesta, subsp. nov.

Chars. subsp.—Similar to *Dendrocincla homochroa homochroa*, but larger; decidedly darker and rather more olivaceous throughout.

Geographical Distribution.—Panama, Costa Rica and Nicaragua.

Description.—Type, adult male, No. 62,043, U. S. N. M.; Chiriqui, Panama; Enrique Arcé.

Upper surface burnt-umber brown with a slight olive shade, the pileum more rufescent, the rump also more reddish, and paler, the longest upper tail-coverts chestnut; tail and wings, including the upper wing-coverts, chestnut, the primaries tipped with fuscous; sides of neck and head dull reddish-brown, the lores dull light brownish-gray; chin dull tawny; under tail-coverts chestnut; rest of ventral surface dull reddish-brown like the back, but somewhat paler; lining of wing light chestnut.

Five adult males exhibit the following measurements:

Locality.	*Wing.*	*Tail.*	*Exposed Culmen.*	*Tarsus.*	*Middle Toe.*
........[24]	105	77	23	27	17
Chiriqui, Veragua, Panama........	105	78	23	26.5	17
" " " [25]........	107	84	24	26	17
Navarro, Costa Rica........	107	82.5	26	26.5	16
Sacuyá, Nicaragua........	106	81.5	25	25.5	17
Average........	106	80.6	24.2	26.3	16.8

This form of *Dendrocincla*, though occupying in part the same region as *D. ruficeps*, is apparently distinct, differing in its larger size; much more reddish rump, back, and lower parts; and more uniform upper surface, the pileum being in color less definitely distinct from the interscapular region.

[24] Lafresnaye Collection, No. 2,310.
[25] Type.

POST-GLACIAL NEARCTIC CENTRES OF DISPERSAL FOR REPTILES.

BY ARTHUR ERWIN BROWN.

If lasting values are to be reached in the study of geographical distribution, its conclusions must accord with all else that is known of the dynamics of evolution. Or, stated with more exact reference to its especial problems, the areas marked off by it must correspond to the distributional relations of genetically connected species and, at the least, must not be at fault with possible lines of dispersal from centres of development by which they may have come to occupy their present range. What is proposed here is an attempt to determine such centres for *Reptilia* in North America.

The scarcity of Tertiary remains of reptiles belonging to existing groups confines the student of geographical distribution in the main to post-glacial conditions, with little more knowledge of those preceding than the practical certainty that genera now widely ranging are of great antiquity and were likewise wide ranging in earlier periods, and that a former north Atlantic land connection between Europe and America must have coincided with a climate of sufficient warmth to serve for the passage of reptiles belonging to genera now common to both.

In other ways the problem is simplified by the absence in later periods of a circumpolar reptilian fauna, a consequence of which is that the chief zoological bond of connection between the eastern and western continents is wanting, and for reptiles a "Holarctic" region or an "Arctogæan" realm can not be said to exist, the families and genera common to more southern portions of both being insufficient to link them. For this reason Mr. Sclater's term "Nearctic" is used here. It should be said, however, that if for purposes of convenience or uniformity it be desired to retain these later and broader generalizations, no harm is likely to ensue if it be remembered that they do not express the exact facts of present reptilian distribution, whatever they may have been during the Tertiary.

A further simplification results in northern regions from this same absence of boreal reptiles, for it eliminates the meeting ground of a northern with a southern migration, which constitutes the "Transition" zone of various authors in other groups. If a transition zone existed in the Nearctic for reptiles it would follow meridians of longitude west of the Mississippi river, instead of extending from east to west.

I have stated elsewhere[1] that the present distribution of Nearctic reptiles points to the two post-glacial centres indicated by Prof. C. C. Adams,[2] one in the southeastern Austroriparian, the other southwestern, in the Sonoran. Some space must now be given to the evidence.

In the same paper it was shown that in the southern Nearctic the eastern and western reptilian faunas are so distinct that the community between them is limited to a few species belonging to widely ranging genera, and that the zone of change between them lies approximately between the 96° and 98° meridians of longitude in Texas. In a general way this zone may be carried north along those meridians, to mark the separation between the whole Atlantic and the whole Sonoran faunas, widening, however, toward the north in following up the rivers of the Mississippi drainage.

The division is in some measure obscured by the presence in the lowlands of the Mississippi and its tributaries of a few species, chiefly serpents, originally derived from both faunas and occupying the contiguous portions of their respective areas.

The proposition that original post-glacial centres must have lain far to the south, is more logically necessary in the case of reptiles than with other vertebrates, and follows from their dependence as a class upon warmth. If further evidence were needed, it would be found in their great numerical superiority, both in species and individuals, in the south. The whole extent of North America reaching from the border of the great plains eastward to the Atlantic coast, and from the Gulf of Mexico to the northern limit of reptiles, which, following Agassiz, will here be known as the Atlantic subregion, to avoid confusion with its Eastern district, contains 113 species and recognizable subspecies in all orders of reptiles. Of these 56 are confined to some portion of the Austroriparian district, and 15 are exclusively Eastern, with 42 common to both, practically all of which are southern intrusions to varying distances into the Eastern. In the western Nearctic the distribution of species is vastly more complex as to its details, on account of the great variety of surrounding conditions in contiguous areas produced by rapid changes in altitude, and is not yet fully known, but the excess of southern species is even greater, for assuming that Dr. Merriam's division of the country from the western border of the

[1] *Proc. Acad. Nat. Sci. of Phila.*, 1903, p. 551.
[2] *Biological Bulletin*, Vol. III, p. 121 (1902).

Atlantic subregion to the Pacific coast into a Lower and an Upper Sonoran accords best with present knowledge, the Lower Sonoran seems to have about 74 peculiar species, and the Upper Sonoran plus his Transition has but about 13, with 35 common to both, of which 19 may be regarded as Lower Sonoran and only 6 as Upper. The remainder belong to the Atlantic fauna. It should be explained that these estimates are based upon a somewhat conservative view as to species, but if the method of minute analysis characteristic of the present time be followed, the predominance of Lower Sonoran forms will be even greater.

Both from the logical necessity of the case and from the application of one of the main criteria in common use, it seems clear that the areas which at the retreat of the ice contained the elements from which our present reptilian fauna has developed, must be sought for in the south.

The briefest examination of the character and the abounding richness of the reptiles inhabiting the dry plateau extending from Texas to Arizona and south into Mexico, as well as the physical geography of the whole Sonoran subregion, are enough to show that the dispersal centre of that fauna was here, in Cope's Chihuahuan.

The Austroriparian is less clear without close examination of evidence. Two localities in this subregion excel all others in variety of species, one in the extreme southeast toward Georgia and Florida, corresponding to the fauna termed by Cope *Ocmulgian;* the other, or *Louisianan*, on the lower Mississippi. Fifty-one species are common to both, and in addition the Ocmulgian, including Cope's *Floridan*, presents 21 not extending into the Louisianan, which in turn has 14, one half of them, however, only entering its western border from the Sonoran. Of the two the Ocmulgian shows a decidedly greater diversity in species.

A study in some detail of the genera points in the same direction. Little argument is required to demonstrate the proposition that genera now common to the Nearctic and the western Palæarctic must have had that range established at a time when a Tertiary north Atlantic land connection coincided with a warm climate in the north, for the absence from all beyond the northern border of the Neotropical of such vigorous Nearctic genera as *Coluber, Zamenis, Tropidonotus, Eutænia, Ophibolus* and others, which are identical with or nearly related to Holarctic genera, renders it impossible that such community in northern regions could have come about by means of the Antarctic continent whose former existence is now urged by many palæontologists, however well this would serve to explain such anomalies as the presence of pleurodire turtles in South America, and of two genera of Neotropical Boidæ in Madagascar. It has been shown by Heer, in his researches upon Arctic fossil plants, that in the process of secular cooling the mean temperature of northern Greenland, as late as the early Miocene, was not far removed from that of central Virginia at the present time—quite warm enough for the needs of such hardy stocks as the genera above named—and the differentiation of reptiles of modern types had progressed so far by the close of the Mesozoic, that not much risk is incurred in believing that many existing genera were in existence long before the end of the Eocene. Assuming a north Atlantic highroad to have been the means of communication, the longest Nearctic establishment of these common forms is likely to have been in the older geological regions far in the east. It is further true that with many of them traces of their primitive representatives appear to be found in existing species of the eastern part of the Austroriparian.

Omitting mere Neotropical intrusions into the southern border of the Nearctic, such as *Alligator*, *Crocodilus*, *Anolis*, *Sphærodactylus*, *Helicops*, *Spilotes*, *Rhadinea*, *Drymobius*, *Tantilla*, *Erythrolamprus* and *Elaps*, as well as *Trionyx*, *Chelydra*, *Emys* and *Testudo*, each of which had a wide Tertiary extension in northern regions, but whose recent distribution throws no further light on the present question, most of the remaining genera may be referred for their origin to the Austroriparian or Lower Sonoran faunas.

Austroriparian:

Macroclemmys	*Seminatrix*	*Ophibolus*
Aromochelys	*Storeria*	*Stilosoma*
Cinosternum	*Clonophis*	*Carphophis*
Chrysemys	*Tropidoclonium*	*Farancia*
Malaclemmys	*Haldea*	*Abastor*
Terrapene	*Amphiardis*	*Virginia*
Ophisaurus	*Coluber*	*Cemophora*
Liolepisma	*Zamenis*	*Heterodon*
Rhineura	*Cyclophis*	*Ancistrodon*
Eutænia	*Liopeltis*	
Tropidonotus	*Diadophis*	

Lower Sonoran:

Ctenosaura	*Gerrhonotus*	*Phyllorhynchus*
Dipsosaurus	*Xantusia*	*Contia*
Crotaphytus	*Verticaria*	*Ficimia*
Sauromalus	*Cnemidophorus*	*Chilomeniscus*
Callisaurus	*Eumeces*	*Rhinochilus*
Uma	*Anniella*	*Hypsiglena*
Holbrookia	*Glauconia*	*Trimorphodon*
Uta	*Lichanura*	*Sibon*
Sceloporus	*Charina*	*Sistrurus*
Phrynosoma	*Arizona*	*Crotolus*
Eublepharis	*Pityophis*	
Heloderma	*Salvadora*	

In searching for the localities which may be conceived to have been those of the Nearctic origin of genera, it is to be observed that little is to be learned from Chelonia, for the aquatic habits of most of the order renders them relatively untrustworthy as guides in terrestrial distribution and, furthermore, we are as yet ignorant of the characters in most genera which should be regarded as primitive. Nevertheless, it is obvious that conditions best favoring the development of fresh-water turtles must have always been far more completely presented in the well watered Atlantic subregion than in the arid Sonoran.

In Cinosternidæ the extensive range of the Atlantic species, *Cinosternum pennsylvanicum* and *Aromochelys odoratus*, favors the view that they have been longest established, and it would appear further that the Louisianan and Sonoran species do not exhibit any great amount of differentiation from these forms.

Of the thirteen species of *Chrysemys* found in the whole Nearctic, ten are restricted to the Atlantic subregion. Eight of these are Austroriparian, three of them entering the Eastern. The near relationship between *C. concinna*, *C. mobilensis*, *C. scabra* and *C. rubriventris*, all especially numerous on the southeastern coast, points to their long presence there.

In the Nearctic, *Emys* and *Clemmys* are confined to the Eastern, with the exception of one species of *Clemmys* on the Pacific coast, but each has a representative in the Palæarctic, and *Emys* is known from the Eocene of both continents. No reason can be assigned for their present limited Nearctic range, which must be looked upon as one of the anomalies of survival of ancient forms.

The box tortoises of the genus *Terrapene* range everywhere east of the Rocky mountains, but if the view of Dr. Baur be accepted, that the gradual disappearance of the quadrato-jugal is a progressive character, *T. major* of the southern Austroriparian and *T. bauri* of Florida are the most primitive.

A distinctly negative character of the whole Atlantic subregion is its poverty in lizards, their almost complete absence being, in fact, the correlative of an abundance of water turtles. Its lizards are Sonoran, with the exception of *Ophisaurus*, restricted to the Austroriparian, whose close relationship to the Palæarctic *Pseudopus* justifies placing its original centre along the Atlantic coast, and *Rhineura*, now only found in Florida, but perhaps known from the Oligocene of Dakota. *Liolepisma laterale*, which occupies only the Austroriparian and the southeastern corner of the Eastern as far as New Jersey, belongs to a genus of wide extension in the Australian, Ethiopian and Oriental regions, but having no other representative in the Holarctic except one in China, whose specific characters are identical with it.[3] This instance conforms to the unknown law which has preserved on the eastern shores of Asia and North America so many allied remnants of ancient groups among both animals and plants.

More exact evidence is afforded by Ophidia, for with two exceptions it is believed that the genera now widely spread in the Nearctic can be shown to have probably originated in the eastern centre. Of those more locally restricted, which must in most cases be descendants of these earlier forms, a difficulty must be admitted in the comparative absence of structural clues to relationship, especially in Colubridæ. The relative position assigned to genera by Mr. Boulenger, however, merits a high degree of confidence and has been much relied upon. It may be added that there are quite enough cases where high probability can be assured, to warrant propositions with which the uncertain ones at least fail to conflict.

The genus *Tropidonotus*, cosmopolitan as to the greater life areas except that it enters only the northern border of the Neotropical, in the Nearctic is absent from the Pacific coast, and in fact enters the Sonoran only by its river bottoms, from which the assumption is justified that it originally entered North America from western Europe. The common species of the whole Atlantic subregion, *Tropidonotus sipedon*, seems quite surely to have been near the parent form, though it is less clear which of the two subspecies, *T. s. sipedon* or *T. s. fasciatus*, should be regarded. The young of both, as a rule,

[3] Boulenger, *Cat. of Lizards*, Vol. III, p. 264.

have the color pattern of the adults, but more or less cross-banding with narrow interspaces frequently replaces the spots on the forepart of the body in young and some adult *T. s. sipedon,* resembling those which form the normal pattern on the whole length in eastern examples of *T. s. fasciatus*—a fact which perhaps signifies the partial retention of an ancestral pattern, now completely lost in the third subspecies, *T. s. transversus* of the Louisianan fauna. It is probable that *T. s. fasciatus* of the southeast represents the earliest form. Within the bounds of the Ocmulgian, *T. cyclopeum* and *T. taxispilotus* have developed from *T. sipedon,* while farther west, in the Mississippi valley, the way to *T. rhombifer* was through *T. s. transversus.* The whole of the ill-defined series grouped about *T. compressicaudus* and *T. ustus* is Floridan and shows the wealth of differentiation, still unstable as to fixity of character, which has resulted in the Ocmulgian under conditions highly favorable to the genus. There seems no clue to the direct origin of the group of species represented by *T. leberis* and its allies, with seventeen or nineteen rows of scales and longitudinal stripes, but it is worth noting that a similar distribution of color occurs in a number of eastern Palæarctic and Oriental *Tropidonotus.*

Separated structurally from the foregoing genus only by its entire anal plate is *Eutænia,* which covers the whole Nearctic to the northern limit of snakes, and perhaps equals in number of individuals all other species combined. From its cosmopolitan extension *Tropidonotus* must be the parent. It is suggestive that the eastern form of the common garter snake, known as *E. sirtalis ordinatus,* with dark spots on a greenish ground and no stripes, much resembles some color phases of *Tropidonotus natrix* of Europe, and has like it nineteen rows of scales and seven upper labials. The yellow collar of *T. natrix* is not known in any race of *E. sirtalis,* but it possibly reappears in the pale postoral crescents of some Sonoran species, as *E. marciana* and *E. hammondi.*

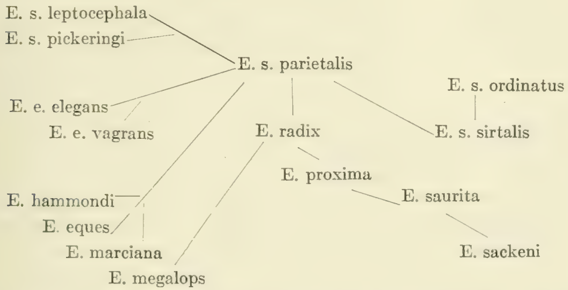
E. s. ordinatus grades into *E. s. sirtalis,* whose western representative, *E. s. parietalis,* on the Pacific coast runs into *E. elegans* through such examples as those which Cope regarded as *E. infernalis,*[4] and in the southwestern Sonoran into *E. marciana, E. hammondi* and *E. eques.*

The species of the great plains, *E. radix,* has commonly twenty-one scale rows and seven upper labials, but often presents the scutellation of *E. sirtalis* and probably is derived from it, an important change being that the lateral stripe has moved up one row of scales. And it

[4] A. E. Brown, *Proc. Acad. Nat. Sci. of Phila.,* 1903, p. 288, etc.

is of interest here to note that certain garter snakes from Indiana, about the eastern limit of *E. radix,* called by Cope *E. butleri,* show irregularities in the position of the lateral stripe perhaps indicating transition. *E. radix* is a connecting link on the one hand with *E. proxima* of the Mississippi valley, which in the east has given off *E. saurita* and *E. sackeni,* and on the other, in the southwest with *E. megalops* and doubtles other Mexican forms.

If this hypothetical family-tree of *Eutænia* is correct, an interesting lesson in lines of dispersal of Austroriparian genera may be gained from their diagrammatic representation:



Of the remaining so-called Natricinæ, all of which are small and more or less degenerate representatives of *Tropidonotus* and *Eutænia* or of the stock from which they came, the most widely spread genera, *Storeria, Haldea* and *Virginia* are chiefly Atlantic, *Seminatrix* is wholly Oemulgian, *Tropidoonium,* of limited range and probably of relatively late origin, belongs to the Mississippi valley, and the very few specimens of *Amphiardis* known are from Dallas, Texas, on the western borderland of the Austroriparian.

Among other widely ranging genera, *Zamenis* is an ancient form whose present distribution includes also the Palæarctic and Oriental regions. The earliest Nearctic style seems likely to be represented by *Z. flagellum flagellum,* which belongs to the Oemulgian centre. The young of this species show narrow cross-bands, and occasionally much wider ones, as well as a tendency to form narrow stripes on the centres of some of the lateral scale rows, all of these being present as diagnostic characters in various combination in adults of most other American species. The inequality of color between the anterior and posterior portions of the body, characteristic of all, is most pronounced in *Z. f. flagellum.*

Coluber has about the same range as *Zamenis*, but in the Nearctic does not pass beyond the Rocky mountains. The distribution of color most common in the genus consists of three rows of spots, but in many species, especially in America, there is a disposition for these to run together by their corners and form longitudinal stripes. This is indicated more especially in some western and Central American species, as *C. subocularis* and *C. lineaticollis*, and culminates in *C. quadrivittatus*, which is spotted when young and wholly striped when mature. *C. obsoletus confinis* is in most respects generalized as to pattern, and either this species, or less probably *C. guttatus*, both chiefly Ocmulgian, are likely to be near the primitive form.

In the Lower Sonoran *Coluber* has given off *Arizona* and *Pityophis*, the last having sent one species, *P. melanoleucus*, the most specialized of the genus in the shape of its rostral, and in disappearance of the head bands in adults, back into the Atlantic as far north as New Jersey.

The genus *Ophibolus*, generally distributed in the Nearctic, except in the northwest, is nearly related to *Coronella* of the western Palæarctic and Ethiopian. It does not seem possible to determine whether the parent is represented by some color form of *O. getulus* or *O. doliatus*, but the coronelline affinity indicates with sufficient certainty that *Ophibolus* must have come from a source whose Palæarctic connections were by way of the eastern or north Atlantic route. It may be significant that while no subspecific distinction is warranted, most Floridan examples of *O. getulus getulus*, which is the most vigorous and extended species, seem to be rather generalized in the character of the dorsal spots and bands, as between northern specimens of the same form and the Louisianan *O. g. sayi*. The further fact has a bearing, that the specific characters of forms from the western part of the Nearctic seem to show less stability than the eastern ones, especially so in *O. g. boylii* and *O. g. californiæ*, thus pointing to a more recent development of these subspecies.

Liopeltis and *Cyclophis* are examples of the remarkable discontinuity already noted in the range of certain other genera common to eastern Asia and eastern North America. In the last *Liopeltis* covers the whole Atlantic subregion, while *Cyclophis* is mainly Austroriparian. Both extend to no great distance into the Sonoran.

The case for *Heterodon* is not free from doubt. The form of its rostral seems to suggest that it belongs among the types which have been so freely developed in the dry Lower Sonoran, and its possible relationship to the South American *Lystrophis* would accord with this assignment, but on the other hand, the largest and most widely spread species, *H. platyrhinos,* is found upon suitable soils over most of the Atlantic subregion and is especially common on the coast from New Jersey to Florida; *H. simus* is Austroriparian and chiefly Ocmulgian; while the smallest and most feeble species only, *H. nasicus,* is Sonoran and does not extend west of the Rocky mountains. There is good reason, therefore, to refer *Heterodon* to the Austroriparian, in which case its Neotropical affinity renders it probable that Florida was the region of its origin.

Among Crotalidæ, *Ancistrodon* only can be referred to the Atlantic subregion, *A. contortrix* being spread over its whole extent and *A. piscivorus* confined to the Austroriparian, where numerically it is in excess in the extreme southeast. Both species enter the borders of the Sonoran at suitable localities. The assignment of the genus to the Atlantic coast is further justified by its occurrence in eastern Asia.

Of these more or less cosmopolitan, or Holarctic genera, which must be supposed to have occupied the Nearctic during the Tertiary, and even of related groups restricted to the Nearctic but of sufficient extension there to warrant belief in their relatively considerable age, it is seen that there is reason to believe that all but *Sceloporus, Cnemidophorus, Eumeces, Sistrurus* and *Crotalus* belonged to the Atlantic post-glacial centre, which from the present numerical proportion of species and individuals, as well as the geological age of the region, seems to have been the Ocmulgian.

From this centre a route to the north has been freely open along the low coast plain east of the Alleghenies, to distances into the Eastern district determined for each migrant by limiting conditions, of which, in this case, temperature must be regarded as the most important. A few powerful species, such as *Coluber obsoletus obsoletus, Ophibolus doliatus triangulus* and to a less extent *Pityophis melanoleucus,* have chosen this route to the region north of the Ohio river, turning westward about the Potomac or Susquehanna.

The other main highway was westward along the Gulf coast to the Mississippi river and up that valley, where conditions are highly favorable to reptilian life, spreading eastward at the north to southern Indiana and Ohio. Few species traveled this route unaltered, for with most of them the changed conditions encountered have resulted in the establishing of variations, at least of color, with which a sound taxonomy must reckon. An excellent example of this is *Ophibolus getulus getulus,* which ranges from Florida north to the pine region of New Jersey with no change which has yet been held to warrant a new trinominal, but on its western course, as it enters the Louisianan it becomes *O. g. sayi*, and still further west, in the Texan, is even now perhaps differentiating into a color form known as *O. g. splendidus*. The Louisianan subspecies has moved up the Mississippi valley as far as southern Illinois, and even in that region an occasional specimen shows the pattern of *splendidus*. The lower Mississippi valley may indeed, with some reason, be regarded as a secondary and more modern centre of development in *Chelonia* and *Ophidia*.

Quite different from the condition of temperature which has limited the northward extension of Ocmulgian forms, that which has checked or transformed them on the western route is the lack of moisture encountered beyond the Mississippi, about the beginning of the great plains.

Another northwestward route from the Ocmulgian may have been directly through or around the lower end of the Alleghenies by way of ancient river valleys, but it is not probable that this was traveled as freely as those leading by the coast plain in either direction.

It may be repeated that the present study deals only with post-glacial conditions. If, as has been assumed, the interchange of reptiles between the Nearctic and the Palæarctic was by means of a north Atlantic connection, their Tertiary centres of development were doubtless of greater area and much farther to the north.

May 3.

Mr. Arthur Erwin Brown, Vice-President, in the Chair.

Thirty-nine persons present.

A Spencer Objective.—Mr. F. J. Keeley described a microscope objective of one-fourth inch focus, made in 1860 by Charles A. Spencer. It was recently necessary to take apart the back system for re-balsaming, when it was found to consist of five lenses, three of which were convex and two concave. One of these proved, on examination with polarized light, to be fluorite, which mineral, while isotropic, exhibits characteristic optical anomalies between crossed prisms that permit of its identification, at least in contradistinction from glass or other material used for lenses. The fluorite lens is perfectly preserved, as might be expected from the stable character of the mineral. When objectives of more recent manufacture containing fluorite have deteriorated, the fluorite has been blamed for faults which should undoubtedly have been attributed to unreliable glass used in connection with it.

This objective is historically interesting as illustrating the complex nature of the corrections adopted by Spencer at so early a date, as well as confirming the previous reports that he had appreciated the possibilities connected with the use of fluorite in securing superior color corrections and employed it for the purpose twenty years before it came into use abroad.

The objective has an aperture of 142 to 152 degrees, according to position of adjustment, which acts by rectilinear movement of back systems, and is unusually well corrected for color. It resolves *Pleurosigma angulatum* sharply into dots with central light from mirror, and with oblique illumination resolves markings 76,000 to the inch. In some respects its performance was possibly slightly sacrificed in eliminating color, for with a large central illuminating cone, its definition is somewhat inferior to that of objectives of similar power made by Tolles at slightly earlier and later dates, which show considerably more color. The latter, although both over forty years old, compare favorably, optically and mechanically, with best achromatics made to-day, and it seems not unlikely that Spencer abandoned the use of fluorite because he realized that sharp definition was more important than the elimination of last trace of color, rather than from any fear of its lack of permanency.

The Publication Committee reported that a paper had been presented for publication under the title "Observation on Hyrax," by Henry C. Chapman, M.D. (April 29, 1904).

The following was ordered to be printed:

OBSERVATIONS ON HYRAX.

BY HENRY C. CHAPMAN, M.D.

The structure of *Hyrax* has been so thoroughly investigated by Pallas,[1] Owen,[2] Brandt,[3] Mirie and Mivart,[4] and George,[5] as well as by other anatomists, that little or nothing remains now to be said by any one to whom the rare opportunity is afforded of dissecting this interesting animal. In exhibiting to the Academy the muscular system and viscera of a fine male specimen of *Hyrax* (*Procavia Brucei*), most kindly put at the disposition of the writer by Messieurs Edmond, Perrier and Gervais, of the Jardin des Plantes, Paris, attention was nevertheless called to the fact that the figures illustrating the form of stomach as offered by Pallas, Brandt and George give an imperfect, even an erroneous, idea of that of the stomach of the *Hyrax* dissected by the writer. According to the anatomists just referred to, the cardiac portion of the stomach in *Hyrax* is large and globular, the pyloric portion small and narrow, whereas exactly the reverse obtains in the stomach of the specimen submitted to the writer (fig. 1). Inasmuch as the narrow cardiac portion of the stomach is extremely muscular in *Hyrax*, it might be supposed that such condition may have been due to the fluid in which the specimen had been preserved. In the judgment of the writer the marked difference in contour presented by the two regions of the stomach cannot be so accounted for. In confirmation of the view that the form of the stomach so found was normal and not due to post-mortem

Fig. 1.

[1] *Spicilegia Zoologica*, 1767, p. 16.
[2] *Proc. Zool. Soc. London*, 1832, p. 202.
[3] *Mémoires de l'Acad. Imp. des Sciences de St. Péterbourg*, VII Sér., Tome XIV.
[4] *Proc. Zool. Soc. London*, 1865, p. 329.
[5] *Annales des Sciences Nat.*, 6me Serie, I, 1874.

contraction, it should be mentioned that when the animal was opened, although the two parts of the stomach were distended with food, it nevertheless presented two distinct cardiac and pyloric portions. At the same time the small intestine was empty, which would not have been the case had the stomach contracted to any extent upon its contents. It is well known that in the six-banded armadillo (*Dasypus sexcinctus*), in the two-toed ant eater (*Myrmecophaga didactyla*) and in the two-toed sloth (*Cholœpus Hofmanni*) the cœcum presents two cœcal processes, and in *Hyrax*, in addition to a cœcum proper, the alimentary canal is provided with a second dilatation, terminating also in two cœcal processes resembling somewhat those just referred to as occurring in the edentates just mentioned. It will be observed, however, that the two cœcal processes found in *Hyrax*, but in no other mammal, so far as is known to the writer, are appendages of the colon and not of the cœcum proper. The significance of these colonic appendages is not known.

The length of the alimentary canal in *Hyrax* is as follows according to

	Owen	George	Chapman
Small intestine, ...	54	64	38 inches.
Cœcum, ...	3	4	4 "
Colonic cœcum, ...		3[6]	6 "
Large intestine, ...	58	52	35 "
	112	120	77[6]

The length of the alimentary canal was nearly five times that of the animal, measured from snout to anus, a ratio not differing essentially from that of Owen[7] and George.[8]

The villi of the small intestine of *Hyrax*, as is well known, are remarkably well developed, indeed as long proportionally as in the rhinoceros.[9] The attention of anatomists does not appear, however, to have been directed to the fact that some of the villi are longer than others, the former terminating in branched or club-like processes (fig. 2), resembling somewhat the villi of the Indian rhinoceros studied by the writer. In view of the difference of opinion that has prevailed among systematists as to the affinities of *Hyrax* with the remaining mammalia, this fact might be urged as con-

[6] Exclusive of colonic cœca.
[7] *Op. cit.*, p. 204.
[8] *Op. cit.*, p. 38.
[9] Meckel, *Systeme der vergleichenden Anatomie*, Band IV, S. 595.

firming the view held by Cuvier[10] and Owen,[11] that *Hyrax* is nearly related to the rhinoceros, as shown by its rhinoceros-like incisor and molar teeth, the incisor teeth being developed as in the extinct *Rhinoceros incisivus*, the molar teeth presenting essentially the same pattern in both animals; the position of the œsophagus in regard to the stomach, the relatively simple stomach and complex cœcum, the perissodactyle number of ribs 22, the hoofs of the unsymmetrical tetradactyle fore-foot and tridactyle hindfoot as in *Aceratherium*, an extinct hornless rhinoceros, etc. On the other hand, as first shown by Home,[12] the placenta in *Hyrax* is zonular, like that of the elephant and carnivora—a fact somewhat inconsistent with the view that would regard *Hyrax* as a little rhinoceros. Still, it must be admitted, since it has been shown by the writer[13] that the same kind of mammals (*Edentata*) may have different form of placenta and different kinds of mammals the same form, that the form of the placenta is of little or no value in the classification of the mammalia. In the absence of fossil remains of *Hyrax*, though the extinct *Hyracotherium* may be somewhat allied, it is impossible to assign *Hyrax* to any living form of mammals. For the present, therefore, it may be regarded as *sui generis* the representative of an extinct order Hyracoidea, of which *Dendrohyrax* is also a member. As a matter of record, it may be stated that fragments of a species of tapeworm (*Moniezia*) were found in the small intestine, and also a number of specimens of *Ascaris ferox*, as identified by my colleague, Prof. Percy Moore. In regard to the urogenital apparatus, its disposition was found to be essentially the same as described by Pallas, George, etc. In the specimen of *Hyrax* dissected by the writer, the testicles were found lying in the abdominal cavity below the kidneys, and were longer rather than shorter than the latter, as hitherto described. The ureters opened into the fundus of the bladder, the aperture of the left one being situated a trifle lower than that of the right one. The *vasa deferentia*, as they pass behind the bladder, become so much convoluted as to resemble a second epididymis, terminating finally in two openings situated in the under part of the *veru montanum* of the urethra. The lower convoluted portions of the *vasa deferentia*, just referred to,

Fig. 2.

[10] *Ossemens Fossiles*, 1834, Tome 3, p. 251.
[11] Owen, *Anat. of Vertebrates*, III, p. 742.
[12] *Lect. on Comp. Anat.*, Vol. VI, 1828, Pl. 61–62.
[13] *Proc. of Acad. of Nat. Sci. Phila.*, 1901, p. 366.

are regarded by George[14] as performing the functions of seminal vesicles. Owen, however, states[15] having found true seminal vesicles quite distinct from the convoluted portions of the *vasa deferentia* just mentioned. Further, there are two additional pairs of glands, the ducts of the first opening into the upper portion of the *veru montanum*, those of the second into the bulb of the urethra, and regarded respectively by George[16] as prostate and Couper's glands. The prostate glands were considered by both Pallas[17] and Cuvier[18] to be the seminal vesicles, but as the ducts of the latter terminate by openings quite distinct from those of the *vasa deferentia*, their nature as interpreted by George is probably the correct one. The levatores muscles of the penis arise from the symphysis pubis, and terminate in a single tendon, as was the case in the rhinoceros dissected by the writer, a disposition first noticed by Owen.[19] The erectores and acceleratores muscles were well developed.

The *Hyrax* is regarded by naturalists and Biblical scholars as being the animal referred to in the Bible as the "coney"—the שָׁפָן (saphan) of the Hebrews and the *χοιρογρυλλιος* of the Greeks. The Hebrews were forbidden by their law to make use of the coney as an article of food, it being considered by them to be unclean, "because he cheweth the cud, but divideth not the hoof" (Lev. xi. 5). Biblical scholars, in their efforts to determine what kind of an animal the coney of the Bible really was, do not appear, however, so far as known to the writer, to have noticed that, according to readings of Tischendorff and Van Ess, *Vetus Test Græce* (Leviticus xi. 5), the coney does not chew the cud, "*και τον χοιρογρυλλιον, οτι ουκ αναγει μηρυκισμον*"; whereas, according to Deuteronomy xiv. 7, it does chew the cud, "*και ταυτα ου φαγεσθε απο των αναγοντων μηρυκισμον.*" There is no such discrepancy of reading, however, between the corresponding texts in the Hebrew, the Vatican Codex[20] and Sweet's Septuagint, the Latin and English versions of the Bible, it being stated in all

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[14] *Op. cit.*, p. 192.
[15] *Op. cit.*, p. 206.
[16] *Op. cit.*, p. 193.
[17] *Op. cit.*, p. 29.
[18] *Anat. Comp.*, Tome VIII, p. 165.
[19] *Op. cit.*, p. 207
[20] It is a curious fact that notwithstanding the Tischendorff Septuagint is supposed to be an exact copy of the Vatican Codex, the *ουκ* that occurs in the former (Lev. xi. 5) is absent in the latter, and that no reason is given for the variant reading. The writer takes the opportunity of expressing his thanks to Prof. W. C. Lamberton, the distinguished Greek scholar, for giving him the opportunity of consulting the different Greek versions of the Old Testament referred to in the text.

the versions that the coney cheweth the cud. As a matter of fact the *Hyrax* does not chew the cud, even though the movements of its jaws during feeding would suggest such action. Its stomach, though divided into two distinct regions, is not adapted for rumination, and the animal has never been observed to perform that act either in the wild state or in captivity. It is possible, therefore, that the *Hyrax* of Syria, after all, is not the animal referred to in the Bible as the coney, even though the rocks were a refuge for the latter, according to the Psalmist (civ. 18), as they still are for the *Hyrax*, and that the coneys, like the *Hyrax*, are a "feeble folk, yet make their houses in the rocks" (Prov. xxx. 26). On the other hand, if the *Hyrax* is still to be regarded as the coney, as the Arabs think, then the Biblical texts in which it is stated that the coney cheweth the cud should be revised to make them consistent with what is known to be the habit of *Hyrax* in this respect.

MAY 17.

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

Thirty-six persons present.

The deaths of Maxwell Sommerville, a member, May 5, and of Henry M. Stanley, a correspondent, May 10, were announced.

The Publication Committee reported that a paper entitled "New Polychæta from California," by J. Percy Moore, had been offered for publication (May 16).

Summer Activity of Some Spring Flowers.—DR. IDA KELLER remarked that the suddenness with which the first warm days of spring call into being the so-called "spring flowers" is a yearly repeated surprise, and although the following summer months are characterized by conditions far more conducive to vegetative activity, we are accustomed to find the plants which were conspicuous in April, May and June sinking gradually into insignificance. Their time of active service seems, therefore, to be confined within narrow limits.

The slightest acquaintance with the laws governing plant physiology leads to the conclusion that the complex structures thus quickly appearing are in reality the result of the usual slow and elaborate processes of the various phases of metabolism, and indeed close observation shows that at least some of our well-known species are busily at work during the entire summer, preparing with great care and circumspection for the sensational outburst of the vernal season.

No better illustration of this point could be found than the May-apple. It is interesting to dig in the soil about these plants in July or early August. Close to the surface the trowel is impeded by a network of tough stems. Instead of growing upward, these formidable structures run parallel to the surface, or they run diagonally downward, or perhaps they may even point vertically downward, in defiance to the laws of geotropism. The stems are anchored in the ground by rather stout roots which come off at various points, and each stem is terminated by a large bud. Lateral buds are also to be found. At this time of the year the overground portion is in a process of slow decomposition. The decaying leaf-stalk gives no evidence of this underground activity, as a result of which we have great patches of *Podophyllum* early the following year.

While making these observations she had also noticed the False Solomon's Seal. The flowering plants of the season had produced fruit, but there were also many younger plants which had not yet reached the flowering stage. On none of the plants were long underground stems visible, but their rhizomes were all well supplied with conspicuous buds. It was worthy of notice that the plants which were too immature to produce flower and seed readily form several underground buds, indicating that the latter method of reproduction takes place at an earlier stage than that of seed formation. Owing to this wise arrangement the danger of extermination from the ravages of enthusiastic collectors is much reduced, since the plants thus reproduce freely at this early stage of their existence without offering any temptation to the hunters of wild flowers, who abound in the woods at this time of year.

By far the most interesting observations on this underground method of reproduction were made on *Arisæma triphyllum.*

On the 27th of July a locality was found on Crum creek where the plants were very plentiful and in the various stages of development. At the time of year mentioned the fruit was formed, and while still green in color it showed a tendency to turn red. Below was the thick corm and the two leaves were showing symptoms of decay by their yellowish tinge. In some cases the leaves had already dropped off completely. In one case the corm was of the same shape as that of the mature plant, namely, depressed globose, while in another the form was markedly different, being decidedly elongated and at the free end there was the appearance of a scar, indicating some previous attachment. It was these longish corms which appeared to indicate some hidden meaning and which led her to continue the observation in regard to their origin and significance.

Some years ago, in a short paper entitled *Underground Runners,* she had called attention to peculiar growths on *Arisæma triphyllum* as found in April. At that time of year they were small knob-like projections on the corm, while in July these formations were at least an inch in length. There may be several of them on the same corm, nor are they restricted to the mature plants. This species also reproduces freely before it reaches the flowering age and thus decreases the chances of extermination. This may partially explain the persistence of the plant in our woods in spite of the fact that it is one of the favorites of the enthusiastic collectors before mentioned.

She had found that these structures drop off very readily, and was much impressed with this peculiarity. In fact, it seemed impossible to keep a corm and its growth intact. On close inspection it appeared that there had been a separation between the main body of the corm and the structure even before they were disturbed. The attachment was entirely superficial, being simply due to a layer of skin which loosely covered and hid the point of separation. The body is somewhat bean-shaped, the bulk being made up of nourishing material, while the apex is occupied by the terminal bud and the scar at the base marks the point where it was originally connected with the parent plant. A space already indicated the separation. Although still loosely united by the skin above alluded to, each of the two structures is prepared for an independent existence.

On the 20th of September she again observed the patches with the view of determining the sequel of the interesting story. By this time most of the plants had died down, the still remaining leaves were yellowish and in a state of decay. The red fruits were numerous, and it did not seem as though the plants were in immediate danger of extermination, even if their sole method of propagation were by seed. On uprooting some, she had found that the growths had been completely severed from the parent corms, and that, in fact, they seemed to be moving away from them. It is a significant fact that we do not find the Jack-in-the-pulpit growing close together in tufts, as would naturally follow were these short underground growths to develop in connection with the corms from which they spring. The result of the spontaneous loosening leads naturally to a prevention of this condition. Future observations must determine just how far the young corms may travel from the spot where they had their origin. The elongated form terminated by a point would offer but slight resistance to any force which would tend to carry them away. Thus we find in this plant a rather unusual form of reproductive bodies in these underground sprouts and probably also an unusual method of dissemination.

A considerable amount of activity is manifested in the formation of these bodies, but this by no means represents the entire summer work of this typical spring flower, even aside from the fruit formation. On removing the decaying stems from the plant, a large pinkish, wholesome bud comes into view. Within the three heavy protecting sheaths the Jack-in-the-pulpit is completely formed in miniature. The leaf is unmistakable in its form, standing bolt upright, even emphasizing the peculiarity of the adult leaf. Close to it is the inflorescence with a fully formed spathe and the flowers within are marked by well-defined masses of cells. Thus all is in readiness for the first warm days of the following spring.

To some extent the same is true of *Podophyllum*. In the vigorous buds terminating the underground stems, described above, the leaf and flower are also plainly formed. It is also true of *Smilacina racemosa*, though perhaps to a less degree. Here the future raceme is foreshadowed by the characteristic shape of the vegetative point.

We may safely conclude, therefore, that the summer months are also a busy season with these spring flowers. We can appreciate how heavy the demands are on the vegetative activity of the leaves of *Arisæma triphyllum* when we remember that one current must carry nutrition to the forming fruit, at least in the seed-bearing plants, another stream travelling in the opposite direction must provide for the food supply of the miniature plant in the bud, and also for the formation of the underground reproductive bodies above described. The season is indeed one full of activity up to the time when its close is marked by the fruit dropping heavily from the exhausted stalk.

Henry D. Jordan, M.D., and James Harold Austin were elected members.

The following were ordered to be printed:

NEW POLYCHÆTA FROM CALIFORNIA.

BY J. PERCY MOORE.

Some Polychæta gathered by Mr. E. C. Starks, at San Diego, California, were recently sent to me for determination by Prof. Harold Heath, of Leland Stanford, Jr., University. Besides the eight herein described the collection includes about thirty species, most of which have been recorded from the Pacific coast by Johnson, Baird, Fewkes and others. A full list of these will be published in another connection.

Diopatra californica n. s. (Pl. XXXVII, figs. 1 to 9.)

This species probably attains a length of 200 mm., although the only complete example measures only 110 mm. long and 5 mm. wide at the termination of the region of long branchiæ. Prostomium small, mostly concealed by the bases of its appendages. Frontal tentacles nearly in contact at their bases, fusiform, nearly equal to the prostomium in length. Five principal tentacles similar in size, form and structure, arising in close contact from an arcuate area nearly covering the dorsum of the prostomium. The basal fourth of each forming a conspicuous ceratophore divided into twelve to fourteen rings equalling in length the head and frontal tentacles, the styles smooth, slender and tapering, apparently subequal, but the tips imperfect. Eyes, a pair of prominent, slightly pigmented swellings nearly in contact and occupying most of the region of the head posterior to the tentacles. Palps prominent, slightly bilobed processes bounding the mouth in front and in contact mesially.

Peristomium slightly shorter than the prostomium, which it embraces laterally. Nuchal tentacles on its extreme anterior margin, and in line with the outer edge of the inner lateral tentacles. The next two or three somites nearly equal the peristomium, and are rounded at the margins, while the remaining ones are much shorter, usually only about one-sixth or one-eighth of their width. For about the first fifth of the body through the branchial region they are much flattened, but beyond that become gradually rounded and taper toward the tail, which is terminated by a bead-like pygidium bearing near the middle line a pair of delicate ventral cirri having a length equal to the last eight or nine somites.

The first distinct parapodium is on the somite following the peristomium and consists of a setigerous body with three cirri, a postsetal lobe and a dorsal and ventral cirrus, all slender and conical and the latter about twice as long as the others. The second and third parapodia are similar, with the dorsal cirri longer. As far as the sixth or seventh the dorsal cirri continue to increase in length, then gradually diminish through the branchial region, and behind the latter remain small and slender to the end. The ventral cirrus undergoes no change in the first four parapodia, but suddenly disappears in the fifth, where it is represented by a small glandular prominence, which increases in size and in the middle branchial region extends about one-fourth of the distance across the venter. Beyond the branchial region it becomes smaller. The postsetal lobe is likewise largest on the first four somites, and after reduction in the first few branchial segments, accompanied by a rotation ventrad, remains for the entire middle region of the body a blunt, moderately sized lobe ventro-caudad of the setæ tuft. In the posterior half of the body all parts of the parapodia are reduced and finally become mere low papillæ.

In the region of their greatest development the branchiæ are large and prominent, of a tall and slender form, much like a juniper tree, but with the spirally disposed branches more open in arrangement and, below them a distinctly annulated basal portion of the trunk. They begin abruptly on the fourth parapodium, and the first is about three-fifths as long as the largest on the sixth or seventh parapodium. Beyond this point they gradually decrease in size, the number of whorls of branches at the same time increasing, and their arrangement becoming more open. By the twenty-seventh parapodium the spiral arrangement has disappeared altogether and the stem is simply curved, with the branches in a linear series on the convex side, an arrangement which begins to appear at the tip of some of the preceding gills, as though they were gradually unwinding. The number of turns in different branchiæ of the type is 11 on the first, 13 on the second, 15 on the third and fourth, 13 on the sixth, 10 on the tenth, 7 on the fifteenth, 4 on the twentieth, and none on the twenty-fifth. Beyond the thirtieth parapodium each gill consists merely of a stalk, usually curved at the free end and bearing a terminal tuft of short branches, with a few others in a series below. These gradually decrease in size, and by the fortieth parapodium are nearly or quite simple, and finally disappear by the sixtieth parapodium.

On the first four parapodia the setæ are of two kinds, guarded uncini and simple slender setæ. The former are nearly colorless and have an incomplete transverse fracture or joint near the outer end and a strongly hooked tip with a stout subterminal spur; the guard extends somewhat beyond the terminal hook, and in the larger uncini at least reaches far down the shaft, along which its margin is distinctly free and denticulated. They are arranged in three groups, a ventral of two small and slender uncini (Pl. XXXVII, fig. 2), a middle of one large stout (Pl. XXXVII, fig. 1) and three to five smaller ones, and a dorsal group of one or two which are usually longer, especially in the end piece, than any of the others and intermediate in thickness. The more slender uncini, as shown in the ventral one figured, have the guards more prolonged. Of the simpe setæ (Pl. XXXVII, fig. 3) there are but one or two in each foot, and they arise just dorsad of the posterior row of uncini, the longest one reaching nearly or quite to the tip of the posterior lobe and nearly equalling in diameter all but the very stoutest uncini. They are colorless, translucent, have barely visible oblique striations, become increasingly curved toward the tip, and when perfect are terminated by a small flexible filament.

On the tenth and succeeding parapodia the character of the setæ is altogether changed. There are no uncini, but in their place a spreading ventral vertical row of rather stout pale yellow strongly striated setæ, four to six in number, with the outer ends broadened, flattened and rather strongly curved and tapered to a very acute point (Pl. XXXVII, fig. 4). Dorsad of the postsetal lobe is a compact horizontal row of more numerous, longer, narrower and straighter setæ of otherwise similar form and structure. At the base of these, on the dorsal side, is a group of a few colorless spatulate setæ with slender stems and abruptly broadened fork-shaped ends with seven tines (Pl. XXXVII, fig. 5).

By the thirty-fifth parapodium the setæ are practically all confined to the horizontal dorsal fascicle and the spatulate setæ are more numerous, and have broader more curved plates with as many as nine rather spreading tines. Among them are also a few very small spatulate setæ with ovoid blade and simple mucronate tip. Posteriorly the setæ, especially the simple ones, are reduced in number, become more slender and project far beyond the now very small ventro-caudal lobe. By the seventy-fifth parapodium only about six such setæ remain, and the spatulate setæ have continued to widen and bear as many as eleven times. Still further caudad the number of setæ is further reduced and they become more slender.

The four anterior parapodia are each supported by about three slender aciculi which enter the base of the dorsal cirrus, and the same number of stouter ones in the setigerous lobe. A single hooked and guarded aciculus appears ventrally at about the tenth parapodium, and by the twenty-fifth there are two very stout ones (Pl. XXXVII, fig. 6), and above these a vertical row of four or five less stout but more opaque and deeply colored aciculi, whose ends project freely as acute points which increase in length dorsally where they pass into the regular series of setæ. Just beyond the point of their emergence is a slightly swollen deep brown spot, at which they readily break, indicating the existence of an imperfect joint (Pl. XXXVII, fig. 7). The arrangement just described continues to the seventy-fifth somite at least, and probably considerably beyond, but the one hundred and twenty-fifth has two hooked aciculi, only two pointed ones and a single simply bent and unguarded one (Pl. XXXVII, fig. 8).

The jaws (Pl. XXXVII, fig. 9) are nearly black and stout. The maxillæ have short, broad carriers, not united in the middle, and their bases bear two prominent tubercles. The next dorsal plate bears six or seven stout teeth, the next five on the left and seven on the right side, with a thin edentulous plate on each side. The extra plate on the left side bears seven or eight teeth. The mandibles have the terminal piece white and translucent, the carriers deep brown, loosely joined, very broadly rounded at the base and with a prominent longitudinal ridge.

Eunice biannulata n. s. (Pl. XXXVII, figs. 10–18; Pl. XXXVIII, fig. 42.)

The type and largest example is 137 mm. long and 5.3 mm. between the tips of the parapodia at the widest point. The prostomium is short and broad, the length barely exceeding one-half the width, the anterior border scarcely emarginated, but the anterior lobes or palpi swelling broadly ventrad and laterad, and separated by a distinct median ventral furrow passing backward to the mouth, while a faint transverse groove separates a small anterior from a larger posterior portion. The tentacles arise in a nearly straight transverse line across the anterior portion of the white posterior half of the prostomium; the paired tentacles are in contact at their bases and are separated from the median tentacle by a distance about equalling the diameter of the latter. Ceratophores all very low and broad; styles constricted at the base, increasing gradually in diameter for one-fourth or one-fifth of their length and then tapering regularly to the end, simply articulated at the base, strongly beaded distally, the terminal joints caducious. The first joint is always much the longest, the second very short and often imperfectly differentiated, the others increasing in length more or less irregularly to the end, giving the impression of a budding zone at the distal end of the basal segment. The type specimen, which has suffered less from maceration than the others, has the median tentacle with twenty-one articulations reaching to the middle of VI, the inner lateral thirteen articulations reaching IV, and the outer lateral seven articulations reaching II. Eyes black, somewhat elongated and crowded into the recess behind and between the bases of the lateral tentacles.

Peristomium considerably longer than the prostomium and slightly wider than its widest part, the anterior third distinctly separated dorsally as a ring which is sometimes elevated prominently above the head. The principal ring presents the usual lateral or mandibular lobes and a smooth unfurrowed ventral lip. The nuchal cirri have the characters of the tentacles, about equal the peristomium in length and have four to seven articulations. Somite II is very short, scarcely more than one-fourth of the prostomium, V is slightly enlarged, and behind it the remaining somites are of nearly uniform length until they begin to diminish at the posterior end. They are all smooth, simple and, especially in the branchial region, very clearly defined. A short cylindrical pygidium bears a pair of short stiff cirri and laterad of these, but still ventral to the anus, a pair of long, slender, flexible cirri equalling the fifteen terminal segments.

The first parapodium is strictly ventro-lateral; those following rise gradually to a half-way level. In form they undergo the changes usual in the genus, their chief characteristic being the prominence of the cirri, which are retained both dorsally and ventrally throughout the entire length of the worm. The dorsal cirri are especially prominent and distinctly articulated anteriorly where each consists of a larger basal and two smaller joints, together equalling the basal one. About XXV one of these disappears, and a little farther on the other, the cirrus at the same time becoming more slender, but remaining about twice as long as the setigerous lobe; posteriorly, as the latter becomes smaller, the cirrus is relatively much more slender, three or four times the length of the setigerous lobe, and often faintly articulated. The ventral cirrus also, while undergoing reduction in the middle region, exceeds the setigerous lobe throughout and always bears a small terminal joint.

The branchiæ are of typical uniserial pinnate form, the main stem curving mediad over the back and the end not being strongly bent upward. The branches are long, slender and simple but never exceed the dorsal cirri; they arise from the main stem at right angles, not dichotomously, and curve slightly mesiad. On two specimens they have the following average distribution and complexity: Begin on V with one filament, 3 on VI, 5 or 6 on VII, 6 to 8 from VIII to XXX, 4 or 5 to XXIX, 3 to XLII, 2 to XLVI, 1 to LIV, and cease by LV.

The first parapodium (III) is supported by a pair of pale yellow, simple pointed, sharply bevelled aciculi (Pl. XXXVII, fig. 13), and bears a small number of ventral compound and dorsal capillary setæ, as well as one or two spatulate setæ. On IV the number of each kind, especially the last, is increased. By VI the typical number, size and arrangement is attained. The neuropodial aciculi are two or rarely three, stout and blunt, and in the case of one somewhat enlarged at the end (Pl. XXXVII, fig. 14). Between XL and L a single ventral crochet appears, and the dorsal aciculi become tapered and slightly curved at the end (Pl. XXXVII, fig. 15). The number of both compound and capillary setæ decreases in this region, and in the posterior somites the latter seem to be absent altogether. The compound setæ also undergo a slight alteration in form. The dorsal cirrus throughout is supported by about three slender aciculi.

The compound setæ (Pl. XXXVII, fig. 10) are all rather slender, nearly colorless, have curved, finely striated stems moderately enlarged at the ends; the appendix is not over two and one-half times the greatest diameter of the stem, the end is prominently hooked and bidentate, the accessory tooth distinctly triangular, guard narrow, scarcely covering the end. From the posterior branchial region caudad the hook gradually diminishes, while the accessory tooth increases in size, the base of the appendix becomes more oblique, and the end of the shaft more strongly curved and thicker (Pl. XXXVII, fig. 11). Throughout most of the branchial region the compound setæ are arranged in a nearly complete circle somewhat open both dorsally and ventrally.

The capillary setæ form a dense dorsal tuft reaching far beyond the compound setæ. They are pale greenish or nearly colorless, curved, finely pointed and faintly obliquely striated (Pl. XXXVII, fig. 12). Back as far as the end of the branchial region they exhibit a slight enlargement in the outer third, but posteriorly are strictly capillary. Spatulate setæ (Pl. XXXVIII, fig. 42) form a close dorsal tuft at the base of the capillary. They are colorless and very delicate, the ends half round with the outer angles prolonged and the distal margin folded and split into nine or ten processes tipped with short filaments which bend abruptly inward nearly at a right angle. These setæ appear as a single one or two in the first parapodium and continue to C at least.

The jaws (Pl. XXXVII, fig. 18) are delicate and nearly colorless, except in the thickest parts, which are brown. The maxillæ are slender, acute and at the base extend beyond the small carriers laterally. The basal dorsal plates have five or six teeth, and the much smaller anterior plates six and ten teeth on the left and right side respectively. The extra plate on the left side has six teeth.

Even in alcohol the colors of this species are well preserved and rich. The cuticle is everywhere smooth, polished and iridescent. For most of its length the body is beautifully annulated with a rich brown on a creamy-white ground. Each somite is marked on the dorsum with two narrow brown half rings separated from each other by an often impure area of the ground color, often divided by a narrow transverse brown line, and from the bands of the neighboring somites by a narrower, purer and more sharply defined intersegmental ring, also usually divided in the middle by a narrow transverse line. A dark median dorsal line is also often evident. The ventral colors are more obscure, but each somite in the anterior region has a dull brown cross-stripe. Farther back the stripes break into a paired series of spots replaced posteriorly by a series of narrow median spots, three on each segment, a very small one in the furrow, followed by a considerable interval, then a larger spot, a small interval and then the largest, an oval spot which extends over nearly one-half the length of the somite. The sides of the segments and, except anteriorly, the parapodia are colorless. For about the first ten somites the brown color becomes richer and nearly continuous on the dorsum, except that the somewhat enlarged fifth segment is pure white and conspicuous and the ninth is chiefly white. On the caudal region of the body the color approaches orange and becomes more suffused. Except for a row of minute dots about its dorsal posterior margin and a pair of larger spots at the base of the caudal cirri, the pygidium is white. The head is pale below with a brown spot in the ventral furrow; above its anterior half and a narrow median triangle extending from the base of the median tentacle to the posterior margin are brown, the rest pale. All of the tentacles, tentacular cirri and the anterior dorsal cirri are similarly colored; the ceratophore and all of the constrictions are brown, the enlargements white, resulting in a very sharply defined color annulation. The longer anal cirri are chiefly brown with white rings.

Lumbriconereis erecta n. s. (Pl. XXXVII, figs. 19 to 22; Pl. XXXVIII, figs. 23 to 25.)

The form and general aspect are about as usual in the genus, though the unusual length and prominence of the lobes of the posterior parapodia overcomes the trimness general to these worms. Full-grown specimens are 300 mm. or more in length, and have a width of 3.5 mm. without and 5 mm. including the parapodia. The usual number of somites is about 330. The prostomium is sugar-loaf shaped in outline, slightly depressed, the length slightly exceeding the basal width, the apex narrowly rounded; at the base it is slightly mortised into the peristomium above and on the sides is marked by a pair of faint oblique grooves, in front of which are a few pigment spots but no distinct eyes; on the middle of the lower surface is a shallow median depression. Mouth large, bounded laterally by a pair of prominent L-shaped lobes connected with the peristomium, a much wrinkled fold of which bounds the mouth posteriorly. The peristomium is divided into two rings (perhaps somites) by a furrow which is very distinct above, obsolete below; the first ring equals the first setigerous somite, the second is two-thirds as long. Body nearly terete, very slightly depressed toward the ends; the somites all well marked, simple, smooth except for a very slightly raised welt around the middle; their length nearly uniform, from one-third to one-fifth their width, which is greatest at the middle. Toward the posterior end of the body there is a faint neural groove. The pygidium is a small platform ventral to the anus and provided with a pair of prominent short and thick bifid cirri, the median lobes of which come into contact in the median line.

In the middle region of the body the parapodia are situated about midway between the dorsal and ventral surfaces which are equally convex, but toward the ends they assume a lower level and the ventral surface becomes flattened. The parapodia (Pl. XXXVII, figs. 19–21) have a short, thick rounded base, a very small notopodial tubercle which receives four to six aciculi, a presetal lobe which is very short, thick and rounded throughout the series, and a prominent postsetal lobe which gradually increases in size from before backward, and in the middle and posterior regions has the form of a long finger-like process which generally bends abruptly upward at a right angle and rises above the back. The setæ are of the usually acute, winged and the hooded, hooked forms and vary greatly in details and particularly in the degree of curvature and geniculation. The anterior parapodia contain the acute type only (Pl. XXXVIII, figs. 23 and 24), at first in a somewhat broken fan-shaped tuft, but soon in a dorsal group of longer and middle and ventral groups of shorter setæ. At about XLV, guarded uncini (Pl. XXXVIII, fig. 25) appear in the ventral group, and by L are alone present to the number of four or five, which is further reduced to two or even one posteriorly. The ventral setæ of the dorsal bundle exhibit a reduction in size at about L, and by LX have given place to uncini, but the slender setæ do not altogether disappear until about LXXV, from which point backward the uncini become stouter and the number gradually reduced to from one to three in each parapodium.

The jaws are coarse, black and very brittle. The mandibles (Pl. XXXVII, fig 22) are pale, stout and broad, with the two halves strongly united, especially by transverse striated bands across the end pieces. The bases are broad and roughly laminated.

Much of the original color has been lost, but the head and anterior region of the body retains a rich bronze with a beautiful blue and green iridescence; the posterior part is dull brown, due to heavy masses of pigment which are scattered everywhere through the deeper integument, but especially in a narrow transverse band and a pair of dorso-lateral spots on each somite.

Cirratulus spirabranchus n. s. (Pl. XXXVIII, figs. 26 and 27.)

Form rather stout, thickest in middle and tapering almost equally both ways. The type is 105 mm. long and 5.5 mm. in diameter at the widest part. Prostomium elongated, pointed and slightly depressed, with a short oblique groove on each side above and near the union with the peristomium. No eyes visible. Peristomium enlarged, its length equal to six succeeding somites, somewhat irregularly divided into three or four rings of which the last is much longer than the others. There are about 300 setigerous somites, of which the first three or four are longer than the others. Nearly terete, but slightly flattened ventrally where the muscle coats are considerably thickened particularly toward the ends. All somites clearly marked, but short and uniannulate. The anus is a large dorsal slit reaching through 7 or 8 faintly marked somites and followed by a minute tubercle-like pygidium.

The branchiæ are numerous and crowded and usually more or less spirally coiled. They differ much in size, probably, however, only as a result of loss and regeneration, but their length does not exceed about five times the diameter of the body. Beginning with the first setigerous a pair occurs on every somite except the last thirty, arising immediately dorsad of the notopodial setæ or from the margin of the elevated band just above them. On the seventh setigerous somite occur the special branchiæ in a pair of dense tufts of about 20, arranged in two transverse rows which nearly meet medially. They are mostly smaller than the ordinary branchiæ, and owing to the crowding of this region usually appear to cover two somites, either VII and VIII or VIII and IX.

The setigerous tubercles (Pl. XXXVIII, figs. 26, 27) are separated by a smooth space about 3 or 4 times as broad as they, and both are placed on a wide elevated band, the dorsal margin of which rises prominently about the notopodial tubercles and bears the branchiæ on its edge. The usual spines and capillary setæ are present, distributed as follows: Anterior to somite XL the latter only occur, but at XL or thereabout small, nearly colorless spines appear among the capillary bristles in the neuropodial fascicles; by L there are usually five, quite distinct and dark colored, though small; they alternate with the setæ, and as the latter diminish the former increase in number, the maximum of six being found from about C to CL, behind which the capillary setæ have nearly or quite disappeared, and the number of the spines becomes again reduced to four or five, a number which remains constant to the end, though further diminution in size occurs. In the notopodial fascicles the spines are smaller, slightly more numerous and first appear a little more caudad than in the ventral fascicles.

Cirratulus luxuriosus n. s. (Pl. XXXVIII, figs. 28 to 31.)

Form slender throughout, thickest at about end of anterior third (somite C), tapering thence very gently to posterior end. The type and largest specimen is 110 mm. long and 4.5 mm. in diameter at somite C. In the best-preserved specimens the body is strongly convex above, concave below and angulated at the setæ levels, particularly the neuropodial. Prostomium about three-fifths as long as broad, rounded anteriorly, depressed, slightly retracted within the peristomium, grooved below in the middle line, thus leaving a pair of lateral palp-like thickenings which bound the mouth above; no eyes nor sensory slits apparent. Peristomium somewhat inflated, about twice as long as the prostomium and divided into two or three annuli. Setigerous annuli numerous (358 in the type), all very short and distinct, those of the posterior third rather longer and with faint indications of irregular division into two wings. The branchiæ form a conspicuous tangled mass, and even in the alcoholic specimens are very long, equalling ten times the diameter of the body but, unlike *C. spirabranchus*, exhibiting little tendency to coil spirally. They begin on the first setigerous somite in contact with the notopodia above, but continually rise to a higher level, until toward the posterior end they are much nearer to the dorsal middle line than to the setæ. To the 200th somite at least a pair of branchiæ occurs on every somite, but for the next 70 or 80 on every second, third or fourth somite only; there is no diminution in size posteriorly. The special branchiæ are in a pair of close tufts crowded on the sides principally of the fourth setigerous somite. The number appears to be 12 or 14 on each side, but cannot be ascertained with certainty. Anus rather small, nearly transverse, widely open and succeeded by a small median ventral tubercle.

The setigerous tubercles (Pl. XXXVIII, figs. 28 to 30) are very small, not elevated on any special muscular band, though appearing at the lateral angles posteriorly, and are well separated throughout. The first 30 somites bear capillary setæ only. Spines appear at that point in the ventral fascicle and soon become thick and dark brown. By XL there are usually four of these spines associated with capillary setæ, but the number soon becomes reduced to three, the number of capillary setæ simultaneously diminishing. From CXX to CL there are two spines and the capillary setæ have disappeared; beyond CL there is one (or rarely two) large, stout, nearly black spine which continues to increase gradually in size. Toward the posterior end a reverse change begins, and behind CCC there are usually two comparatively slender and pale spines. In the notopodial fascicles spines appear later, the first at about L. At about C three small pale spines usually occur, with the capillary setæ. The fascicles undergo changes analogous to those just described, but in the same segment the spines are almost always more numerous, not over one-third as large and always associated with capillary setæ.

Maldane disparidentata n. s. (Pl. XXXVIII, figs. 28 to 31.)

The length of complete examples is from 100 to 150 mm., and 4 to 6 mm. in diameter in the somewhat contracted state; some fragments indicate specimens of larger size. Probably owing in part to contraction, as indicated by a distinct fold of the first setigerous somite which overlaps the head ventrally, the latter is truncated with little obliquity; its v ntral length, including the united prostomium and peristomium, is scarcely one-third more than the dorsal. Cephalic plate broadly oblong-elliptical, its width at least four-fifths its length, the surface smooth and slightly elevated in the center. The frontal ridge low, broad and inconspicuous; beginning just anterior to this elevation and ending anteriorly in the palpode; its length equal to one-third the cephalic plate; posteriorly one-third as wide as the plate, gradually widening for its posterior half, then suddenly expanding into the palpode which is broad, thick, rounded, smooth and separated from the cephalic margin laterally by only a slight emargination. Sensory slits short, sharply defined but inconspicuous. Cephalic margin nowhere much produced, low and thick, probably in part the result of contraction; a pair of lateral clefts divide the posterior one-third from the anterior two-thirds. The former is lower, embraces the latter at the sides and has its margin divided into about fifteen low, broad, truncate teeth, very irregular and inconstant in different individuals, but always diminishing in size and distinctness toward the posterior middle line and often grouped in pairs. The lateral lobes, which reach forward to the palpode, are considerably more elevated and bear five or six larger, more prominent, rounded teeth. The mouth is a conspicuous opening bounded behind by a transverse fold and laterally by distinct thickened lobes. Behind it is a distinct peristomial half-ring rendered more conspicuous by contraction.

There are nineteen setigerous somites, the first seven thick-walled and largely glandular, the first six strongly biannulate with the anterior ring larger and setigerous. This region is usually slightly depressed with each of the first six somites about as long as wide, but the uniannular seventh only equalling the larger anterior ring of the others. Behind VIII the somites increase gradually in length and become somewhat narrower to XVI, which is three times as long as wide; XVIII, XIX and XX become successively shorter. From the eighth to the nineteenth inclusive the parapodia are posterior in position, and the more anterior are situated on complete glandular zones which soon become incomplete and restricted to the lateral faces of the somites. Distinct constrictions occur at the intermetameric furrows which are rendered much more conspicuous by the prominent tori preceding them. The surface of all somites is more or less annularly furrowed and bears numerous small glandular and sensory papillæ. The last somite (XXI) bears no setæ and is smooth and uniannulated. Caudally it enlarges and passes gradually into the anal funnel, dorsad of which the anus is situated behind a somewhat wrinkled anterior fold. The anal funnel consists of two parts, the ventral funnel proper, the cavity of which reaches to the anterior end of the anal segment while the margin is even and not at all flaring, and the dorsal platform, which arises within the dorsal part of the ventral funnel and spreads in a flat, broad petaloid form vertically behind the anus. The margins of both parts are slightly irregular, but entirely without lobes or processes.

On the anterior somites the parapodia are strictly lateral, on the posterior ventro-lateral and more prominent. Somite II bears setæ alone, III to XX both dorsal setæ and ventral uncini. The setæ are of three forms which, however, vary and intergrade. The several kinds arise in more or less distinct fascicles, but spread in such a manner that they appear at the surface in pairs or triplets composed of one of each kind; thus on II they form a fan-shaped figure of about 25 pairs, on III about 15, on IV 12, on V 10 and a more irregular arrangement in triples on the abdominal segments. Slender capillary wingless setæ, rather abruptly attenuated at the surface of the body wall, occur in all setigerous somites. The anterior ones project about one-third as far ar the larger setæ, but in the posterior segments they become much longer and filamentous. Winged setæ also occur in all somites. They are about three or four times the diameter of the smaller ones in their exposed parts and quite deeply colored, nearly straight, tapered to an acute tip, broadly winged on one margin and very slightly on the other. The stoutest ones occur in the posterior thoracic somites, where also setæ of intermediate form are present, some of the smaller ones having short basal wings. In the abdominal bundles most of the larger setæ are provided with delicate doubly spirally fringed tips (Pl. XXXVIII, fig. 35) which differ considerably in length, the longest in the middle abdominal region forming more than one-half of the exposed portion. Posteriorly the number of setæ is reduced, the filamentous ones predominating.

The uncini are all rather stout and of a deep yellow color; 7 or 8 occur on III, about 10 on V, and about 35 on VIII and the following somites. On somites III to V the uncini have the form shown in Pl. XXXVIII, fig. 32. The stems are very slightly curved, strongly striated and have a scarcely perceptible shoulder; the heads are but little enlarged with a blunt pointed beak bent at an angle of 100° to 120°; a crest composed of two rows of teeth, the anterior with a few large teeth in the middle, the posterior and lateral smaller, and a simple guard of about 12 spreading hairs ending at the tip of the beak. On the remaining somites the crochets form a much longer row and have the stems more curved, the shoulder larger, the head more expanded, the beak much longer, more acute, much more strongly hooked at an acute angle, the crest more elevated, with the smaller teeth in more numerous rows and more closely embracing the base of the beak, and the guard arising from a distinct flange below a re-entering angle (Pl. XXXVIII, fig. 33).

This species is represented by a large number of examples.

Terebella (Schmardanella) californica n. s. (Pl. XXXVIII, figs. 36, 37.)

This species has the general aspect of *Amphitrite spiralis* Johnson, from which it is readily separated by the much smaller number of setigerous somites in addition to other characters. The type measures 75 mm. from the pygidium to the tip of the prostomium, but another less perfect specimen is nearly twice as large; the diameter at X is 3.3 mm. The prostomium is prominent, little arched, projects forward and is faintly trilobed its margin slightly revolute and its lateral portion distinctly reflexed. Eyes absent. Tentacles very numerous, deeply grooved, arising from the posterior border of the prostomium for its entire width in three or four transverse crowded rows, behind which is a slightly elevated border. Most of the tentacles are colorless, but usually some are pale brown. Mouth large with a broad peristomial lower lip. Peristomium about as long as succeeding somites, distinctly visible as a ring both above and below.

Branchiæ two pairs on the posterior part of somites II and III, the first just anterior to the first setæ tuft, the second above and behind it. All of the branchiæ are prominent, and of about equal size. They are of a spreading bushy form; the main stem very short, dichotomy occurring almost immediately and the outermost branch again dividing at once, so that three main branches appear to arise almost separately. After about four or five dichotomous divisions, which are usually unequal, one or two irregular divisions occur, the result being a very large number of terminal twigs. When contracted the minor divisions coil inward toward the axis, so that the gill presents a very compact appearance. There is, however, much irregularity in this respect, some of the filaments merely shortening, others coiling spirally.

The body is slender and club-shaped, nearly terete throughout the abdominal region, gently tapered to the anus and the anterior end of the thorax somewhat enlarged. The thoracic segments increase slightly in diameter to about X, and then decrease very gradually into the abdominal region. The dorsum is regularly arched, the venter somewhat angulated, flattened or slightly convex, according to the state of the specimen. Above the somites are somewhat indistinctly separated and somewhat irregularly divided into three rings which are usually again biannulate. On the ventral half the intersegmental furrows are well marked and the somites only biannulated. This region is also rough and thickened, and separated from the faintly granulated, thin-walled dorsal region by a longitudinal groove below which is a ridge-like row of glandular thickenings. The first one or two ventral plates are very short. They increase in length to the tenth, and in width decrease regularly and gradually to the sixteenth, which is square, while the tenth is twice, and the fifth three times as wide as long. Usually a cross-furrow divides each one and the surface is wrinkled. On most specimens the fifth or sixth plate is sunken below the general surface. Behind the sixteenth they become very small, but may be traced for some distance further. The thorax passes very gradually into the abdomen, which is very prominently arched and thin-walled, the somites numerously and finely ringed and indistinctly separated from one another. At the posterior end the metamerism becomes obscure and the pygidium is truncated.

Throughout the thoracic and much of the abdominal region the uncinigerous tori are prominent. They begin on V, increase in length to about XIII, remain practically uniform to about XX, and then very gradually diminish, the last thoracic being about equal to the seventh. As they become smaller and the ventral plates narrower, the tori are carried more and more to the ventral surface, until in the middle abdominal region they form bead-like swellings on a pair of muscular ridges separated by a narrow median groove. Toward the posterior end they are barely recognizable. Setigerous tubercles begin on IV, and continue for from twenty-three to twenty-eight somites, twenty-six being the most frequent number. They stand out prominently from the dorsal end of the tori, especially the anterior ones, which bear the greatest number of setæ. Whitish glandular thickenings occur just dorsad of the setæ lobes as far as somite XXII and prominent nephridial papillæ from VII to XX inclusive, and less prominently and regularly on some of the succeeding somites.

The setæ (Pl. XXXVIII, fig. 36) are noteworthy for the prominence of their pennant-like fringed tips. They are arranged as a single row of larger ones flanked on one or both sides by a row of smaller setæ. The former are straight or slightly curved, with about one-half of the exposed portion included in a loose sheath beginning abruptly and tapering to the terminal pennant which begins as a sudden, much flattened, very thin angulated expansion, curved strongly to one side, tapered to a delicate point and prominently fringed on one margin. The smaller setæ are little more than one-half as thick as their exposed parts, only half as long as the larger. Their form is generally similar, but the sheath is less evident and the tips broader, longer and more abruptly bent to one side. Setæ of the first tuft are more slender and of the posterior ones fewer than elsewhere.

The uncini (Pl. XXXVIII, fig. 37) are biserial and opposite on XI and all following somites; uniserial on those anterior to XI. They have a rather short base strongly convex below with a prominent toe, a small posterior ligament process and a subrostral process with a guard; the sinus is narrow with subparallel sides, the beak long, acute and strongly hooked and the crest prominent, elevated and composed of three or four transverse tooth rows, the lowermost large. On the posterior somites the uncini are small, lack the posterior ligament process and are consequently less angulated and they have a larger number of teeth in the crest.

Distylia rugosa n. s. (Pl. XXXVIII, figs. 38 to 41.)

This is a large, handsome species, somewhat resembling *Bispira polymorpha* Johnson, but differing from that species in the fewer spiral turns of the branchial base, the greater number of branchial radioles, the arrangement of the eyes, the form of the spatulate thoracic setæ and pick-shaped uncini and probably the deep rugous dorsal folds.

Exclusive of the branchiæ, the type is 67 mm. long, the width at the posterior end of the thorax to the middle abdominal region being 8 mm. and the depth at the same points 6 and 5 mm. respectively. The ventral ends of the stiff, cartilage-like branchial bases are prolonged and spirally coiled, but make only $1\frac{1}{4}$ turns. The radioles, which reach a length of 22 mm. at the dorsal and somewhat less at the ventral end of the series, arise to the number of 58 on the left, 55 on the right, in a crowded, closely interlocking double row from the entire distal margin of the basal lobes. Each is strictly simple and perfectly free from the others to the base; the outer surface is rounded and the inner bears the numerous barbs, which have a length about twice the diameter of the radiole, in a crowded double series for its entire length except a short naked terminal region. In this species the eyes are less perfect but far more numerous than in *D. polymorpha*, the number on each radiole approximating 100. They are very irregularly distributed in groups on both margins, most plentifully on the distal half, where a very constant group of large eye-spots occurs just proximad of the naked tip. In the type the branchiæ are pale-colored, each plume with three brown spots, one near the base and two in the outer half; the other specimen has the gills almost continuously pale reddish-brown mottled with white, especially on the basal half. The palpal membrane has a free margin completely encircling the bases of the branchial radioles within. It extends around the sides of the mouth, ventrad to which the two halves meet as a pair of vertical plates contiguous to the middle line, and entering the ventral collar incision partly join the somewhat swollen bases of the ventral collar lobes. The tentacles are about as long as the basal branchial lobes, and have the basal half broadly margined, the distal half filamentous.

The collar is rather thick, stiff, flaring and prominent throughout its extent. The dorsal opening is equal to nearly $\frac{1}{2}$ the body width at the peristomium, with the broadly rounded dorsal lobes bounding it slightly, curving around the dorsal side of the first pair of setæ fascicles, but free from them. The ventral opening is narrow but deep and, as mentioned above, is partly occupied by the ventral prolongations of the circumoral membrane; on each side of it are the short, broad and thick ventral lobes. There is a pair of slight lateral emarginations, but no well-marked incisions.

Except at the rounded peristomium the body is depressed. It increases in width to the end of the thorax, from which point it diminishes very gently to the posterior one-tenth or beyond, and then very rapidly to the small pygidium, on each side of which is a conspicuous cluster of numerous brown pigmented eye-spots. There are 8 setigerous thoracic and 107 abdominal segments. The coalesced peristomium and first setigerous somite are about twice as long as succeeding somites. Besides the collar they bear an undivided, very thick ventral plate, which is about twice as long and much wider than any succeeding thoracic plate, but about equal in the latter respect to the first abdominal. The remaining thoracic plates are about equal in length, but from the third, which is the narrowest, they increase gradually in width to the last. Owing to lateral extensions anterior to the uncinigerous tori, the margins of the ventral plates are strongly serrated. The abdominal ventral plates are also thick and occupy about three-fifths of the ventral area. Widest at the anterior end, the first 15 or 20 become gradually narrower, after which there is no change until at the posterior end of the body they diminish correspondingly. Throughout they are sharply defined by straight margins. In the alcoholic specimens all of the segments are short and sharply defined, and an extensive area on the dorsal surface is thrown into very deep rugous glandular folds, occupying on the posterior one-third of the type specimen the entire width of the dorsal area, but anteriorly becoming lower and more and more restricted to the middle region until they finally fade out. On the second specimen they are less conspicuously developed, but are otherwise similar. A well-marked fæcal groove divides the abdominal ventral plates into equal halves to the first, cuts this obliquely to the left and passes dorsad in the thoracico-abdominal groove to the level of the abdominal setæ tufts, and then obliquely across the last thoracic somite dorsal to its setæ tuft to the middle line, along which it proceeds as a deep and conspicuous groove to the dorsal collar opening.

All setæ tufts are large and prominent, the abdominal strictly vertical and ventral, the thoracic dorsal and slightly oblique, except the first, which is nearly horizontal, entirely free from the collar and slightly smaller than the others. The uncinigerous tori are also well marked, on the thoracic somites meeting the ventral plates below and slightly hooked backward above. The first pair, on the second setigerous somite, are the longest; the seventh and last about three-fourths as long; reduction in length takes place at both ends and the setæ tufts descend to a correspondingly lower level. All abdominal tori are shorter than the last thoracic and they diminish gradually and constantly to the posterior end. They are especially prominent dorsally where they terminate in a prominent projection marked with a conspicuous black spot.

All setæ are nearly colorless, translucent and striated. Those of the first or collar fascicle are all of one form, slender, narrowly lanceolate, slightly curved and with a single narrow wing, but differ considerably in length. On other thoracic somites those in the dorsal rows of the bundles are similar (Pl. XXXVIII, fig. 38), but the ventral ones (Pl. XXXVIII, fig. 39) are shorter, spatulate, doubly winged, and have acute but not mucronate tips; they differ somewhat in curvature and breadth of wings, but the one figured is typical. The abdominal setæ are again all of one kind, rather more broadly lanceolate than, but otherwise similar to, those of the collar fascicle.

The thoracic uncini are of two kinds—large aviculæ and smaller pick-shaped hooks, arranged in opposed parallel rows, there being 105 of each on II, 97 on V, and 90 on VIII on the type specimen. The aviculæ (Pl. XXXVIII, fig. 40) are of a very pale yellow, the bases long, slender, slightly curved; the neck and head prominent and erect, slightly inclined forward; the breast prominent, hemispherical; the neck slightly tapered and about as long as thick at the base, the head scarcely enlarged with the rather stout but acute beak strongly bent downward, the crest little elevated and forming a dense sheath of fine spines arranged in numerous transverse and longitudinal rows closely appressed on the upper half of the beak. Abdominal aviculæ differ only in their somewhat shorter bases and less prominent breasts. They are not associated with pick-shaped uncini and the type specimen has about 80 in each torus.

The pick-shaped uncini (Pl. XXXVIII, fig. 41) have stems about as long as the bases of the aviculæ, but much more slender; they are nearly straight, but more or less slightly enlarged and bent at about the beginning of the outer one-third. The tip curves to a short blunt point enclosed within a loose expanded hood, from which arises a delicate, colorless, very slender process, making an angle of about 60° with the stem.

Except as already described for the branchiæ, all pigment has faded out. *Distylia* Quatrefages is employed instead of the earlier *Bispira* Kroyer, because the author of the latter seems never to have applied the name to any species.

Explanation of Plates.

Plate XXXVII.

Diopatra californica, Figs. 1 to 9.

Fig. 1.—Large guarded and hooked seta from the middle of the third parapodium. $\times$ 250.
Fig. 2.—Small one from ventral bundle of the same. $\times$ 250.
Fig. 3.—Simple slender seta from the same. $\times$ 250.
Fig. 4.—Broader winged seta from the tenth parapodium. $\times$ 250.
Fig. 5.—Spatulate and pectinate seta from the same. $\times$ 440.
Fig. 6.—Crochet-shaped aciculus from the twenty-fifth parapodium. $\times$ 250.
Fig. 7.—Simple pointed aciculus from L. $\times$ 250.
Fig. 8.—Simple blunt aciculus from LXXV. $\times$ 250.
Fig. 9.—Jaws, all parts in dorsal view; on the left the maxillæ are shown *in situ*, on the right the plates are separated. $\times$ 8.

Eunice biannulata, figs. 10 to 18.

Fig. 10.—Compound seta from second parapodium. $\times$ 250.
Fig. 11.—Compound seta from somite LXX. $\times$ 250.
Fig. 12.—Slender seta from second parapodium. $\times$ 250.
Fig. 13.—Pointed aciculus from the first parapodium. $\times$ 250.
Fig. 14.—Flattened aciculus from X. $\times$ 250.
Fig. 15.—Dorsal aciculus from LXV. $\times$ 250.
Fig. 16.—Dorsal aciculus from LXX. $\times$ 250.
Fig. 17.—Hooked and guarded ventral aciculus from LXV. $\times$ 250.
Fig. 18.—Dissected jaws viewed from above. $\times$ 12.

Lumbriconereis erecta, figs. 19 to 22.

Figs. 19, 20, and 21.—Anterior views of the 10th, 100th and 250th parapodia respectively. $\times$ 33.
Fig. 22.—Mandible. $\times$ 8.

Plate XXXVIII.

Lumbriconereis erecta, figs. 23 to 25.

Figs. 23 and 24.—Slender winged seta from the 10th and 25th parapodia respectively. $\times$ 130.
Fig. 25.—Hooded crochet from middle of the 10th parapodium. $\times$ 250.

Cirratulus spirabranchus, figs. 26 and 27.

Fig. 26.—Outline of side of 50th setigerous somite. $\times$ 24.
Fig. 27.—Same of 150th setigerous somite. $\times$ 24. *a*, ventral, and *b*, dorsal spine. $\times$ 55.

Cirratulus luxuriosus, figs. 28 to 31.

Fig. 28.—Outline of side of 50th setigerous somite. $\times$ 24.
Fig. 29.—Outline of side of 150th setigerous somite. $\times$ 24.
Fig. 30.—Outline of side of 150th setigerous somite. $\times$ 24.
Fig. 31.—A spine from the ventral bundle of the 50th somite. $\times$ 55.

Maldane disparidentata, figs. 32 to 35.

Fig. 32.—Outer end of a crochet from the 2d setigerous somite. $\times$ 250.
Fig. 33.—Outer end of a crochet from the 14th setigerous somite. $\times$ 250.
Fig. 34.—Front view of the last. $\times$ 250.
Fig. 35.—Portion of a spirally fringed seta from the 14th somite. $\times$ 440.

Schmardanella californica, figs. 36 and 37.

Fig. 36.—A seta from somite XI. × 600.
Fig. 37.—An uncinus from the same somite. × 600.

Distylia rugosa, figs. 38 to 41.

Fig. 38.—Slender seta from dorsal part of VI. × 250.
Fig. 39.—Broad seta from ventral part of VI. × 250.
Fig. 40.—Avicular uncinus from VI. × 250.
Fig. 41.—Pick-shaped uncinus from VI. × 440.
Fig. 42.—*Eunice biannulata.* A spatulate and pectinate seta from a middle parapodium. × 440.

THE FISHES OF NANTUCKET.

BY DR. BENJAMIN SHARP AND HENRY W. FOWLER.

Fish are taken in Nantucket by hand-lines, trolling, line-trawls, drift- and set-nets and pounds or traps. Hand-lining is employed for scup, plaice, flatfish, cod, haddock, and in times past for dogfish and halibut. The line-trawls are used in the spring and fall for cod and haddock, drift-nets in the spring for mackerel, set-nets in the summer and fall for bluefish and bonito. The two pounds fixed in water of about 4 fathoms are inside, that is on the west of Great Point, about midway between the Koskata U. S. Life Saving Station and Great Point Lighthouse. These pounds are the property of the Petrel Fishing Company, which employs a small steamer and a sailboat. Every species of commercial fish found about the island has been taken in the pound, and many others mentioned in this list. Bluefish are very rarely found in them. During the spring of the year the steamer *Petrel* is employed drifting for mackerel off the south side of the islands of Nantucket and Tuckernuck. During the summer she steams around the island for bluefish and an occasional trip is made for swordfish, when she cruises some 30 or 40 miles from the land. The bluefish are taken by sweeping nets around a school of fish. This is done by dories which put out from the steamer when a school is discovered.

The steamer *Waquoit* is also employed in fishing for mackerel, swordfish and bluefish. This steamer and the *Petrel* are the only two steam fishing-boats owned in Nantucket.

The line-trawls are used in the spring and fall in the cod and haddock fisheries. These are set from dories which put out from the beaches on the south and east sides of the island when the weather permits, and on returning are hauled up out of the surf to a safe place and the fish carted to town.

At Quidnet there are a number of houses where the Portuguese salt codfish. Salting and drying codfish is also carried on by a number of fishermen from the Cape. They have established a small village on Coatue ("New Chatham"), and in catboats sail out of the "opening" at the head of the harbor and fish off the eastern side of the island.

A gasoline-power boat, the *San Antonio*, has recently been built by some enterprising Portuguese on Nantucket, and is employed in various kinds of fishing about the island.

The set-nets, used in the fall for catching bonito, are hung in the "Cod" of the Bay—the sheet of water enclosed by the arm of the island called Great Point.

Collections of Nantucket fishes have been made by the senior writer and presented by him to the Academy of Natural Sciences of Philadelphia. The * affixed to certain species indicates that material from this source has been examined.

In conclusion, we wish to thank the members of the "Petrel Company" for their kindness and interest in helping us in this work.

PETROMYZONTIDÆ.

Petromyzon marinus Linnæus. ("Lamprey.")

Specimen taken in the pound, April 28, 1904, about 3 feet in length.

GALEORHINIDÆ.

***Mustelus canis** (Mitchill).

Found associated with *Squalus acanthias.*

Prionace glauca (Linnæus). ("Blue Dog." "Man-eater.")

Caught with the sand shark (*Carcharias littoralis*), but by no means so common.

"Sharking" is one of the sports of the island. Those caught are not used now commercially. Some years ago, when "sharking" was carried on regularly at Wawinet, a village at the head of the harbor, the livers of all the sharks caught were saved, dried out in the sun and the oil shipped away.

Carcharhinus obscurus (Le Sueur) ?

About 6 or 8 examples probably of this or some closely related species have been taken at various times at or near Great Point. A large example was taken by the senior writer during the summer of 1877, weighing 650 pounds. It measured 11 feet 6 inches.

SPHYRNIDÆ.

***Sphyrna zygæna** (Linnæus).

Two examples seen. One washed ashore many years ago, and another taken in a set-net September 25, 1903. The latter examined by the junior writer.

ALOPIIDÆ.

Alopias vulpes (Gmelin). ("Thrasher.")

Two examples seen. Both taken at Great Point, one with a line and the other in the pound. The tail of the latter measured 7½ feet.

LAMNIDÆ.

Isurus dekayi (Gill)? ("Mackerel Shark.")

Taken in the spring in the mackerel drift-nets.

CARCHARIIDÆ.

***Carcharias littoralis** (Mitchill). ("Sand Shark.")

This is the commonest shark in these waters. They are taken on lines and sometimes rolled up in the set-nets. Occasionally in the harbor. A small one was taken a few years ago in one of the docks. It measured about 5 feet.

SQUALIDÆ.

Squalus acanthias Linnæus. ("Dog Fish.")

They breed on the bar in May. Some years ago they were regularly fished for by sailboats. They were so plentiful that it was the custom to break off the barb of the hook to make it easier to get the fish off when caught. They are a great nuisance to the mackerel fishermen, not only in tearing the nets, but in mangling the mackerel already in the net. In October, 1903, for two or three days they filled up the pounds.

RAJIDÆ.

Raja erinacea Mitchill. ("Skate.")

Common all about the island and associated with—

Raja lævis (Mitchill). ("Skate.")

MYLIOBATIDÆ.

Rhinoptera bonasus (Mitchill).

Only one specimen seen. Taken in the pound, October 16, 1902.

ACIPENSERIDÆ.

Acipenser sturio Linnæus. ("Sturgeon.")

Often seen "breaking" (jumping out of water) on still days off the east end of the island. Occasionally taken in the nets.

ANGUILLIDÆ.

***Anguilla chrisypa** Rafinesque. ("Eel.")

Taken by spearing in shallow water in the harbor and in Madequet "creek," a tide-water stream at the western end of the island. They are also taken at night torching and with the "bob." In winter holes are cut in the ice and the eel-spear thrust through into the mud and many eels taken. This was especially resorted to in the long freeze-up of 1904. A perfect albino specimen was taken by Henry Folger in the spring of 1903 and is now in the Academy's collection.[1]

ELOPIDÆ.

***Elops saurus** Linnæus. ("Lady Fish.")

Taken in the pound in October, 1903.

CLUPEIDÆ.

Clupea harengus Linnæus. ("Herring.")

Taken in the spring by opening the south head of the Hummock pond (fresh-water) to the sea. As they run in they are scooped out with hand-nets. Many remain through the summer in the pond after it is closed. They are also taken in the pound.

Pomolobus pseudoharengus (Wilson)? ("Herring.")

Alosa sapidissima (Wilson). ("Shad.")

A few taken in the pound in the spring of 1901. Tradition says that they were common about the island before the bluefish became so numerous. Thirty-six taken April 29, 1904, and 30 taken May 7, 1904, in the pounds.

***Brevoortia tyrannus** (Latrobe). ("Menhaden.")

SALMONIDÆ.

Salmo salar Linnæus. ("Salmon.")

One weighing 3½ pounds taken off Tuckernuck in the mackerel drift-nets of the *Waquoit* on the night of May 6 and 7, 1904.

PŒCILIIDÆ.

***Fundulus majalis** (Walbaum). ("Cat Fish.")

Caught with the following about the wharves by boys, and the name given as they are caught for cats' food.

***Fundulus heteroclitus macrolepidotus** (Walbaum). ("Cat Fish.")

Abundant about the wharves. Used with the above for bait for plaice fish.

SYNGNATHIDÆ.

Siphostoma fuscum (Storer). ("Pipe Fish.")

Common on the bars in August and September. Associated with and closely resembling floating eel-grass. This is undoubtedly a case of color and form protection.

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[1] A spotted eel about four feet long has been noticed by the senior writer. Three specimens were seen at different times, one on exhibition four or five years ago and two were seen in October, 1902, which were sent to Albany by Sydney Fisher. They were called Conger Eels by the fishermen, and thought to be related to *Murœna ocellata*.

ATHERINIDÆ.

*Menidia notata (Mitchill).

BELONIDÆ.

*Tylosurus acus (Lacépède). ("Bill Fish.")

Rare. One taken September 23, 1901, and another August, 1903, in the pound.

SCOMBRIDÆ.

Scomber scombrus Linnæus. ("Mackerel.")

Caught in drift-nets which are set at night off the south side of the island in the spring of the year. Sometimes in the fall they are taken on hand-lines in Nantucket Sound. Some taken also in the pounds. First taken (in the pound) in 1904, April 28. On April 29, 32 taken; on May 6 and 7, 160 taken by steamer *Waquoit* "drifting" off south side.

Thunnus thynnus (Linnæus). ("Horse Mackerel.")

Caught around the island by the *Petrel* with swordfish gear, and also in the pounds. Schools of 60 or 70 have been seen.

Sarda sarda (Bloch). ("Bonito.")

Caught in set-nets through September and October, rarely caught trolling.

Scomberomorus maculatus (Mitchill). ("Spanish Mackerel.")

TRICHIURIDÆ.

*Trichiurus lepturus Linnæus. ("Hair Tail.")

Three large examples secured, four in all, taken in the pound in July, 1903.

XIPHIIDÆ.

Xiphias gladius Linnæus. ("Sword Fish.")

Common in July off the south side of the island, from 20 to 40 miles from the land. They are taken by the ordinary swordfish gear by the steamers *Petrel* and *Waquoit*. Many years ago sail-boats from Nantucket made a business of swordfishing.

CARANGIDÆ.

*Seriola zonata (Mitchill). ("Rudder Fish.")

Taken in pound, 1903.

*Caranx crysos (Mitchill). ("Yellow Tail.")

Taken in pound, 1903.

Selene vomer (Linnæus). ("Moon Fish.")

A small example taken in the pound, September 26, 1901.

Trachinotus carolinus (Linnæus). ("Pompano.")

Two examples taken in the pound, September, 1901.

POMATOMIDÆ.

Pomatomus saltatrix (Linnæus). ("Blue Fish.")

These are taken by trolling in the Rips—Muskeget Rip, Great Point Rip and Bass Rip (off Sankaty Head)—and for many years great numbers were caught by boats in the opening which broke through some fifty years ago between Nantucket and Tuckernuck. This place is now given up. When the bluefish first became common about the island, in the early 60's, they were caught in the harbor, now they are rarely seen there. Set-nets were also used, but of late these are but little used. The *Petrel* gets them off the south and east ends of the island by means of sweep-nets. When a school is seen—and this can be done at some distance by the terns which hover over them—the net is shot from dories and pulled around the school, the fish in darting away get gilled and are then taken from the net.

"Heaving and hauling"—*i.e.*, throwing a drail or leaded hook from the shore and hauling in—is now occasionally done at the south shore, and on September 26, 1903, an example weighing 27 pounds was taken. This is considerably larger than the largest heretofore reported by Jordan and Evermann, *Food and Game Fishes*, 1902, p. 321, where one weighing 22 pounds and measuring 3 feet in length is mentioned.

Up to 1880 hundreds were often caught in an afternoon from the south shore.

CENTROLOPHIDÆ.

***Palinurichthys perciformis** (Mitchill). ("Rudder Fish.")

STROMATEIDÆ.

***Rhombus triacanthus** (Peck). ("Butter Fish." "Butter Scup.")

These have never been known to take a hook. All the specimens are taken in the pounds, as many as twenty barrels having been obtained in a day. The first taken in 1904 was on May 6, and two the next day.

PERCIDÆ.

Perca flavescens (Mitchill). ("Pond Fish." "Perch.")

Only taken in the fresh-water ponds, and very abundant.

SERRANIDÆ.

Roccus lineatus (Bloch). ("Striped Bass.")

Rarely taken on the scup grounds.

Centropristes striatus (Linnæus). ("Black Bass.")

In October, 1903, about ten barrels were taken one day from the pounds. Occasionally taken on the scup grounds.

SPARIDÆ.

***Stenotomus chrysops** (Linnæus). ("Scup" [abbreviation of Indian word *Mishcuppauog*].)

This is an important food fish, and until the introduction of the pounds was only taken by hand-lines. They arrive in these waters about June 1. The first fish are always the largest. Later in the season smaller ones occur. It is said that the first fishing-boat built with a well (in 1763) was first employed in the scup fishery. In the summer of 1903 these fish practically abandoned these waters, a few were taken in the pounds, and the hand-lining was given up. The first (two) were taken in the pound in 1904 on May 8.

SCIÆNIDÆ.

***Cynoscion regalis** (Schneider). ("Squi-dee.")

Common since the bluefish have become scarce. Occasionally taken trolling, but never, as far as we know, have they been fished for with rods—so commonly practiced in the Jersey waters. Large numbers taken in the pounds.

Menticirrhus saxatilis (Schneider). ("Whiting.")

Taken with the mackerel in drift-nets in the spring and are given away, not being very highly esteemed as a food fish.

LABRIDÆ.

Tautogolabrus adspersus (Walbaum). ("Wharf Fish.")

Fished by boys for cat food. Common about the wharves.

Tautoga onitis (Linnæus). ("Tautog.")

Not common. Taken on the scup grounds and in the pounds.

BALISTIDÆ.

***Balistes vetula** Linnæus. ("Trigger Fish.")

Taken on the scup grounds. The three secured were taken in the pound in 1903.

TETRAODONTIDÆ.

Spheroides maculatus (Schneider). ("Swell-belly.")

Taken on the scup grounds.

MOLIDÆ.

Mola mola (Linnæus). ("Sun Fish.")

Rare. Seen in deep water on calm days about the island. One taken some years ago was sent by Dr. Harold Williams to Tuffts College, Massachusetts.

COTTIDÆ.

***Myoxocephalus octodecemspinosus** (Mitchill). ("Sculpin.")

On scup grounds and in pound. One seen in pound, May 7, 1904.

CYCLOPTERIDÆ.

Cyclopterus lumpus Linnæus. ("Lump Fish.")

One specimen (8 inches long) taken in the pound, May 8, 1904.

TRIGLIDÆ.

***Prionotus carolinus** (Linnæus). ("Peter Grunter.")

Common on scup grounds. At times as many as two or three barrels taken in the pound. Not used as food. The senior writer has often eaten them, and finds them excellent. Seen on May 6, 1904.

ECHENEIDIDÆ.

Echeneis naucrates Linnæus. ("Sucker.")

Rare.

MERLUCCIIDÆ.

Merluccius bilinearis (Mitchill). ("Hake.")

But one adult seen. Taken in the trap October, 1903. In the spring of 1902 the young, about 4 inches in length, were very abundant about the wharves.

GADIDÆ.

Polachius virens (Linnæus). ("Pollock.")

Caught trolling off east coast. Since the introduction of the pound they have been taken in great numbers. From April 9 to May 5, 1904, very nearly 20,000 were taken by the *Petrel.*

Gadus callarias Linnæus. ("Cod.")

Taken in the spring and fall by hand-lines and line-trawls on the shoals about the island and occasionally in the Sound at Long Hill. Most of those taken by the Petrel Company are sent away, fresh, in ice, some are pickled and others salted and dried. These fish for the last two years have greatly diminished in number.

Melanogrammus æglefinus (Linnæus). ("Haddock.")

Mostly taken in the spring of the year.

PLEURONECTIDÆ.

Hippoglossus hippoglossus (Linnæus). ("Halibut.")

Many years ago regularly fished for off Great Point. In April, 1904, Mr. Burchell, while cod-fishing off the east end of the island, caught a halibut on a codfish hook, but lost him. He estimated the fish, which he saw, as weighing about 100 pounds.

Paralichthys dentatus (Linnæus). ("Plaice.")

Very common on the bar in the summer of 1903.

Paralichthys oblongus (Mitchill). ("Flounder.")

Two or three taken in the pound early in May, 1904.

Lophopsetta maculata (Mitchill). ("Flat Fish.")

Pseudopleuronectes americanus (Walbaum). ("Winter Flounder.")

Fished for in the harbor in the late fall and early spring.

LOPHIIDÆ.

Lophius piscatorius Linnæus. ("Goose Fish." "Monk Fish.")

About fifty seen at one time in the pound in the fall of 1903, and appeared to average from 50 to 75 pounds apiece.

NOTES ON ORTHOPTERA FROM NORTHERN AND CENTRAL MEXICO.

BY JAMES A. G. REHN.

The following study is based entirely on material in the collection of the Academy of Natural Sciences of Philadelphia. The States of Chihuahua, Jalisco, San Luis Potosi and Tamaulipas are represented in the series of about four hundred specimens studied. The most extensive series is that, comprising two hundred and sixty-four specimens, collected in Jalisco, chiefly at Guadalajara, in 1903, by Mr. J. F. McClendon, and purchased by the Academy. An exceedingly interesting collection of seventy-one specimens from San Luis Potosi and Tamaulipas was collected by Mr. M. E. Hoag, and this limited series has furnished a surprising number of new and little known forms. Three smaller collections are embraced in this study; a number of Guadalajara specimens collected and presented by Mr. C. H. T. Townsend; a few interesting individuals from Victoria, Tamaulipas, collected by S. N. Rhoads, and a series of Casas Grandes, Chihuahua, specimens, collected and presented by Dr. W. E. Hughes.

Family BLATTIDÆ.

Genus PSEUDOMOPS Serville.

Pseudomops oblongata (Linnæus).

Tuxpan, Jalisco, September 4, 1903. (McClendon.) One male.

Pseudomops discoidalis (Burmeister).

Guadalajara, Jalisco. August 24 and September 18, 1903. (McClendon.) Two females.

These specimens agree with the descriptions and single Orizaba specimen examined, except that the antennæ are not annulate with whitish and the general color of the tegmina is more blackish.

Periplaneta americana (Linnæus).

Guadalajara, Jalisco. August 24, 1903. (McClendon.) One male.

Family MANTIDÆ.

Genus STAGMOMANTIS Saussure.

Stagmomantis limbata (Haan).

Guadalajara, Jalisco. September 14 and 18, 1903. (McClendon.) One male, five females.

One of the females in this series represents the dark wine-color phase.

Genus **OLIGONYX.**

1869. *Oligonyx* Saussure, Mittheil. Schweiz. Ent. Gesell., III, pp. 58, 71. Included *minuta* Drury, *bicornis* and *filiformis* Saussure and *filum* Lichtenstein.

Oligonyx mexicanus Saussure and Zehntner.

1894. *Oligonyx mexicanus* Saussure and Zehntner, Biol. Cent.-Amer., Orth., I, p. 172, tab. IX, figs. 13–15. [Presidio, Mexico; Cubulco, Vera Paz, Guatemala.]

Guadalajara, Jalisco, August 23, 1903. (McClendon.) One male.

This specimen is referred here with some little doubt as the pronotum is slightly shorter and the tegmina slightly longer than Saussure and Zehntner's measurements, but these discrepancies are slight, and the specimen in all probability represents this species.

Genus **VATES** Burmeister.

Vates townsendi Rehn.

Guadalajara, Jalisco. August 9 and September 18, 1903. (McClendon.) One male, one female.

Family **PHASMIDÆ.**

Genus **DIAPHEROMERA** Gray.

Diapheromera calcarata Burmeister.

Guadalajara, Jalisco. September 14, 1903. (McClendon.) Two males.

These specimens agree perfectly with individuals previously recorded from Alta Mira, Tamaulipas.[1]

Genus **PSEUDOSERMYLE** Caudell.

1903. *Pseudosermyle* Caudell, Proc. U. S. National Museum, XXVI, p. 867.

Type.—*Pseudosermyle banksii* Caudell.

Pseudosermyle tridens (Burmeister).

Tuxpan, Jalisco. September 4, 1903. (McClendon.) One male.

Guadalajara, Jalisco, September 18, 1903. (McClendon.) One female.

These specimens agree perfectly with a series of six specimens of both sexes from Cuernavaca, Morelos and Iguala, Guerrero.

Genus **BOSTRA** Stål.

Bostra jaliscensis n. sp.

Type: ♂; Tuxpan, Jalisco, Mexico. September 4, 1903. (J. F. McClendon.) [Coll. of Acad. Nat. Sci. Phila.]

Related to *B. incompta* Rehn,[2] from Costa Rica, but differing in the

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[1] *Proc. Acad. Nat. Sci. Phila.*, 1904, p. 50.
[2] *Proc. Acad. Nat. Sci. Phila.*, 1904, p. 57.

smaller size, more elongate and posteriorly constricted head, more elongate ninth dorsal abdominal segment, heavier cerci and more produced inferior angle of the subgenital opercle. No close relationship exists with *B. dorsuaria* Stål or *turgida* (Westwood).

Size medium; form very elongate; surface smooth. Head distinctly longitudinal, the posterior portion with a marked but gradual constriction; eyes elliptical, not prominent; ocelli absent; antennæ with the basal joint longitudinal, depressed, external margin not distinctly sulcate. Pronotum slightly shorter than the head, slightly expanded posteriorly; cruciform impression weak, the central portion more apparent than the extremes; lateral margins distinctly cingulate. Mesonotum very slender and elongate, equal to the median femora. Metanotum (with median segment) two-thirds the length of the mesonotum; median segment slightly shorter than the remaining portion of the metanotum and slightly longer than the first abdominal segment. Abdomen with all the six basal segments quite elongate, the fifth slightly and the sixth distinctly shorter than any of the basal four; seventh, eighth and ninth segments subequal in length, the seventh expanded apically, the eighth constricted apically, the ninth subequal and with the apical half bearing several distinct longitudinal sulci, apical margin sinuato-truncate; cerci simple, straight, somewhat compressed, slightly shorter than the ninth dorsal abdominal segment; subgenital opercle compressed, not exceeding the apical margin of the eighth dorsal segment, inferior angle produced into a distinct claw-like point. Anterior femora equal to the mesonotum, pronotum and half of the head in length, straight, distinctly carinate, basal flexure short but distinct; tibiæ exceeding the femora by the length of the pronotum, very slender, carinate; metatarsi slender, exceeding the remaining tarsal joints in length, superior surface with a narrow and rather indistinct longitudinal sulcus. Median femora equal to the mesonotum in length, slightly arcuate; tibiæ exceeding the femora in length; metatarsi slightly shorter than the remaining tarsal joints, sulcus as in the anterior metatarsi. Posterior femora reaching to the middle of the fifth abdominal segment, slender, very slightly arcuate; tibiæ slightly exceeding the femora; metatarsi subequal with the remaining tarsal joints, no distinct sulcus above.

General color drab, suffused on the apex of the abdomen with, and a broad lateral streak on the head cream color; eyes mottled cinnamon and umber; postocular streak on head and pronotum hair-brown; limbs drab, more or less distinctly annulate with broad bands of dull brownish, some of the pale annuli wood-brown.

Measurements.

Total length,	96 mm.
Length of head,	4.3 "
Length of pronotum,	3.3 "
Length of mesonotum,	24.3 "
Length of metanotum (including median segment),	15.5 "
Length of median segment,	7 "
Length of abdomen,	49 "
Length of anterior femora,	28.5 "
Length of anterior tibiæ,	33.5 "
Length of median femora,	24.5 "
Length of posterior femora,	29.5 "

Genus **PARABACILLUS** Caudell.

1903. *Parabacillus* Caudell, Proc. U. S. Nat. Mus., XXVI, p. 865.

Type.—*Bacillus coloradus* Scudder.

Parabacillus palmeri (Caudell).

1902. *Bacillus palmeri* Caudell, Ent. News., XIII, p. 274. [Durango, Mexico.]

Guadalajara, Jalisco. July 22 and August 16, 1903. (McClendon.) Four females.

Family **ACRIDIDÆ.**

Subfamily ACRIDINÆ.

Genus **ACHURUM** Saussure.

1861. *Achurum* Saussure, Revue et Magasin de Zoologie, 2e ser., XIII, p. 313.

Type.—*Truxalis sumichrasti* Saussure.

Achurum sumichrasti (Saussure).

1861. *Tr*[*uxalis*] *Sumichrasti* Saussure, Revue et Magasin de Zoologie, 2e ser., XIII, p. 313. [Temperate Mexico.]

Guadalajara, Jalisco. August 20 and September 18, 1903. (McClendon.) Two females.

Genus **SYRBULA** Stål.

1873. *Syrbula* Stål, Recensio Orthopterorum, I, p. 91, 102.

Included *Oxycoryphus montezuma* Saussure and *Syrbula leucocerca* Stål.

Syrbula pacifica Bruner.

1904. *Syrbula pacifica* Bruner, Biol. Cent.-Amer., Orth., II, p. 44. [Tepic.]

Guadalajara, Jalisco. September 14 and 18, 1903. (McClendon.) Male and female.

Syrbula eslavæ Rehn.

1900. *Syrbula eslavæ* Rehn, Trans. Amer. Ent. Soc., XXVII, p. 90. [Eslava, D. F., Mexico.]

La Joya, San Luis Potosi. August 10, 1903. (M. E. Hoag.) One male, one immature female.

Genus **MACHÆROCERA** Saussure.

1859. *Machærocera* Saussure, Revue et Magasin de Zoologie, 2e ser., XI, p. 391.

Type.—*M. mexicana* Saussure.

Machærocera mexicana Saussure.

1859. *M[achærocera] mexicana* Saussure, Revue et Magasin de Zoologie, 2e ser., XI, p. 391. ["Mexico calida."]

Alta Mira, Tamaulipas. June 26, 28 and 30, 1903. (M. E. Hoag.) Two males and one female.

A study of twenty-two specimens of this species from Tamaulipas, Vera Cruz and Morelos furnishes no constant diagnostic character for separating the Vera Cruz form as Thomas's *sumichasti*, as has been done by Bruner.[3] A pair of this species, labelled in Saussure's handwriting and presented by him, the male from "Mexique; Sumichrast," and the female "Orizaba, reg. temp. Sumichrast," agree with the rather large series studied. As the latter specimens are authoritatively determined and agree with specimens from Jalapa as well as Alta Mira, I feel justified in considering them all one species.

Machærocera pacifica Bruner.

1904. *Machærocera pacifica* Bruner, Biol. Cent.-Amer., Orth., II, p. 51. [Tepic, on the Pacific slope, not far from San Blas.]

Guadalajara, Jalisco. August 24, September 14 and 18, 1903. (McClendon.) Five males.

A fairly well-marked species, distinguished by the slender posterior femora and rather heavier antennæ.

Genus **AMBLYTROPIDIA** Stål.

1873. *Amblytropidia* Stål, Recensio Orthopterorum, I, pp. 93, 107.

Type.—*A. ferruginosa* Stål.

Amblytropidia ingenita Bruner.

1904. *Amblytropidia ingenita* Bruner, Biol. Cent.-Amer., Orth., II, p. 67. [Orizaba; Chilpancingo, Guerrero; Cuernavaca, Morelos.]

Cuernavaca, Morelos. September, 1900. (Barrett.) One female. This individual is rather larger than Bruner's maximum measurements.

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[3] *Biol. Cent.-Amer.*, Orth., II, p. 51.

Amblytropidia elongata Bruner.

1904. *Amblytropidia elongata* Bruner, Biol. Cent.-Amer., Orth., II, p. 68. [Tepic, Jalisco.]

Tuxpan, Jalisco. September 4, 1903. (McClendon.) One female.

The following key based on the female will serve to separate several species studied:

A.—Fastigium broad; eye ovoid; disk of the pronotum with the greatest width about two-thirds the length; posterior margin of the pronotum obtuse-angulate; lateral lobes of the pronotum higher than long.

B.—Form heavy; fastigium rather blunt; face somewhat rounded; posterior femora heavy, the slender distal portion less than one-third the total length, *occidentalis* (Saussure).

BB.—Form rather slender; fastigium acute; face distinctly angulate; posterior femora with the slender apical portion more than one-third the total length, . . *mysteca* (Saussure).

AA.—Fastigium rather narrow; eye elongate-ovoid; disk of the pronotum with the greatest width but slightly more than half the length; posterior margin very broadly obtuse-angulate; lateral lobes longer than high, ... *ingenita* Bruner.

Genus **ORPHULELLA** Giglio-Tos.

1894. *Orphulella* Giglio-Tos, Bollett. Mus. Zool. Anat. Comp., IX, No. 184, p. 10.

Based on *O. punctata* (DeGeer), *intricata* (Stål), *gracilis* and *elegans* Giglio-Tos, of which the first may be justly considered the type.

Orphulella tepaneca (Saussure).

1861. *St[enoboth]r[us] tepanecus* Saussure, Revue et Magasin de Zoologie, 2e ser., XIII, p. 319. [Mexico.]

Alta Mira, Tamaulipas. June 24 and 25, 1903. (M. E. Hoag.) Two females.

Genus **DICHROMORPHA** Morse.

1896. *Dichromorpha* Morse, Psyche, VII, pp. 326, 383.

Type.—*D. viridis* (Scudder).

Dichromorpha viridis (Scudder).

1862. *C[hloëaltis] viridis* Scudder, Boston Jour. Nat. Hist., VII, p. 455. [Connecticut.]

Guadalajara, Jalisco. August 6, 24, September 14 and 18, 1904. (McClendon.) Sixteen males, thirteen females.

These specimens are not typical *viridis*, and more material and study may show that they represent another form. The tegmina and wings reach to, or almost to, the tip of the abdomen in all the females, while the males have those members considerably exceeding the apex of the abdomen. A number of other characters exhibit more or less apparent differences, such as the shape of the eye and the vertex, the more gibbous anterior and median femora of the male, and the longer posterior limbs.

Genus **BOOPEDON** Thomas.

1870. *Boopedon* Thomas, Proc. Acad. Nat. Sci. Phila., 1870, p. 83.

Included *B. nigrum* Thomas (=*Gryllus nubilus* Say) and *B. flavofasciatum* Thomas.

Boopedon nubilum (Say).

1825. *G[ryllus] nubilus* Say, Jour. Acad. Nat. Sci. Phila., IV, p. 308. [Arkansa . . . . near the base of the Rocky Mountains"; probably referring to the country at the exit of the Arkansas River from the mountains.]

Casas Grandes, Chihuahua. September, 1902. (Dr. W. E. Hughes.) Two males.

These individuals are both of the black type of coloration, and in one the pregenicular annuli of the posterior femora are absent.

Boopedon hoagi n. sp.

Type: ♂; La Joya, San Luis Potosi, Mexico. August 10, 1903. (M. E. Hoag.)

Allied to *B. nubilum*, but differing in the smaller head and the longer and more distinctly carinate pronotum, the metazona of which is strongly punctate.

Size medium (equal to the male of *nubilum*); form moderately elongate, subbrachypterous, as is usual in the genus. Head of medium size, face moderately declivent, occiput rounded, hardly elevated above the pronotum, no distinct median carina present but with an exceedingly faint one on the fastigium; fastigium considerably broader than long, anteriorly obtuse-angulate, not excavated, margins very slightly elevated; lateral foveolæ linear, slightly marked; interspace between the eyes hardly narrower than the fastigium; eye subovate, anteriorly somewhat truncate, slightly longer than the infra-ocular portion of the genæ; frontal costa moderately broad, subequal, not quite reaching the clypeus, slightly excavated at the ocellus; antennæ about equal to the tegmina in length, somewhat depressed in the apical half, apex acute. Pronotum with the disk subequal in width, prozona and metazona subequal in length; anterior margin subtruncate, posterior margin obtuse-angulate; median carina very distinct, moderately high, lateral angles sharp but not truly carinate; metazona strongly punctate; lateral lobes higher than long, the inferior margin obtuse-angulate. Tegmina slightly shorter than the abdomen; greatest width one-third the distance from the base, costal expansion very large;

apex rounded. Wings equal to the tegmina in length. Abdomen with the apex not elevated; subgenital plate moderately acuminate; supra-anal plate triangular, somewhat convex and with a slight median longitudinal depression; cerci simple, styliform, apex rather blunt. Anterior and median limbs slender for the general size. Posterior femora robust, inflated basally, distal fourth subequal, scalariform markings obtuse; posterior tibiæ slightly shorter than the femora.

General color blackish, a faint line from the superior margin of the eye, a pregenicular annulus on the posterior femora and a proximal annulus on the posterior tibiæ dull ochraceous; distal half of the posterior tibiæ flesh-colored, the spines blackish apically; anterior and median limbs brownish sprinkled with black spots; antennæ flesh on the basal third, blackish beyond.

Measurements.

Length of body,	20.5 mm.
Length of pronotum,	5.7 "
Greatest dorsal width of pronotum,	3.2 "
Length of tegmina,	11.2 "
Length of posterior femora,	15.5 "

The type and an immature topotypic male are the only specimens examined. I have dedicated this species to the collector, the well-known entomologist, Mr. M. E. Hoag.

Boopedon gracile n. sp.

Type: ♂; Alta Mira, Tamaulipas. June 25, 1903. (M. E. Hoag.)

Quite distinct from any of the previously known species of the genus, and easily recognized by the slender form, fully developed tegmina and wings, and distinct carinæ of the fastigium and pronotum.

Size medium; form slender. Head of moderate size; occiput slightly flattened, but elevated somewhat above the pronotum; fastigium slightly broader than long, anteriorly rectangulate, shallowly but distinctly excavated, a distinct and sharp median carina present, margins as distinct as the median carina; interspace between the eyes about equal to the width of the fastigium; frontal costa rather broad, slightly constricted below the ocellus, reaching the clypeus, slightly excavated at and for a slight distance below the ocellus; eye ovate, subtruncate anteriorly, longer than the infra-ocular portion of the genæ; antennæ slightly more than half as long again as the head and pronotum. Pronotum rather narrow, disk about half as long again as the greatest (posterior) width; anterior margin rotundato-truncate, posterior margin obtuse-angulate and with the apex rounded; metazona slightly longer than the prozona; median carina very distinct, sharp; lateral carinæ distinct anteriorly, rounded on the metazona, which latter is very closely punctate; lateral lobes higher than broad, infe or margin obtuse-angulate, rounded posteriorly. Tegmina considerably exceeding the apex of the abdomen and but very slightly shorter than the tips of the posterior femora, subequal in width, the costal field moderately expanded; apex obliquely rotundato-truncate. Wings equal to the tegmina in length. Abdomen not recurved apically. Posterior femora slender (for the genus), tapering through the entire length; posterior tibiæ slightly shorter than the femora.

General color bistre; the top of the head, disk of the pronotum and anal field of the tegmina broccoli-brown; lateral lobes of the prozona and the genæ shining blackish; face and antennæ wood-brown, the latter infuscated in the apical half. Pronotum with the lateral carinæ marked anteriorly with buff. Anterior limbs pale cinnamon. Posterior femora blackish externally and inferiorly, except for a pregenicular annulus of ochraceous, superior and internal faces ochraceous with four blackish bars, the two proximal ones of which do not join the blackish external face, their distribution being, one genicular, one postmedian, one premedian and the other basal; posterior tibiæ blackish proximally with a broad dull ochraceous annulus, followed by a blackish annulus, the remainder dull isabella color suffused with blackish, the spines all blackish apically; tarsi ochraceous.

Measurements.

Length of body	22	mm.
Length of pronotum,	5	"
Greatest dorsal width of pronotum,	3	"
Length of tegmina,	18.7	"
Length of posterior femora,	16	"

The type is the only specimen of the species examined.

Genus **PLECTROTETTIX** McNeill.

1897. *Plectrotettix* McNeill, Psyche, VIII, p. 71.

Proposed to replace *Plectrophorus* McNeill (preoccupied) and including *P. viatorius* (Saussure) and *P. gregarius* (Saussure).

Plectrotettix viatorius (Saussure).

1861. *St*[*enobothrus*] *viatorius* Saussure, Revue et Magasin de Zoologie, 2e ser., XIII, p. 317. ["In tota Mexico occurrunt et gregibus copiosus campis damnum inferrunt."]

Guadalajara, Jalisco. June 28, July 17 and September 18, 1903. (McClendon.) Four males, six females.

Zapotlanejo, Jalisco. July 31, 1903. (McClendon). One male.

Zapotlan, Jalisco. July 7, 1902. (C. H. T. Townsend.) Four males, five females.

La Joya, San Luis Potosi. August 10, 1903. (M. E. Hoag.) Two females.

Alta Mira, Tamaulipas. June 24, 1902. (M. E. Hoag.) One male.

Genus **AULOCARA** Scudder.

1 76. *Aulocara* Scudder, Bull. U. S. Geol. Surv. Terr., II, p. 266.

Type.—*A. cæruleipes* Scudder = *A. elliotti* (Thomas).

Aulocara elliotti (Thomas).

1870. *S[tauronotus] Elliotti* Thomas, Proc. Acad. Nat. Sci. Phila., 1870, p. 82. [Eastern Colorado.]

Casas Grandes, Chihuahua. September, 1902. (Dr. W. E. Hughes.) One female.

Subfamily ŒDIPODINÆ.

Genus **ARPHIA** Stål.

1873. *Arphia* Stål, Recensio Orthopterorum, I, pp. 113, 119.

Included *A. sulphurea* (Fabricius) and *A. sanguinaria* Stål, of which the former may be considered the type.

Arphia simplex Scudder.

1875. *Arphia simplex* Scudder, Proc. Boston Soc. Nat. Hist., XVII, p. 514. [Dallas, Texas.]

La Joya, San Luis Potosi. August 10, 1903. (M. E. Hoag.) One male, two females.

Alta Mira, Tamaulipas. June 24 and 25, 1903 (M. E. Hoag.) Four males.

Victoria, Tamaulipas. January 14 or 15, 1903. (S. N. Rhoads.) Two males.

The male specimens are slightly smaller than several Texan representatives examined, but their measurements are about equal to those given by Scudder. The females, however, have the tegmina distinctly shorter than Texan individuals, but otherwise appear to fully represent this species.

Arphia truculenta n. sp.

Type: ♂; Guadalajara, Jalisco, Mexico. September 18, 1903. (McClendon.)

Allied to *A. nietana* Saussure,[4] but differing in the slenderer posterior femora, the broader and less sulcate frontal costa, and the more acute posterior process of the pronotum.

[4] Comparisons made with specimens of *nietana* from Eslava, D. F.

Size medium; form robust. Head with the vertex subhorizontal; scutellum of the vertex as broad as long, not appreciably excavated except for the distinct transverse depression, rugulose, median carina continued posteriorly on to the occiput, lateral carinæ of the scutellum low, but distinct; lateral foveolæ subquadrate, slightly excavated; frontal costa broad at and below the ocellus, slightly constricted below the latter, superiorly contracted and with an indistinct median carina, broadly sulcate at and for quite a distance below the ocellus; eye subovate, equal in length to the infraocular portion of the genæ; antennæ of medium length, slender basally, apically somewhat expanded and depressed. Pronotum with the disk of the prozona rather inflated, that of the metazona depressed; median carina distinct, but not high, subequal in height; anterior margin very obtusely angulate, posterior margin rectangulate with the angle rounded and the remainder of the margin rather sinuate; surface of the prozona rugose, of the metazona longitudinally verrucose; lateral lobes deeper than wide, subequal in breadth, inferior margin rounded with the angles not pronounced. Interval between the metasternal lobes slightly longer than broad. Tegmina exceeding the posterior femora by about one-fifth their total length, rather broad, apex obliquely truncate; dilation of the costal margin basal and very pronounced; intercalary vein nearer the ulnar vein proximally, nearer the median vein distally. Wings with the apex slightly falcate. Posterior femora rather slender (for the genus), the apical half tapering without any curve; posterior tibiæ slightly shorter than the femora.

General color wood-brown strongly maculate and closely punctulate with bistre. Head with the portion posterior to and below the eye blackish; antennæ blackish apically; eyes Prout's brown. Pronotum with the lateral lobes blackish. Pleura blackish. Tegmina very distinctly and closely punctulate with the overlying shade except the axillary field which is unicolor. Wings with the disk orange-chrome; fuscous band, which is very much circumscribed, limited to little more than the apical fourth of the wing and failing to reach the posterior margin, blackish in color, the tip of the same color and separated by a small subhyaline area from the band itself; ulnar tænia broad, subequal and solid in color, reaching more than two-thirds the way to the base of the wing; costal margin colored as on the disk. Posterior femora externally with indications of a preapical annulus; genicular region blackish; internal face blackish with two transverse dull yellowish bands. Posterior tibiæ dull cinnamon; spines tipped with black.

Measurements.

Length of body,	22.2 mm.
Length of pronotum,	6 "
Greatest width of pronotum,	4 "
Length of tegmina,	23 "
Greatest width of tegmina,	4.5 "
Length of wings,	22.2 "
Length of posterior femora,	16.5 "

Three males of this species have been examined, all from Guadalajara. They agree perfectly in structure, but exhibit some diversity in coloration. The black on the lateral lobes of the type is not so distinct in the other specimens, and the general features of the color pattern more subdued in both of them.

Genus **ENCOPTOLOPHUS** Scudder.

1875. *Encoptolophus* Scudder, Proc. Boston Soc. Nat. Hist., XVII, p. 478.

Type.—*Œdipoda sordida* Burmeister.

Encoptolophus costalis (Scudder).

1862. *Œ[dipoda] costalis* Scudder, Boston Jour. Nat. Hist., VII, p. 473. [Texas.]

Alta Mira, Tamaulipas. June 24, 1903. (M. E. Hoag.) One female.

Zapotlanejo, Jalisco. July 31, 1903. (McClendon.) Three males, three females.

Juanacatlan, Jalisco. July 22, 1903. (McClendon.) One female.

This series is quite uniform structurally, and such color differences as exist are very slight. The Alta Mira specimen has a more reddish cast when compared with Jalisco specimens of the same sex, but this coloration is found in the Jalisco males.

Encoptolophus parvus Scudder.

1875. *Encoptolophus parvus* Scudder, Proc. Boston Soc. Nat. Hist., XVII, p. 480. [Dallas, Texas.]

Guadalajara, Jalisco. August 8 and 20, 1903. (McClendon.) One male, one female.

Genus **HIPPISCUS** Saussure.

1861. *Hippiscus* Saussure, Revue et Magasin de Zoologie, 2e ser., XIII, p. 398.

Type.—*Œdipoda (Hippiscus) ocelote* Saussure.

Hippiscus ocelote Saussure.

1861. *Œ[dipoda] (Hippiscus) ocelote* Saussure, Revue et Magasin de Zoologie, 2e ser., XIII, p. 398. [Mexico.]

Guadalajara, Jalisco. September 14 and 18, 1903. (McClendon.) Eight males and eight females.

Saussure has recorded this species from Cordova and Guanajuato.

Hippiscus zapotecus Saussure.

1884. *X[anthippus] zapotecus* Saussure, Prodr. Œdipod., p. 91. ["Agei mexicanus."]

Guadalajara, Jalisco. August 17, 1903. (McClendon.) One female.

Genus **LEPRUS** Saussure.

1861. *Leprus* Saussure, Revue et Magasin de Zoologie, 2e ser., XIII, p. 398.

Type.—*Œdipoda* (*Leprus*) *elephas* Saussure.

Leprus elephas Saussure.

1861. *Œ[dipoda]* (*Leprus*) *elephas* Saussure, Revue et Magasin de Zoologie, 2e ser., XIII, p. 398. [Mexico.]

La Joya, San Luis Potosi. August 10, 1903. (M. E. Hoag.) One male, three females.

These specimens exhibit considerable variation in the extent of the inflation of the prozona and in the pattern and intensity of the coloration.

Genus **TROPIDOLOPHUS** Thomas.

1873. *Tropidolophus* Thomas, Synopsis Acrididæ N. Amer., p. 138.

Type.—*Tropidolophus formosus* (Say).

Tropidolophus formosus (Say).

1825. *Gryllus formosus* Say, American Entomology, II, Pl. 34, text page four (unnumbered). [Colorado: "About an hundred and fifty miles from the mountains, on the banks of the Arkansaw river."]

Casas Grandes, Chihuahua. September, 1902. (Dr. W. E. Hughes.) One female.

Genus **SPHARAGEMON** Scudder.

1875. *Spharagemon* Scudder, Proc. Boston Soc. Nat. Hist., XVII, p. 467.

Type.—*Gryllus æqualis* Say.

Spharagemon cristatum Scudder.

1875. *Spharagemon cristatum* Scudder, Proc. Boston Soc. Nat. Hist., XVII, p. 470. [Dallas and Waco, Texas.]

La Joya, San Luis Potosi. August 10, 1903. (M. E. Hoag.) Two adult males, one immature individual.

These specimens are considerably smaller than Scudder's measurements, but otherwise agree very well with this species.

Genus **LACTISTA** Saussure.

1884. *Lactista* Saussure, Prodr. Œdipod., p. 142.

Included *L. gibbosus, punctatus, pulchripennis* and *pellepidus*, of which *punctatus* may be considered the type.

Lactista punctatus (Stål).

1873. *O[Edipoda] punctata* Stål, Recensio Orthopterorum, I, p. 130. [Mexico.]

Alta Mira, Tamaulipas. June 24, 25 and 30, 1903. (M. E. Hoag.) Three males and one female.

The female is of unusually large size, but otherwise these specimens agree very well with Presidio, Vera Cruz, individuals.

Genus **TOMONOTUS** Saussure.

1861. *Tomonotus* Saussure, Revue et Magasin de Zoologie, 2e ser., XIII, p. 320.

Included *T. zimmermanni, mexicanus, nietanus* and *otomitus*, of which *mexicanus* is the only one uneliminated, and it consequently is the type of the genus.

Tomonotus mexicanus Saussure.

1861. *Tom[onotus] mexicanus* Saussure, Revue et Magasin de Zoologie, 2e ser., XIII, p. 321. [Temperate Mexico.]

Guadalajara, Jalisco. July 17, August 24 and 29, September 14 and 18, 1903. (McClendon.) Twenty-six males and twenty-five females.

Zapotlanejo, Jalisco. July 31, 1903. (McClendon.) One female.

Zapotlan, Jalisco. July 7, 1902. (Townsend.) Two males.

This large series is extremely interesting and shows considerable variation in the size of the male.[5]

Tomonotus orizabæ Saussure.

1861. *Œ[dipoda] mexicana* Saussure. Revue et Magasin de Zoologie, 2e ser., XIII, p. 397. [Mexico.]

1884. *T[omonotus] Orizabæ* Saussure, Prodrom. Œdipod., p. 98. [Texas; Mexico; Guatemala.]

Zapotlan, Jalisco. July 7, 1902. (Townsend.) Three males, two females.

Inseparable from a specimen from Uruapan, Michoacan.

Tomonotus aztecus (Saussure).

1861. *Œ[dipoda] azteca* Saussure, Revue et Magasin de Zoologie, 2e ser., XIII, p. 397. [Mexico.]

Alta Mira, Tamaulipas. June 25, 1903. (M. E. Hoag.) Two males.

Victoria, Tamaulipas. January 14 or 15, 1903. (S. N. Rhoads.) One female.

[5] The specimens recorded by the writer from Mazatlan as *Lactista gibbosus* (*Trans. Amer. Ent. Soc.*, XXIX, p. 10) are a species of *Tomonotus*, and in all probability *T. mexicanus*. The individuals there recorded had been dried from alcohol and many characters exhibited by them are misleading. The receipt of a specimen of true *L. gibbosus* from California (Claremont: C. F. Baker) caused me to make a second study with the above results.

La Joya, San Luis Potosi. August 10, 1903. (M. E. Hoag.) One female.

The males are inseparable from an individual of that sex from Cuernavaca, Morelos.

Genus **MESTOBREGMA** Scudder.

1876. *Mestobregma* Scudder, Bull. U. S. Geol. and Geograph. Surv. Terr., II, p. 264.

Type.—*Œdipoda plattei* Thomas.

Mestobregma mexicanum (Saussure).

1884. *Ps[inidia] mexicana* Saussure, Prodr. Œdipod., p. 164. ["Ager mexicanus."]

Guadalajara, Jalisco. August 17, 1903. (McClendon.) One male.

La Joya, San Luis Potosi. August 10, 1903. (M. E. Hoag.) One male, one female.

The female individual has the metazona dull green and the anal field of the tegmina margined with rosaceous.

Genus **TRIMEROTROPIS** Stål.

1873. *Trimerotropis* Stål, Recensio Orthopt., I, p. 118, 134.

Included *T. placida* Stål (=*ochraceipennis* Blanch.) and *T. maritima* (Harris), of which the latter may be considered the type.

Trimerotropis vinculata Scudder.[6]

1876. *Trimerotropis vinculata* Scudder, Proc. Boston Soc. Nat. Hist., XVIII, p. 270. [Guadalupe Island, off Lower California; San Diego, Cal.; Mexico.]

La Joya, San Luis Potosi. August 10, 1903. (M. E. Hoag.) Two males, three females.

San Luis Potosi, State of San Luis Potosi. August 5, 1903. (M. E. Hoag.) Five males, three females.

Guadalajara, Jalisco. August 24 and 28, September 14, 18 and 22, 1903. (McClendon.) Three males, seven females.

Zapotlanejo, Jalisco. July 31, 1903. (McClendon.) Three males.

Genus **HADROTETTIX** Scudder.

1876. *Hadrotettix* Scudder, Rep. Chief Engineers, 1876, Pt. 3, p. 511.

Type.—*Gryllus fasciatus* Say.

Hadrotettix trifasciatus (Say).

1825. *Gryllus trifasciatus* Say, Amer. Ent., II, Pl. 34, page seven of text (unnumbered). ["In Arkansaw, at the distance of about three hundred miles from the Rocky Mountains."]

Casas Grandes, Chihuahua. September, 1902. (Dr. W. E. Hughes.)

[6] The specimens previously recorded by me as *T. fascicula* (*Trans. Amer. Ent. Soc.*, XXVII, p. 227, and XXIX, p. 11) prove to belong to this common species of the western United States.

One male, one female, one nymph. This record extends the range of the species south of the Mexican boundary line.

Genus **HELIASTUS** Saussure.

1884. *Heliastus* Saussure, Prodr. Œdipod., p. 212.

Included *H. sumichrasti, venezuelæ, aztecus* and *obesus,* of which the first may be considered the type.

Heliastus sumichrasti (Saussure).

1861. *Œ[dipoda] Sumichrasti* Saussure, Revue et Magasin de Zoologie, 2e ser., XIII, p. 324. ["Mexico calida."]

Alta Mira, Tamaulipas. June 28, 1903. (M. E. Hoag.) One female.

This individual fully agrees with two authentic specimens from Ruatan Island, Honduras, and Chilpancingo, Guerrero, received from Dr. Saussure.

Heliastus aztecus Saussure.

1884. *H[eliastus] aztecus* Saussure, Prodr. Œdipod., p. 214. ["Ager mexicanus septentrionalior."]

Victoria, Tamaulipas. January 14 or 15, 1903. (S. N. Rhoads.) One female.

Genus **BRACHYSTOLA** Scudder.

1876. *Brachystola* Scudder, Bull. U. S. Geol. and Geograph. Surv. Terr., II, p. 267.

Type.—*Brachypeplus virescens* Charpentier.

Brachystola magna Girard.

1854. *Brachypeplus magnus* Girard, Explor. Red River Louisiana, p. 231, Zoology, Pl. XV, figs. 1–4. [Northern Texas.]

Casas Grandes, Chihuahua. September, 1902. (Dr. W. E. Hughes.) Six females, two nymphs.

Subfamily PYRGOMORPHINÆ.

Genus **SPHENARIUM** Charpentier.

1845. *Sphenarium* Charpentier, Orthopt. Descr. et Depict., tab. 31.

Type.—*S. purpurascens* Charpentier.

Sphenarium borrei Bolivar.

1884. *Sphenarium Borrei* Bolivar, Monograf. Pirgomorfinos, p. 99. [Guanajuato.]

Guadalajara, Jalisco. September 14 and 18, 1903. (McClendon.) One male, five rather immature females.

The male individual is rather strikingly colored, having the genicular regions of the posterior femora and the antennæ blackish, and the posterior and inferior margins of the pronotum purplish.

CALAMACRIS[7] n. gen.

Allied to *Orthacris* Bolivar,[8] but differing in the more elongate form, the more prominent fastigium, the presence of tegmina and the compressed abdomen. In general appearance it somewhat approaches *Dyscolorhinus* Saussure[9] from Madagascar, but it is separated by a number of characters.

Form elongate, moderately compressed. Head with the fastigium strongly produced; eyes elongate-elliptical; antennæ moderately elongate, depressed. Pronotum cylindrical. Prosternum erect, conoid, blunt. Interspace between the mesosternal lobes distinctly narrower than long, enlarged anteriorly. Tegmina very short, simple. Abdomen distinctly compressed, carinate above. Cerci simple, tapering. Subgenital plate moderately produced, compressed and keeled above apically. Anterior and median limbs rather short; posterior limbs elongate, femora tapering, tibiæ with a distinct apical spine on each margin.

Calamacris clendoni n. sp.

Types: ♂ and ♀. Guadalajara, Jalisco, Mexico. August 25 (♀) and September 18 (♂), 1903. (J. F. McClendon.) Coll. Acad. Nat. Sci. Phila.

♂. Size rather small; surface lineato-granulate. Head elongate; fastigium moderately broad, produced in front of the eyes a distance equal to the length of one of them, apex rounded; eye equal to the tuberculous postocular ridge; antennæ subequal in width, apical segment lanceolate, the entire length about equal to that of the head and pronotum. Pronotum with the median and lateral carinæ represented by imperfect ridges of granules; anterior margin arcuate, posterior margin with a deep median triangular sinuosity; lateral lobes nearly twice as long as the apparent height, anterior angle obtuse, inferior margin slightly sinuate, posterior angle rectangulate, but slightly produced posteriorly. Mesonotum almost hidden under the pronotum. Metanotum simple and resembling an abdominal segment, but shorter. Tegmina not reaching the apex of the metanotum, subequal in width, about four times as long as wide, the apex rounded. Abdomen with a number of longitudinal granulose strigæ on the dorsal surface. Supraanal plate acute trigonal, slightly longer than the preceding abdominal segment. Cerci about equal to the subgenital plate in length, compressed, slightly incurved with a distinct apical crook.

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[7] καλαμη, *stalk of corn*, and ακρις, *grasshopper*.

[8] *Monogr. Pirgomorfinos*, p. 93.

[9] *Abhandl. Senckenb. Naturf. Gesell.*, XXI, p. 640, taf. XXXVIII fig. 38.

Subgenital plate strongly compressed apically, and bearing a very distinct keel on the apical half of the upper surface; apex when viewed laterally blunt. Anterior and median limbs short, the femora stout. Posterior femora not reaching the apex of the abdomen, slender.

♀. Size medium; form much as in the male but slenderer; surface finely tuberculate. Head as in the male but proportionately shorter, the interspace between the eyes broader, and the eyes themselves not so elongate; antennæ triqueteous, rather short, but slightly exceeding the head in length. Pronotum as in the male, but the traces of the lateral carinæ slight, and the posterior emargination more pronounced. Ovipositor jaws rather straight, blunt, compressed. Posterior limbs weak, in fact hardly exceeding the male limbs in size, the femora not exceeding the fifth abdominal segment in length.

General color of male above clay color, finely and rather obscurely sprinkled and washed with dull olive. Eyes walnut-brown; antennæ olivaceous at the bases, washed with sienna apically. Under surface buffy.

General color of female dull olive-greenish, probably more brilliant in life.

Measurements.	♂	♀
Length of body,	19.5 mm.	39 mm.
Length of antennæ,	7 "	8 "
Length of pronotum,	3 "	4.5 "
Greatest width of pronotum,	2.2 "	3.8 "
Length of tegmina,	1 "	2.5 "
Length of abdomen,	11.5 "	23 "
Length of posterior femora,	8.2 "	11 "

This species is dedicated to Mr. J. F. McClendon, who secured the type while making a very interesting collection of Orthoptera in Jalisco.

A paratypic female, in addition to the type, has also been examined.

Subfamily LOCUSTINÆ.

Genus **TÆNIOPODA** Stål.

1873. *Tæniopoda* Stål, Recensio Orthopterorum, I, pp. 32, 51.

Included *Monachidium superbum* Stål and *T. picticornis* Stål (= *Rhomalea picticornis* Walker), of which the latter may be considered the type.

Tæniopoda burmeisteri Bolivar.

1901. *T[æniopoda] Burmeisteri* Bolivar, Boletin Soc. Españ. Hist. Nat., 1901, pp. 265, 266. [Mexico.]

City of Mexico. November, 1901. (Mrs. Charles Schäffer.) One female.

Guadalajara, Jalisco. August 5 and 10, September 14, 1903. (McClendon.) Fifteen males, eleven females.

Tuxpan, Jalisco. September 4, 1903. (McClendon.) One male.

Monterey, Nuevo Leon. One male.

This species exhibits a great amount of color and considerable structural variation. The single individual from Tuxpan is almost solid black in color, but no doubt represents this species, as extreme Guadalajara specimens have the pronotum and head, aside from the yellow lines and borders which are faintly marked in the Tuxpan individual, solid black. The City of Mexico specimen is much more robust than any of the others examined, and may possibly prove to be a distinct species. This form can readily be distinguished from *picticornis* (Walker) by the orange instead of crimson antennæ. This character may be subject to variation, as most the other color characters of the species are, but nevertheless it holds true in the above series, and in eight specimens of *picticornis*. Good structural characters exist, however, to separate the two forms.

Tæniopoda tamaulipensis n. sp.

Type: ♀; Alta Mira, Tamaulipas, Mexico. July 4, 1903. (M. E. Hoag.) Coll. Acad. Nat. Sci. Phila.

Allied to *T. picticornis* (Walker), but differing in the higher and slightly more arcuate median carina of the pronotum, the greater interspace between the eyes, and the different coloration

Size large; form very robust. Head with the occiput inflated, median carina obsolete; fastigium obtuse-angulate with distinct but rather low lateral ridges; frontal costa narrow, strongly constricted and evanescent inferiorly, distinctly sulcate; eye subreniform, somewhat prominent, slightly shorter than the infraocular portion of the genæ. Pronotum cristate, the prozona exceeding the metazona in length; anterior margin obtuse-angulate, posterior margin acute-angulate; prozona with the median carina arcuate and cut, but not deeply, by three transverse sulci; metazona with the crest bent arcuate and very slightly higher than that of the prozona; metazona with distinct lateral angles but no carinæ; lateral lobes slightly longer than deep, the inferior margin slightly emarginate anteriorly; surface rugoso-punctate. Tegmina equalling the apex of the abdomen, anterior margin arcuate, apex somewhat constricted and very slightly oblique truncate. Wings large, equally as long as the tegmina when in repose; apex slightly falcate. Posterior femora almost equal to the abdomen in length, rather slender.

General color burnt-sienna, the median carina and posterior margin of the pronotum as well as a median line on the head ferruginous, median stripe of the pronotum bordered by clear black longitudinal lines. Tegmina blackish, the veins olive-green. Wings with the disk pale geranium-red, the apex and almost the entire margins blackish. Abdomen above blackish with an interrupted median line of orange-ochraceous. Beneath tawny-ochraceous, the lower part of the face cream color, the abdomen with a longitudinal lateral line of black. Limbs maculate and punctate with blackish as is usual in the genus, the ground color of the anterior and median pair being gray-brown, the posterior ochraceous.

Measurements.

Length of body,	61.5 mm.
Length of pronotum,	19.5 "
Greatest width of pronotum,	11 "
Length of tegmina,	42 "
Length of wing,	37 "
Length of posterior femora,	27.5 "

The type is the only specimen of this species seen.

Tæniopoda auricornis (Walker).

1870. *Rhomalea auricornis* Walker, Catal. Spec. Derm. Salt. Brit. Mus., III, p. 538. [Oaxaca; Vera Cruz.]

Alta Mira, Tamaulipas. July 4, 1903. (M. E. Hoag.) One male, one female.

After comparison with Walker's description, I have concluded that these specimens represent his species. They are closely related to *T. centurio* (Drury), but can be separated by the larger size, shorter wings, which also have the apical third narrowed, the more produced posterior margin of the pronotum, the greater space between the eyes, and the slenderer posterior limbs.

Genus **CHROMACRIS** Walker.

1870 *Chromacris* Walker, Catal. Spec. Derm. Salt. Brit. Mus., V, p. 643.

Included *C. speciosa* and *colorata*, of which the former (= *miles*) was represented by specimens and can be considered the type.

Chromacris colorata (Serville).

1839. *Acridium coloratum* Serville, Orthoptères, p. 674. [South Carolina(?)].

Alta Mira, Tamaulipas. June 25, 26 and 28, 1903. (M. E. Hoag.) Three males, eight females.

Genus **LEPTYSMA** Stål.

1873. *Leptysma* Stål, Recensio Orthopterorum, I, pp. 42, 85.

Included *Opsomala filiformis* Serville, *Truxalis obscurus* Thunberg and *Opsomala marginicollis* Serville, of which the latter may be considered the type.

Leptysma marginicollis (Serville).

1839. *Opsomala marginicollis* Serville, Orthoptères, p. 591. [North America.]

Ojos del Diablo, Chihuahua. May 2, 1902. (C. H. T. Townsend.) One female.

Zapotlanejo, Jalisco. July 31, 1903. (McClendon.) One female.

Guadalajara, Jalisco. August 9 and 25, 1903. (McClendon.) One male, one female.

Genus **PROCTOLABUS** Saussure.

1859. *Proctolabus* Saussure, Revue et Magasin de Zoologie, 2e sér., XI, p. 393.

Type.—*Ommatolampis mexicana* Saussure.

Proctolabus mexicanus (Saussure)?.

1859. *O[mmatolampis] mexicana* Saussure, Revue et Magasin de Zoologie, 2e sér., XI, p. 393. [Toluca, Mexico.]

Guadalajara, Jalisco. September 14 and 18, 1903. (McClendon.) One male, two females.

This specimen belongs to this genus and probably to this species, but several characters are at variance with those given in the brief original description. The lower portion of the lateral lobes of the pronotum as well as the meso- and metapleura of the male are milky-white, while the lower as well as the upper face of the posterior femora of the same sex bear a line of the same color. Anterior and median limbs and external face of the posterior femora of the male are solid French green. The females are almost uniform olivaceous.

Genus **SCHISTOCERCA** Stål.

1873. *Schistocerca* Stål, Recensio Orthopterorum, I, p. 64.

Included *Acridium peregrinum, melanocercum, americanum, pallens, bivittatum, flavo-fasciatum,* and *columbinum,* of which *americanum* may be considered the type.

Schistocerca vaga (Scudder).

1876. *Acridium vagum* Scudder, Proc. Boston Soc. Nat. Hist., XVIII, p. 269. [Guadalupe, Island off Lower California; San Diego, California; California.]

Guadalajara, Jalisco. July 17 and September 14 and 18, 1903. (McClendon.) Two males, three females.

Zapotlan, Jalisco. July 8, 1902. (C. H. T. Townsend.) One female.

La Joya, San Luis Potosi. August 10, 1903. (M. E. Hoag.) One male, two females.

Schistocerca pyramidata Scudder.

1899. *Schistocerca pyramidata* Scudder, Proc. Amer. Acad. Arts and Sciences, XXXIV, pp. 443, 455. [Cuernavaca, Mexico.]

Zapotlan, Jalisco. July 18, 1902. (C. H. T. Townsend.) One male.

Guadalajara, Jalisco. August 26, 1903. (McClendon.) One male.

Schistocerca obscura (Fabricius).

1798. [*Gryllus*] *obscurus* Fabricius, Ent. Syst. Suppl., p. 194. [North America.]

Guadalajara, Jalisco. September 14, 1903. (McClendon.) Two males.

Schistocerca lineata Scudder.

1899. *Schistocerca lineata* Scudder, Proc. Amer. Acad. Arts and Sciences, XXXIV, pp. 445, 465. [Barber county, Kansas; Texas; San Antonio, Texas; Gulf Coast of Texas; Montelovez, Coahuila, Mexico.]

Guadalajara, Jalisco. September 14 and 18, 1903. (McClendon.) Three females.

Schistocerca americana (Drury).

1770. *Libell*[*ula*] *Americanus* Drury, Illust. Nat. Hist., I, pp. 128 and two of index, Pl. LXIX, fig. 2. [Virginia; Antigua; New York; Madras in the East Indies; Sierra Leon in Africa.]

Guadalajara, Jalisco. August 15 and 24, 1903. (McClendon.) One male, two females.

Genus **PHÆDROTETTIX** Scudder.

1897. *Phædrotettix* Scudder, Proc. U. S. Nat. Mus., XX, p. 22.

Type.—*P. augustipennis* Scudder.

Phædrotettix augustipennis Scudder.

1897. *Phædrotettix augustipennis* Scudder, Proc. U. S. Nat. Mus., XX, p. 22, Pl. II, fig. 7. [Mount Alvarez, San Luis Potosi, Mexico; Comacho, Durango, Mexico; Corpus Christi Bay, Nueces county, Texas.]

Victoria, Tamaulipas. January 14 or 15, 1903. (S. N. Rhoads.) Two males, two females.

One of the male specimens was kindly compared by Mr. A. N. Caudell with typical specimens from San Luis Potosi, and he states that they are probably identical, though some slight differences do exist. The drawing of the genitalia given by Scudder is misleading, as one receives the impression that the subgenital plate is longer in the Victoria males, while Mr. Caudell, after comparison with a co-type, states that the reverse is true.

Genus **SINALOA** Scudder.

1897. *Sinaloa* Scudder, Proc. U. S. Nat. Mus., XX, p. 40.

Type.—*S. behrensii* Scudder.

Sinaloa brevispinis n. sp.

Types: ♂ and ♀; Victoria, Tamaulipas, Mexico. January 14 or 15, 1903. (S. N. Rhoads.) Acad. Nat. Sci. Phila.

Allied to *S. behrensii* from Sinaloa, but differing in the shorter but distinctly spiniform furcula, the subtruncate tips of the tegmina, and in the different coloration.

♂.—Size rather small. Head with the occiput flattened; interspace between the eyes but little more than half the width of the frontal costa; fastigium strongly declivent, rather shallowly excavated; frontal costa subequal, except above where it is slightly narrowed, moderately sulcate at and below the ocellus; eye ovate, moderately prominent. Pronotum strongly rugoso-punctate, with the median carina present as a rather coarse ridge, subobsolete between the sulci, the traces of the lateral carinæ of the faintest character; transverse sulci distinct; prozona almost twice as long as the metazona; anterior margin arcuate, posterior margin with a broad shallow median emargination; lateral lobes slightly longer than high, the posterior and inferior margins sinuous. Prosternal spine erect, retrorse, rather blunt; interspace between the mesosternal lobes longitudinal, almost twice as long as wide; metasternal lobes subattingent. Tegmina reaching to the apex of the metanotum elongate-ovoid, apex rotundato-truncate, longitudinal veins distinct. Abdomen faintly carinate above, the apex somewhat upturned; furcula spiniform, compressed, attingent, as long as the last dorsal segment; supraanal plate semi-ovate, apex obtuse-angulate, median ridge dividing centrally and sending forward two parallel branches, lateral sections of the plate rather deeply excavated; cerci simple, about two and a half times as long as the basal width, moderately tapering, the apical fourth with a slight emargination of the posterior margin; subgenital plate moderately produced, the apex moderately acute but not elevated. Anterior and median limbs with the femora considerably inflated; posterior femora robust, genicular region rather large; tibiæ with nine spines on the external margin.

♀.—Size medium. Head with the interspace between the eyes but little narrower than the frontal costa; frontal costa evenly but distinctly constricted inferiorly as well as above the ocellus; eye elongate-subovate, distinctly longer than the infraocular portion of the genæ; antennæ slightly shorter than the head and pronotum, blunt. Pronotum as in the male but broader, more inflated and subtectate. Prosternal spine very short, thick and blunt; interspace between the mesosternal lobes slightly longitudinal; metasternal lobes subattingent. Posterior femora with ten or eleven spines on the external margin. Ovipositor valves exserted.

General color olive-green above, beneath dull yellowish. Head with a line along the superior border of the eye and a postocular streak greenish-yellow; eyes umber in the male, chestnut in the female; antennæ brownish with the basal portion dull yellow. Pronotum with the postocular streak continued along the lateral margins of the disk, rather broken in the female; lateral lobes in the male bearing on the inferior half a broken bar of dull yellow. Tegmina dull vinaceous. Abdomen with the median portion of the dorsal surface bearing a series of triangular patches of dull brownish. Limbs (except the posterior tibiæ) oil-green, more or less infuscate; genicular region of the posterior femora outlined with blackish; posterior tibiæ basally verditer-blue, apical portion and tarsi scarlet-vermilion.

Measurements.	♂	♀
Length of body,	17.5 mm.	26.5 mm.
Length of pronotum,	4.3 "	6 "
Greatest width of pronotum,	3.9 "	6 "
Length of tegmina,	2.8 "	4.2 "
Greatest width of tegmina,	1.5 "	2 "
Length of posterior femora,	10.5 "	13.5 "

Three specimens (one male, two females) from the type locality have been examined in addition to the types. Considerable variation exists in the intensity of the coloration, the two paratypic females being uniform wood-brown with the femora conspicuously fasciate internally with blackish.

Genus **AIDEMONA** Scudder.[10]

1897. *Aidemona* Scudder, Proc. Amer. Acad. Arts and Sciences, XXXII, pp. 198, 204.

Type.—*A. azteca* (Saussure).

Aidemona azteca (Saussure).

1861. *Pl[atyphyma] aztecum* Saussure, Revue et Magasin de Zoologie, 2e sér., XIII, p. 161. [Temperate Mexico.]

Guadalajara, Jalisco. July 17, August 23 and 29, 1903. (McClendon.) One male, two females.

Zapotlanejo, Jalisco. July 31, 1903. (McClendon.) Two males.

[10] This name is not available from Brunner, *Ann. Mus. Civ. Stor. Nat. Genova*, XXXIII, p. 145.

Zapotlan, Jalisco. July 7, 1902. (C. H. T. Townsend.) Two males.

La Joya, San Luis Potosi. August 10, 1903. (M. E. Hoag.) One female.

Genus **HESPEROTETTIX** Scudder.

1875. *Hesperotettix* Scudder, Bull. U. S. Geol. and Geogr. Surv. Terr., II, No. 3, p. 262.

Type.—*Hesperotettix viridis* Scudder (not of Thomas) = *Hesperotettix festivus* Scudder.

Hesperotettix meridionalis Scudder.

1897. *Hesperotettix meridionalis* Scudder, Proc. U. S. Nat. Mus., XX, p. 59. [Guanajuato; Sierra Nola, Tamaulipas.]

La Joya, San Luis Potosi. August 10, 1903. (M. E. Hoag.) One female.

This specimen, while fully agreeing in measurements, structural characters and major color characters, differs from Scudder's description in the more uniform greenish-yellow color of the head, and in the presence of dull red pregenicular annuli on the anterior and median as well as the posterior femora.

Genus **MELANOPLUS** Stål.

1873. *Melanoplus* Stål, Recensio Orthopterorum, I, p. 79.

Type, as designated by Scudder, *M. femur-rubrum* (De Geer).

Melanoplus marculentus Scudder.

1897. [*Melanoplus*] *marculentus* Scudder, Proc. Amer. Philos. Soc., XXXVI, p. 6. [Montelovez, Coahuila; Sierra Nola, Tamaulipas; Sierra de San Miguelito, and mountains twelve leagues east of San Luis Potosi; San Luis Potosi; Bledos, San Luis Potosi; Zacatecas; Aguas Caliente, Mexico.[11]]

La Joya, San Luis Potosi. August 10, 1903. (M. E. Hoag.) Two males.

One of the above specimens is considerably larger than Scudder's measurements, and also has the tegmina much longer than either the typical measurements or the other specimen examined.

Melanoplus spretis (Thomas).

"1865. *Acridium spretis* Thomas, Trans. Ill. St. Agric. Soc., V, p. 450."

Guadalajara, Jalisco. August 17 and 24, September 14 and 18, 1903. (McClendon.) Five males, two females.

Melanoplus atlanis (Riley).

1875 *Caloptenus atlanis* Riley, Seventh Ann. Rep. Missouri State Ent., p. 169. [New Hampshire.]

Guadalajara, Jalisco. August 27, 1903. (McClendon.) One male.

[11] As Scudder gives no localities in his preliminary paper, the above information is taken from his later paper (*Proc. U. S. Nat. Mus.*, XX, p. 141).

Melanoplus reflexus Scudder.

1897. [*Melanoplus*] *reflexus* Scudder, Proc. Amer. Philos. Soc., XXXVI, p. 9. [Cuidad del Maiz, San Luis Potosi.[12]]

La Joya, San Luis Potosi. August 10, 1903. (M. E. Hoag.) One female.

This specimen fully agrees with Scudder's description of the single female individual seen by him.

Melanoplus palmeri Scudder.

1897. [*Melanoplus*] *palmeri* Scudder, Proc. Amer. Philos. Soc., XXXVI, p. 23. [Fort Wingate, Bernalillo county, New Mexico; Fort Whipple, Yavapai county, Arizona.[13]]

Casas Grandes, Chihuahua. September, 1902. (Dr. W. E. Hughes.) One male.

This specimen extends the range of the species considerably to the south.

Melanoplus corpulentus Scudder.

1897. [*Melanoplus*] *corpulentus* Scudder, Proc. Amer. Philos. Soc., XXXVI, p. 27. [Tlalpan, Mexico; hills about San Luis Potosi, Mexico; mountains twelve leagues east of San Luis Potosi, Mexico; Sierra de San Miguelito, San Luis Potosi, Mexico; Zacatecas, Mexico; Sonora, Mexico; Silver City, Grant county, New Mexico.[14]]

Guadalajara, Jalisco. September 14, 1903. (McClendon.) One male.

This specimen, when compared with individuals of this species from the Federal District of Mexico, is seen to be larger and with slightly longer (comparatively) tegmina and wings.

Melanoplus differentialis Thomas.

1871. *Caloptenus differentialis* Thomas, Proc. Acad. Nat. Sci. Phila., 1871, p. 149. [Jackson county, Illinois.]

Guadalajara, Jalisco. September 14, 19 and 22, 1903. (McClendon.) Eight males, one female.

Genus **PŒCILOTETTIX** Scudder.

1897. *Pœcilotettix* Scudder, Proc. Amer. Acad. Arts and Sciences, XXXII, pp. 203, 206.

Type.—*Caloptenus* (*Hesperotettix*) *picticornis* Thomas (=*Acridium pantherinum* Walker).

Pœcilotettix pantherinus (Walker).

1870. *Acridium pantherinum* Walker, Catal. Derm. Salt. Brit. Mus., IV, p. 623. [Mexico.]

Guadalajara, Jalisco. September 1, 1903. (McClendon.) One male.

[12] Locality from Proc. U. S. Nat. Mus., XX, p. 222.
[13] Localities from Proc. U. S. Nat. Mus., XX, p. 231.
[14] Localities from Proc. U. S. Nat. Mus., XX, p. 314.

Genus **OSMILIA** Stål.

1873. *Osmilia* Stål, Recensio Orthopterorum, I, p. 68.

Included *Acrydium flavo-lineatum* De Geer, *Gryllus violaceus* Thunberg, *Gryllus rufipes* Thunberg, *Gryllus obliquus* Thunberg and *Acridium maculosum* Stål, of which *flavo-lineatum* may be considered the type.

Osmilia toltecum (Saussure).

1861. *A*[*cridium*] *toltecum* Saussure, Revue et Magasin de Zoologie, 2e sér., XIII, p. 163. [Temperate Mexico.]

Guadalajara, Jalisco. August 24, September 18, 1903. (McClendon.) Two females.

Alta Mira, Tamaulipas. June 28, 1903. (M. E. Hoag.) One female.

Genus **DACTYLOTUM** Charpentier.

1845. *Dactylotum* Charpentier, Orthopt. Descr. et Depicta, tab. 52.

Type.—*D. bicolor* Charpentier.

Dactylotum variegatum (Scudder).

1879. *Pezotettix variegatum* Scudder, Proc. Bost. Soc. Nat. Hist., XX, p. 75. [San Diego, California; Sonora; Fort Whipple and Buchanan, and forty miles east of Tucson, Arizona.]

Casas Grandes, Chihuahua. September, 1902. (Dr. W. E. Hughes.) One female, two immature males.

Dactylotum histricum n. sp.

Type: ♀; La Joya, San Luis Potosi, Mexico. August 10, 1903. (M. E. Hoag.)

Allied to *D. variegatum* (Scudder), but differing in the slightly narrower and more acuminate tegmina, the slenderer posterior femora, the shorter metazona of the pronotum and the rather distinctive coloration.

Size rather large; form as usual in the genus. Head with the occiput hardly elevated above the pronotum, rounded; interspace between the eyes twice as wide as the inferior width of the frontal costa; fastigium broad, very shallowly and broadly excavated; frontal costa slightly constricted above, but broader than below the ocellus, greatest width immediately above the ocellus, moderately sulcate throughout; eyes elongate-ovate, truncate anteriorly, very slightly longer than the infraocular portion of the genæ; antennæ equal to the head and pronotum in length, the extreme apex blunt and slightly depressed. Pronotum slightly arched transversely and with a very noticeable transverse convexity, as usual in the genus; transverse sulci strongly impressed; median carina absent on the prozona, finely marked on the metazona, the latter only two-thirds the length of the prozona and strongly punctate; anterior margin subtruncate with a very slight median emargination, posterior margin arcuate, the apex subtruncate; lateral lobes longer than deep, the lower margin distinctly obtuse-angulate. Prosternal spine rather short, blunt, slightly retrorse; interval between the mesosternal lobes broader than long; interval between the metasternal lobes quadrate. Tegmina equal to the pronotum in length, slightly less than two-thirds as wide as long, subattingent; apical portion subacute, the apex itself rounded. Posterior femora moderately slender, slightly more than four times as long as wide; posterior tibiæ with seven or eight spines on the external margin.

General color bluish-black, variegated with orange-vermilion, orange, lemon-yellow and apple-green. Head ornamented with orange vermilion on the posterior inferior portion of the genæ, an infraocular blotch, a line along the clypeal margin of the face, and a crude semicircle margining the posterior superior borders of the eyes and the interocular space. Pronotum with the usual median crescent and the short anterior median bar orange-vermilion, fading along the posterior median bar into orange, which color decorates the posterior margin of the pronotum, very broadly on the lateral lobes, narrowly on the disk. Tegmina reticulate with apple-green. Abdomen with the dorsal segments posterior margined with lemon-yellow, developed on the median line into a series of triangular blotches which are connected by a narrow line of the same color, an obscure lateral series of lemon-yellow dots are also noticeable; ventral segments dull lemon-yellow with the bluish-black reduced to a series of lateral basal spots, and a broad triangular basal spot on the subgenital plate. Prosternal spine lemon-yellow; mesosternum and metasternum dirty luteous. Anterior and median femora with a median or premedian blotch of orange-vermilion. Posterior femora with three broken bars of lemon-yellow, one basal, one premedian, the other median; external face with the scalariform impressions outlined with yellow, posterior tibiæ blackish-blue, the spines black apically.

Measurements.

Length of body, ...	31.5 mm.
Length of pronotum, ...	7.5 "
Greatest width of pronotum, ...	5.7 "
Length of tegmina, ...	7.5 "
Greatest width of tegmina, ...	4.5 "
Length of posterior femora, ...	15.2 "

Two female specimens examined.

Genus PERIXERUS Gerstaecker.

1873. *Perixerus* Gerstaecker, Entom. Zeit. Stettin, XXXIV, p. 192.

Type.—*P. squamipennis* Gerstaecker.

Perixerus variabilis n. sp.

Type: ♀; Guadalajara, Jalisco, Mexico. September 18, 1903. (J. F. McClendon.) Coll. Acad. Nat. Sci. Phila.

Allied to *P. lævis* Rehn,[15] but differing in the narrower interspace between the mesosternal lobes and the very different blue-gray and yellow coloration.

Size medium; form moderately slender; surface sparsely clothed with long hairs. Head with the occiput moderately inflated, obscurely punctate; interspace between the eyes rather broad, slightly wider than the frontal costa; fastigium depressed, broad, blunt, with a broad and shallow excavation; frontal costa subequal, not reaching the clypeus, rather shallowly sulcate at and below the ocellus; eye subreniform, longer than the subocular portion of the genæ; antennæ slightly shorter than the head and pronotum. Pronotum with the transverse sulci moderately distinct; prozona about half again as long as the metazona; anterior and posterior margins subtruncate; lateral lobes slightly longer than high, the lower margin sinuate anteriorly; surface rugoso-punctate, the metazona with the punctures finer. Prosternal spine short, thick and blunt. Interval between the mesosternal lobes quadrate; interval between the metasternal lobes distinctly longitudinal. Tegmina elongate-ovate, reaching to the apical margin of the first abdominal segment, internal margins distant; apex bluntly rounded; surface coriaceous-reticulate. Anterior and median limbs moderately slender; posterior limbs rather slender, the imbrications of the femora pronounced; tibiæ with seven or eight (on one side) spines on the external margin.

General colors oil-green and lemon-yellow varied with verditer-blue. Head bluish above, with a dull median triangular yellowish spot, and a yellowish post-ocular streak which is bordered above and below with blackish; lower part of face dull bluish and green, the genæ greenish, with the margins clear yellow and an obscure inferior bluish patch; eyes chestnut; antennæ bluish-black narrowly annulate with dull bluish-green. Pronotum above blue with a distinct median line of yellow, the posterior and inferior margins also narrowly edged with dull yellow; lateral lobes of the pronotum yellowish-green; the transverse sulci black except at the yellow median line. Tegmina glaucous

[15] *Trans. Amer. Ent. Soc.*, XXVII, p. 98.

green. Abdomen above bluish, except for a median longitudinal line which, with the inferior surface, is dull yellowish. Limbs dull yellowish-green sprinkled with blackish; posterior femora with the imbrications distinctly outlined with black, genicular region with a crescent of black; tibiæ glaucous, the spines with their apical half black.

Measurements.

Length of body,	22.5 mm.
Length of pronotum,	5.5 "
Greatest width of pronotum,	5 "
Length of tegmina,	4.8 "
Greatest width of tegmina,	3 "
Length of posterior femora,	14.2 "

The type is the only specimen examined.

Family TETTIGONIDÆ.

Genus HORMILIA Stål.

1873. *Hormilia* Stål, Ofversigt af K. Vetensk.-Acad. Förhandlingar, XXX, No. 4, p. 41.

Type.—*Phaneroptera tolteca* Saussure.

Hormilia prasina Saussure and Pictet.

1897. *Hormilia prasina* Saussure and Pictet, Biol. Cent-.Amer., Orth., I, p. 319, tab. XV, fig.14. [Mazatlan, Sinaloa; Guerrero.]

Guadalajara, Jalisco. August 24, 1903. (McClendon.) One male. This individual fully agrees with the original description, except that the posterior margin of the pronotum is centrally emarginate.

Genus ARETHÆA Stål.

1876. *Arethæa* Stål, Bihang till K. Svenska Vet. Akad. Handilngar, Bd. 4, No. 5, p. 55.

Type.—*Ephippitytha gracilipes* Thomas.

Arethæa gracilipes (Thomas).

1870. *E[phippitytha] gracilipes* Thomas, Proc. Acad. Nat. Sci. Phila., 1870, p. 76. [Southern Colorado.]

Casas Grandes, Chihuahua. September, 1902. (Dr. W. E. Hughes.) Two adult males, two immature females.

These specimens are badly shriveled and faded, having been collected in spirits, but they apparently belong to this species.

Arethæa carita Scudder.

1902. *Arethæa carita* Scudder, Proc. Davenport Acad. Sciences, IX, p. 52, Pl. 4, fig. 5. [Mesilla Park, New Mexico.]

Casas Grandes, Chihuahua. September, 1902. (Dr. W. E. Hughes.) One female.

This specimen fully agrees with Scudder's description and figure.

Genus **SCUDDERIA** Stål.

1873. *Scudderia* Stål, Ofversigt ak K. Vetensk.-Akad. Förhandlingar, XXX, No. 4, p. 41.

Type.—*Phaneroptera curvicauda* De Geer.

Scudderia mexicana (Saussure).

1861. *Phaneroptera mexicana* Saussure, Revue et Magasin de Zoologie, 2e sér., XIII, p. 129. [Mexico.]

Guadalajara, Jalisco. August 24 and September 4, 1903. (McClendon.) One male, one female.

Scudderia ungulata Scudder.

1898. *Scudderia ungulata* Scudder, Proc. Amer. Acad. Arts and Sciences, XXXIII, p. 280, fig. 6. [Tepic, Mexico.]

Guadalajara, Jalisco. September 14 and 18, 1903. (McClendon.) Three males, one female.

Genus **STILPNOCHLORA** Stål.

1873. *Stilpnochlora* Stål, Ofversigt af K. Vetensk.-Akad. Förhandlingar, XXX, No. 4, p. 40.

Type.—*Phylloptera marginella* Serville.

Stilpnochlora azteca (Saussure).

1859. *Ph[ylloptera] azteca* Saussure, Revue et Magasin de Zoologie, 2e sér., XI, p. 203. [Mexico (Cordova, etc.).]

Guadalajara, Jalisco. July 17 and August 2, 1903. (McClendon.) Three females.

Genus **CONOCEPHALUS** Thunberg.

1815. *Conocephalus* Thunberg, Mem. Acad. Imp. Sci. St. Petersb., V, pp. 218, 271.

Included *C. subulatus, triops, lanceolatus, hemipterus, acuminatus, nasutus, albifrons, falx, cinereus, varius, virens, discolor, griseus, bilineatus, inflatus, armatus, cornutus, spinigerus, trifidus, tricornis, triceps, viridissimus, rugosus* and *elongatus*.

Conocephalus obscurellus Redtenbacher.

1891. *Conocephalus obscurellus* Redtenbacher, Verh. Zool. Bot. Gesell. Wien, XLI, p. 397. [Cuernavaca, Mexico; Guatemala; Guita; Antilles; Venezuela; Nicaragua; Cuba.]

Guadalajara, Jalisco. (McClendon.) One female.

Genus **STIPATOR** Rehn.

1859. *Orchesticus* Saussure, Revue et Magasin de Zoologie, 2e sér., XI, p. 201. (Not of Cabanis, 1851.)
1900. *Stipator* Rehn, Trans. Amer. Ent. Soc., XXVII, p. 90.

Type.—*O. americanus* Saussure.

Stipator grandis n. sp.

Type: ♀; Alta Mira, Tamaulipas, Mexico. June 27, 1903. (M. E. Hoag.) Acad. Nat. Sci. Phila.

This new species is quite distinct from any of the previously known species in the genus, and can readily be distinguished by its large size, very long and powerful posterior limbs and comparatively short ovipositor.

Size very large; form elongate-fusiform. Head with the fastigium about as wide as the length of the eye, bluntly rounded, touching the facial process; eye ovate, comparatively small and not prominent; antennæ slightly exceeding the body and ovipositor in length, basal joint flattened inferiorly. Pronotum slightly expanding posteriorly, decidedly prolonged; slightly flattened on the disk, but lateral angles rounded; anterior margin truncate, posterior margin broadly rounded, no carina present; lateral lobes longer than high, the posterior margin slightly emarginate, the inferior margin oblique, the angles obtuse. Prosternum with two suberect slender spines; mesosternum and metasternum acutely lobate. Tegmina or wings not apparent. Abdomen moderately compressed, each segment with a slight thickening of the posterior margin on the median line, on the distal segments supplemented by additional like structures, which are arranged in longitudinal series. Ovipositor slightly curved, short, but slightly longer than the pronotum and not more than half the length of the posterior femora, subequal in width; the apex very acute, with superior margin straight for a short distance; subgenital plate subtruncate apically. Anterior coxæ strongly spined; femora about equal to the pronotum in length, two or three spines on the anterior margin, unarmed on the posterior margin; tibiæ slightly longer than the femora, bearing three spines on the posterior superior margin. Median coxæ unarmed; femora slightly longer than the anterior femora, margins unarmed except for the short paired spines on the genicular lobes; tibiæ slightly longer than the femora, anterior superior margin with two spines, posterior superior margin with four spines, one of which is apical. Posterior femora equal to the body in length, strongly inflated basally, slender apically, internal inferior margin spined except apically; tibiæ about equal to the femora, subquadrate, the superior margins closely and evenly spined.

General color prout's brown, marked on the dorsum with vandyke brown and on the lower portion of the lateral lobes and the pleura with wood-brown. Head with the facial portion and the genæ suffused with bistre, a faint postocular streak present; antennæ narrowly annulate with ecru-drab. Pronotum with the upper half of the lateral lobes bistre; posterior margin of the lateral lobes narrowly blackish. Mesonotum and metanotum with lateral blackish patches, more distinct on the mesonotum.

Measurements.

Length of body,	37	mm.
Length of pronotum,	12.5	"
Greatest width of disk of pronotum,	7.5	"
Length of posterior femora,	37	"
Length of ovipositor,	18	"

A paratypic female has also been examined.

Genus **CEUTHOPHILUS** Scudder.

1862. *Ceuthophilus* Scudder, Boston Jour. Nat. Hist., VII, p. 433.

Included *C. maculatus* (Harr.), *C. brevipes* Scudd., *C. lapidicola* (Burm.), *C. uhleri* Scudd., *S. scabripes* (Hald.), *C. divergens*, *C. latens*, *C. niger* and *C. californianus* Scudd., *C. stygius* (Scudd.), *C. agassizii* (Scudd.) and *C. gracilipes* (Hald.). The first of these, *maculatus,* may be considered the type.

Ceuthophilus macropus n. sp.

Type: ♀; Guadalajara, Jalisco, Mexico. September 14, 1903. (McClendon.) Acad. Nat. Sci. Phila.

This new species is provisionally placed in *Ceuthophilus,* but it is possibly distinct, as the median coxæ are not spined. It does not appear to be closely related to any of the previously known species, though running to *occultus* and *discolor* in Scudder's key of the genus, to which, however, it is not closely related.

Size medium; form compressed, elongate-fusiform. Head short and broad; occiput sloping downward and forward; eye rather small, subtrigonal; antennæ about twice as long as the body. Pronotum arched transversely; anterior and posterior margins truncate; lateral lobes slightly longer than high, inferior margin very broadly and slightly arcuate, angles rounded. Mesonotum and metanotum subequal in lateral depth, extending below the inferior margin of the lateral lobes of the pronotum. Abdomen compressed, surface smooth. Ovipositor slightly longer than the pronotum, straight, tapering evenly from the base to one-third the length from the apex, subequal in the apical third; apex obliquely truncate, the superior margin with a prominent rounded emargination which gives the extreme apex an almost needle-like character; internal valves bearing five prominent spines on their inferior margins. Anterior coxæ unarmed; femora about one-fifth longer than the pronotum, somewhat compressed, anterior inferior margin with two distal spines, one large and one small, no genicular spine present; tibiæ about equal to the femora, unarmed above. Median coxæ unarmed; femora about equal to the anterior femora in length, slenderer, anterior inferior margin armed distally with three or four spines, increasing in size toward the apex, posterior inferior margin with several very small spines on the distal half, genicular spine distinct; tibiæ slightly longer than the femora, armed on the anterior superior margin with two large and two small spines, posterior margin armed with two or three spines. Posterior femora almost equal to the body in length, moderately inflated, the length about three and a half times the breadth, external inferior margin unarmed, internal inferior margin supplied with a series of small depressed spines, no genicular spine present; tibiæ straight, exceeding the femora by about one-eighth the length of the latter, armed on the upper surface with four pair of spurs, the smaller spines very uniform and rather stout, median apical spurs equal to the metatarsus in length; second joint of the tarsi about half the length of the metatarsus, third joint of the tarsi slightly more than half the length of the second.

General color cinnamon, suffused on the upper surface of the abdomen, thorax and head and the entire anterior limbs except the tarsi with liver brown; antennæ cinnamon; posterior femora with the inferior margins and two longitudinal bars on the external face blackish-brown.

Measurements.

Length of body,	13.8 mm.
Length of pronotum,	5.2 "
Greatest width of pronotum,	4 "
Length of posterior femora,	14.2 "
Length of ovipositor,	6 "

The type is the only specimen examined.

Family GRYLLIDÆ.

Genus GRYLLUS Linnæus.

1758. *Gryllus* Linnæus, Syst. Nat., Xth edit., p. 425.

Type.—*Gryllus domesticus* Linnæus.[16]

Gryllus assimilis Fabricius.

1775. [*Gryllus*] *assimilis* Fabricius, Syst. Ent., p. 280. [Jamaica.]

Guadalajara, Jalisco. August 21, September 14 and 18, 1903. (McClendon.) Eleven males, six females.

[16] *Vide* Rehn, *Canad. Entom.*, XXXIII, pp. 118–121.

These specimens, though slightly smaller, agree very well with individuals from Jalapa and Teocelo, Vera Cruz.

Gryllus barretti Rehn.

1901. *Gryllus barretti* Rehn, Trans. Amer. Entom. Soc., XXVII, p. 221. [Cuernavaca, Morelos.]

Tuxpan, Jalisco. September 4, 1903. (McClendon.) One female.

This individual fully agrees with the type of *barretti*, and is interesting as it demonstrates the fact that the species is brachypterous as well as macropterous, the typical series being in the latter condition.

Gryllus mexicanus Saussure.

1859. *Gryllus mexicanus* Saussure, Revue et Magasin de Zoologie, 2e sér., XI, p. 316. [Mexico.]

Guadalajara, Jalisco. September 18, 1903. (McClendon.) One female.

Zapotlanejo, Jalisco. July 31, 1903. (McClendon.) One male.

Genus **ŒCANTHUS** Serville.

1831. *Œcanthus* Serville, Ann. Sci. Nat., XXII, p. 134.

Included *Œ. italicus* (=*pellucens* Scopoli), *Œ. bipunctatus* and *Œ. niveus*. Of these, the first may be selected as the type.

Œcanthus niveus (De Geer).

1773. *Gryllus niveus* De Geer, Mém. l'Hist. Ins., III, p. 522. [Pennsylvania.]

Guadalajara, Jalisco. September 18, 1903. (McClendon.) Three males.

Œcanthus varicornis Walker.

1869. *Œcanthus varicornis* Walker, Catal. Derm. Salt. Suppl. Blatt. Coll. Brit. Mus., p. 94. [Mexico.]

Guadalajara, Jalisco. September 14, 1903. (McClendon.) One female.

This specimen does not fully agree with Saussure's figures and description in the *Biologia Centrali-America*,[17] as the pronotum is not so elongate, though this may be due to sex, as Saussure figured a male and the individual in hand is the other sex. Walker's description is so general that little can be made of it, but the Guadalajara specimen fully agrees with it as well as the structure of the opposite sex and the insufficiency of the diagnosis will allow. This species has been recorded from as far north as Tepic.

[17] *Biol. Cent.-Amer.*, I, p. 254, tab. XII, figs. 24 and 25.

Genus **THAMNOSCIRTUS** Saussure.

1878. *Thamnoscirtus* Saussure, Mélanges Orthoptérologiques, VI, p. 630, fig. XLVI, No. 1.

Included *Phylloscirtus cicindeloides* and *vittatus* Gerstaecker, of which the former may be considered the type.

Thamnoscirtus cæruleus n. sp.

Types: ♂ and ♀; Guadalajara, Jalisco, Mexico. September 16 (♂) and 18 (♀), 1903. (McClendon.) Acad. Nat. Sci. Phila.

Allied to *T. cicindeloides*, but differing in the very distinctive coloration, the larger eyes, the more compressed pronotum and a number of minor characters. No close relationship exists with *vittatus* Gerstaecker and *montanus* Saussure, while *viridicator* Saussure can be readily separated by the coloration.

♂.—Size medium; appearance cicindeliform as is usual in the genus. Head trigonal, depressed, interocular region flat; eye subelliptical, prominent, in greatest length almost equal to the interocular width. Pronotum deplanate, somewhat constricted mesially, anterior margin truncate with a slight median emargination, posterior margin truncate; central portion of disk with a distinct longitudinal impressed line which fails to reach either the anterior or posterior margin; lateral lobes of the pronotum with the inferior margin broadly arcuate. Tegmina slightly shorter than the abdomen; axillary veins straighter and less curved than in *cicindeloides*. Anterior tibiæ with the tympanum on the anterior face small and elongate-elliptical. Posterior femora moderately inflated, slightly shorter than the tegmina. (The male individual has been somewhat crushed and many structural features have been damaged or changed to such an extent as to preclude any mention of them.)

♀.—Size medium; form as in the male, but slenderer. Head as in the male. Pronotum as in the male except that the posterior portion is not slightly broader than the anterior as in the male, and the median impressed line is less distinct. Tegmina arched, slightly exceeding the apex of the abdomen, subcoriaceous, apex acute; lateral field of the tegmina apically truncato-emarginate and with but three instead of six principal veins as in *cicindeloides*. Wings with the apical section caudate but not projecting beyond the tegmina. Ovipositor shorter than the posterior femora, moderately arcuate, rather broad and subequal in width; superior margin of the apical section with an oblique truncation, apex finely serrulate above and below. Posterior femora about two-thirds as long as the tegmina.

General color very deep metallic blue in the male, deep metallic greenish in the female; eyes dull brown; interocular region with an obscure transverse elliptical spot of brick red; limbs orange-ochraceous.

Measurements.

	♂	♀
Length of body,	10.5 mm.	8.1 mm.
Length of pronotum,	1.9 "	2.2 "
Greatest width of pronotum,	2 "	2 "
Length of tegmina,	6.2 "	6.5 "
Greatest width of dorsal field of tegmina,	3.5 "	1.7 "
Length of posterior femora,	5.2 "	5.5 "
Length of ovipositor,		3.3 "

The types are the only specimens which have been examined.

Genus **PARŒCANTHUS** Saussure.

1859. *Paroccanthus* (laps. p. *Parœcanthus*) Saussure, Revue et Magasin de Zoologie, 2e sér., XI, p. 317.

Type.—*P. mexicanus* Saussure.

Parœcanthus mexicanus Saussure.

1859. *P[aroccanthus] mexicanus* Saussure, Revue et Magasin de Zoologie, 2e sér., XI, p. 317. [No locality given.]

Alta Mira, Tamaulipas. June 25, 1903. (M. E. Hoag.) One female.

This species has been recorded from Tampico, Tamaulipas, to Teapa, Tabasco.

NEW JAPANESE MARINE MOLLUSCA: PELECYPODA.

BY HENRY A. PILSBRY.

The Pelecypods described herein were nearly all received from Mr. Y. Hirase, of Kyoto, Japan. Most of them are from Hirado, Hizen, at the extreme west of Kyushu, where the wide-ranging species of the central Indo-Pacific province rule, and the exclusively Japanese faunal element is less conspicuous than farther north and east. That many new forms are encountered even here but confirms the experience of other recent workers, that in all parts of the Indo-Pacific area there has been great local differentiation.

In these *Proceedings*, p. 6, I described a *Conus* from Kikai-ga-shima as *C. dormitor*. My attention has been called by several friends to the prior use of this name for an Eocene species; and I would therefore call the Japanese form *Conus comatosa*. It is probably ancestral to the recent *C. sieboldi* Rve.

Mactra carneopicta n. sp. Pl. XXXIX, figs. 1, 2, 3.

Shell *oval*, the beaks slightly in front of the middle; moderately thin, pure white inside; externally profusely painted with flesh-colored rays on a whitish ground, covered with a very thin yellow cuticle toward the margins. Anterior and posterior dorsal areas closely and deeply radially sulcate, and the lower part of the anterior half is concentrically irregularly sulcate; the rest of the surface being smooth. The pallial sinus is very short and semicircular, the muscle-impressions and pallial line but faintly marked. The hinge is that of the typical group of *Mactra*. Length 60, alt. 45, diam. 28.5 mm.

Wakatsuuri, Kitami. Type No. 86,294, A. N. S. P., from No. 1,281 of Mr. Hirase's collection.

This species resembles *M. antiquata* Spengl. somewhat, but is not triangular and is white within. It is not unlike some forms of *M. stultorum* in coloration.

Spisula (Oxyperas) bernardi n. sp. Pl. XXXIX, figs. 4, 5, 6.

Shell long and narrow, the altitude contained about 1.8 times in the length; somewhat triangular, compressed; moderately solid; the beaks at the anterior two-fifths of the length. White under a closely adherent drab and whitish cuticle, which is irregularly dappled with purple-brown spots. Sculpture of coarse and irregular concentric wrinkles and sulci, the umbonal region smooth. Interior of a peculiar Isabella tint. Pallial sinus wide and extending to or a trifle beyond the middle of the shell's length. Muscle scars well impressed. Hinge spisuloid, with the bearing faces of the lateral teeth vertically crenulate.

Length 58, alt. 32.5, diam. 19 mm.

Fukura, Awaji. Type No. 86,313, A. N. S. P., from No. 1,561 of Mr. Hirase's collection.

Compared with *S. aspersa* Sowb.,[1] this species differs in proportions, being longer and narrower. A specimen of *S. aspersa* before me measures, length 53, alt. 33, diam. 18.5 mm., the altitude being therefore contained about 1.6 times in the length. The beaks are correctly stated by Reeve to be at the anterior third. The pallial sinus is much longer than in *S. bernardi*, nearly three-fifths the length of the shell. The lateral teeth are longer in *S. bernardi*. The external sculpture is conspicuously unlike in the two species. It is named in honor of the late M. Félix Bernard.

Cytherea crispata amica n. subsp. Pl. XXXIX, figs. 10, 11.

Shell shortly ovate, ventricose, rather thin, the beaks at about the anterior third of its length. Pale buff, marked with three indistinct diverging brown rays, the color confined chiefly to the lamellæ, and with some scattered spots, and narrow oblique stripes on each side of the beaks. The beaks are rather full; the lunule cordate and defined by sunken lines; no escutcheon is defined on the right valve, but a depression marks it in the left. The immersed ligament is narrowly lanceolate. The anterior end is rounded, the posterior subtruncate. Sculpture of very numerous rounded radial riblets, wider than their intervals, and undivided throughout. These are crossed by many thin erect concentric lamellæ. The upper side of each one is fluted, the ridges corresponding to intervals of the radial riblets, while the lower side is much more deeply fluted, a narrow buttress arising from each radial riblet. The interior is white, the pallial sinus short and ascending, rounded at the end. Muscle impressions and pallial line are very faintly indicated. The anterior and median cardinal teeth are simple and rather slender in the right valve, the posterior tooth deeply bifid. In the left valve the anterior cardinal is simple compressed and high, the middle one wide and deeply bifid, the posterior slender and lamellar. A curved ridge extends from the hinge-plate partly around the anterior

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[1] *Conch. Icon.*, *Mactra*, Pl. 14, fig. 65.

adductor scar, anteriorly. The anterior margin is finely crenulated from the beaks down, and along the basal margin, the posterior end being without internal crenulation.

Length 51, alt. 43, diam. 32 mm.

Hirado, Hizen. Type No. 86,299, A. N. S. P., from No. 1,511 of Mr. Hirase's collection.

This is a less ponderous species than either *Cytherea puerpera* or *C. reticulata*, the radial riblets are more numerous and the concentric lamellæ thinner and higher than in either, and quite different in sculpture. The hinge and teeth, while of the same type, are decidedly more delicate. I rank the form as a variety of *Venus crispata* Desh. (*P. Z. S.*, 1853, p. 2, No. 8), but the lamellæ of that species are stated to be "*in medio et ad margines crassioribus, inflexus,*" terms hardly applicable to the present species. The description of the interior—"*valvis intus in fornice croceis; sinu pallii latissimo, profundo*"—is also at variance with the specimens before me.

Chione micra n. sp. Pl. XLI, figs. 4, 5.

Shell minute, oval, moderately thick, cream-white, some or all of the ribs stained with light reddish-brown. Beaks small, at about the anterior third. Lunule cordate, not distinctly defined, escutcheon lanceolate, slightly excavated. Ligament immersed, short and lanceolate. Sculpture of radial, rounded ribs, 18–20 in number, of which three are on the lunule. The ribs are wider near the anterior end, where several of them are flattened and divided by a median groove, and in the intervals of these bifid ribs a minute riblet is interposed near the lower margin. Elsewhere the intervals are about as wide as the ribs. The concentric riblets are low in the intervals, but on the ribs they rise as erect flat scales. The interior is livid-whitish in the cavity, the muscle-impressions, pallial sinus and space below the pallial line being purple-brown, fading to white at the edge. The pallial sinus is short and ascending, round at the end. Both ends and the ventral margin are minutely crenulate within, and the margin within the lunule has very fine crenulations nearly parallel to the long axis of the shell. In the left valve the anterior and posterior cardinal teeth are simple, the median one bifid, the posterior tooth being very thin. The right valve has a bifid median cardinal, simple ones on each side, the anterior tooth very thin.

Length 5.6, alt. 5, diam 3 mm.

Hirado, Hizen. Types No. 80,583, A. N. S. P., from No. 1,209 of Mr. Hirase's collection.

I have had these minute shells for several years without being able to identify them as the young of any larger species, although I am disposed to believe that it will be found to reach a larger size. The small number of radial riblets is a prominent feature of the sculpture. *Venus imbricata* Sowerby is a longer species with the lamellæ obsolete in the intervals. *V. scabra* Hanley is unlike in sculpture, but both of these seem related to *C. micra*.

Chione hizenensis n. sp. Pl. XLI, figs. 1, 2.

Shell small, shortly ovate, compressed, yellowish, irregularly maculate with reddish-brown. Beaks slightly in front of the middle, small and projecting but slightly. Anterior end broadly rounded, posterior end narrower and somewhat tapering. Sculpture of about 42 rounded radial riblets, a little wider than their intervals, becoming very small at the two ends of the series, though they are largest at the anterior end of the shell. The ribs of the anterior half of the shell are divided by a narrow median groove, on the lower half of each rib. These radial riblets are crossed by many regular narrow concentric ridges, higher on the ribs than in the intervals; the whole producing the effect of a tiled roof. The interior is white, usually with a drop-shaped purple-brown streak at one or both ends, and more or less extensive stains of similar tint in the cavity. The pallial sinus is short and rounded. The edge is crenulated in harmony with the riblets along the posterior half of the lower margin, but along the anterior half there are about two denticles to each rib. The two ends are very finely crenulate, and the anterior side of the dorsal margin is crenulate parallel to the longest axis of the shell, the posterior dorsal margin being smooth. The two obliquely triangular cardinal teeth in the right valve and the short median tooth in the right valve are slightly bifid.

Length 10.8, alt. 8.6, diam. 5 mm.

Hirado, Hizen. Types No. 86,281, A. N. S. P., from No. 1,038*b* of Mr. Hirase's collection.

V. costellifera Adams and Reeve (*Zool. "Samarang," Moll.*, p. 79 pl. 21, fig. 18) is a larger, differently colored form from the Philippines, which seems from the description and figure to be closely related, but the scales are stated to be semilunar, while in *C. hizenensis* they are straight. *V. marica* differs in sculpture and in the pattern of internal crenulation of the valve margins.

Pitar sulfurea n. sp. Pl. XXXIX, figs. 7, 8, 9.

The shell is triangular-oval, inflated, solid; pale sulphur-tinted outside, and distinctly, very finely striate throughout, with some impressions indicating former growth-arrests. Beaks full and prominent, about at the anterior third. Anterior end a little narrower than the posterior, the margin sloping straight to the beak; the posterior upper margin arcuate. No lunule or escutcheon are defined. The ligament is deeply sunken and narrowly lanceolate. The interior is bright reddish-ochre colored in the cavity, white outside the pallial line. Valve margins smooth. The hinge is rather broad, the teeth much like those of *Pitar citrina* Lam. The pallial and muscle scars are but slightly impressed. The pallial sinus small and ascending, extending a little beyond the posterior third of the shell's length.

Length 30.5, alt. 26.5, diam. 19.5 mm.

Length 25.5, alt. 23, diam. 18 mm.

Fukura, Awaji. Types No. 82,135, A. N. S. P., from No. 1,297 of Mr. Hirase's collection.

Tellina hirasei n. sp. Pl. XLI, fig. 3.

Shell irregularly ovate, compressed, white and thin. Posterior end tapering to a narrowly rounded termination, the anterior end longer and broadly rounded; lower margin strongly arcuate, upper margins nearly straightly sloping, the beaks very small and but slightly projecting. Sculpture of very fine low rounded simple radial riblets, at least twice the width of their narrow interstices, crossed by equally spaced, thin, erect, minutely crimped concentric lamellar threads, about one-half a mm. apart on the middle of the disk of the type specimen. There is a slight radial ridge posteriorly, the surface of the valves being elsewhere regularly convex. Interior white and glossy, very faintly showing a very deep and wide pallial sinus, extending beyond the middle of the shell, and partly confluent with the pallial line below. In the right valve there are two delicate diverging cardinal teeth, the ends overhanging the cavity, and strong, triangularly elevated lateral teeth. The left valve has two cardinal teeth, the anterior one vertical, slightly bifid, the posterior tooth very thin, and parallel to the posterior dorsal slope. On each side the margin is raised into small lamellæ fitting above the lateral teeth of the other valve. The ligament is narrow and oblique as usual.

Length 18.5, alt. 13.6, diam. 7 mm.

Hirado, Hizen. Type No. 86,268, A. N. S. P., from No. 1,524 of Mr. Hirase's collection.

This is an exquisitely sculptured shell, with more delicate concentric lamellæ than *Semele exarata* Ads. and Rve., a species curiously like it in sculpture. It is apparently referable to the subgenus *Pseudarcopagia* of Bertin. It resembles *Tellina corbis* Bronn in sculpture and to some extent in contour.

Tellina fabrefacta n. sp. Pl. XLI, figs. 11, 12.

Shell oblong, compressed, thin and white; equilateral, the two ends about equally rounded, the upper and basal margins arcuate, the small beaks but slightly projecting, opisthogyrous. Sculpture of coarse concentric ridges nearly as wide as their intervals, the latter decussated with delicate radial riblets, slightly cuneate in each interval. At the posterior end the ridges are broken up, and in combination with the radii form lozenge-shaped tubercles. The glossy interior shows a very capacious linguiform and ascending pallial sinus, rounded at the end, which extends decidedly past the middle of the valve, its lower margin not confluent with the pallial line. In the left valve there is one short, erect cardinal tooth; in the right valve two short, diverging cardinals, and minute anterior and posterior laterals remote from them.

Length 6, alt. 3.4, diam. 2.1 mm.

Hirado, Hizen. Types No. 86,304, A. N. S. P., from No. 1,545 of Mr. Hirase's collection.

Totally unlike any other species known to me.

Codakia bella delicatula n. subsp. Pl. XLI, figs. 15, 16.

Compared with *C. bella* this form is smaller, more inflated, the diameter decidedly exceeding half the length, with finer, more delicate sculpture.

Length 11.3, alt. 11, diam. 6.5 mm.

Length 10.5, alt. 11, diam. 6 mm.

Riukiu Island. Types No. 82,048, A. N. S. P., from No. 1,307 of Mr. Hirase's collection.

Typical examples of the widespread *Codakia* (*Jagonia*) *bella* Conr. occur in Japan, having been sent from Hirado, Hizen, by Mr. Hirase (No. 1,530 of his register). It has also been reported by Dunker and others as *Lucina divergens* Phil., a name which Dall has shown to be synonymous. Reeve's *Lucina fibula* is apparently a composite of two species, but the Oriental form included by him and by Adams and Reeve under that name is doubtless identical with *C. bella* Conrad.

Cardium hungerfordi Sowerby. Pl. XLI, fig. 17.

Journal of Malacology, VIII, p. 103 (1901).

A figure of this species is given for comparison with the two forms following. All of them occur at Hirado, Hizen, preserving their individuality without intergradation, so far as the material submitted to me shows. All of them are more fragile than *C. papyraceum* Brug., which has been reported from Japan, but which I have not seen from north of the Philippines. It is not unlikely that the records of *Papy-*

raceum from Japan were based upon specimens of this species or of *C. annæ.*

C. hungerfordi is flesh-colored, either almost uniform or with narrow darker concentric zones alternating with wider pale zones. The shell figured measures, length 10, alt. 9, diam. 6.5 mm. It is from Hirado, Hizen, No. 80,601, A. N. S. P., from No. 1,234 of Mr. Hirase's collection.

Cardium hungerfordi undatopictum n. subsp. Pl. XL, figs. 14, 15.

Shell extremely thin, similar in shape to the preceding or with the posterior end longer. Sculpture as in *C. hungerfordi*, except that very low riblets are visible across the whole valve near the basal margin. Concentrically streaked and profusely marked in zigzag pattern with flesh tint on a whitish ground, the beaks dark. Interior more distinctly marked with waved or zigzag concentric streaks of flesh color or crimson; radially finely grooved, and the inner margin is distinctly crenulate in the middle as well as toward the ends.

Length 16.5, alt. 16.5, diam. 10 mm.

Hirado, Hizen. Types No. 80,521, A. N. S. P., from No. 880 of Mr. Hirase's collection.

This form is much larger than *C. hungerfordi* Sowb. III, equally thin, but with another pattern of color, much like that of *C. annæ* Pils., from which it differs in sculpture. As in other forms of the group, there is more or less minute roughening of the ends by fine asperities. The marginal crenulation of this form is a feature strongly differentiating it from *C. hungerfordi* and *stigmaticum.*

Cardium hungerfordi stigmaticum n. subsp. Pl. XLI, figs. 13, 14.

This is a small, thin, nearly equilateral white species, with the apex of each valve red-brown, a vertical streak of the same color on the convexity of the valve below it, and sometimes some faint stains of the same at the sides. The white interior shows the median streak, with usually side streaks and often some mottling or a streak along the pallial line. The sculpture consists of about 9 rather strong but low rounded ribs on the posterior slope, divided into two sets by a shallow, wide radial valley, the last rib dorsally having a linear riblet on each side of it. The median portion of the valve is almost smooth, showing the faintest traces of fine riblets near the lower margin; but where the lower passes into the anterior slope the ribs are decidedly stronger, and denticulate the edge. There is a minute punctulation at both ends in perfectly fresh shells. The right valve has anterior and posterior lateral teeth, the anterior wanting in the other valve.

Length 11.3, alt. 12, diam. 7.3 mm.

Hirado, Hizen. Types No. 86,279, A. N. S. P., from No. 1,410 of Mr. Hirase's collection.

This very pretty little form differs from *C. hungerfordi* Sowb. chiefly in coloration. The latter occurs at Hirado, Hizen, also (1,234 of Mr. Hirase's collection).

Cardium annæ n. sp. Pl. XL, fig. 20.

Shell subcircular and inflated, almost perfectly equilateral, thin white, profusely marked with pale flesh-pink zigzag streaks, the beaks fleshy-brown. Sculpture of fine radial riblets at the ends, each scored at the summit with a finely punctured groove, the grooves persisting over the median portion of the shell where the riblets are obsolete or nearly so. Anteriorly there are about 16 very regular riblets not extending to the edge above, a lanceolate lunular area being left smooth. Posteriorly the riblets are coarser, less regular, part of them flattened and sulcate down the middle. The riblets scarcely crenulate the margins of the valves. The smoothish median part of the shell is regularly marked with close punctured lines, the spaces between them being perceptibly concave. The interior is slightly fluted by the external ribs at the two ends, nearly smooth elsewhere. The zigzag external markings show rose or crimson on a white ground, which deeper in the cavity changes to fleshy-brown.

The right valve has two contiguous cardinal teeth, the anterior one standing almost above the posterior, and well developed anterior and posterior lateral teeth. In the left valve the cardinals diverge, the anterior being the larger. The anterior lateral is well developed, the posterior obsolete.

Length 27, alt. 25, diam. 16 mm.

Hayama, near Kamakura, Sagami, on Sagami Bay. Types No. 86,319, A. N. S. P., collected and given to the Academy by Miss Anna C. Hartshorne.

This beautiful *Cardium* is related to *C. papyraceum* Brug., which I have not yet seen from Japan. It is more fragile and more delicately sculptured than that species, in which the inner margins of the valves are closely and deeply fluted. Moreover, the altitude of *C. papyraceum* decidedly exceeds the length, while in *C. annæ* the length is greater. In *C. papyraceum* the posterior end is more produced than the anterior, the latter being noticeably straightened and subvertical, while in *C. annæ* the two ends are almost equally rounded. The coloration also differs.

There is a specimen of this species in the collection of the Academy, received many years ago from Andrew Garrett, labelled "*C. tcheliense*

Debeaux, China." Debeaux collected in Chinese waters and published a little-known and not very valuable paper on his results in *Recueil de Mémoires de Médicine, de Chirurgie et de Pharmacie militaires, rédége sous le surveillance du Conseil de Santé*, 3 ser., VI, Paris, 1861; but no mention is made therein of a *Cardium tchcliense.* I have been unable to trace it in the literature examined. The name suggests that of a province of northern China, but being orthographically defective, I have thought its retention undesirable.

Kellia porculus n. sp. Pl. XLI, figs. 18, 19, 20.

The small cream-white subglobular shell resembles *K. japonica* Pils. in outlines, except that it is decidedly more ventricose. The glossy surface is minutely striate, with stronger irregularities at unequal distances indicating periods of growth-arrest. In the right valve there is a single rather broad, oblique cardinal tooth, with a socket and a minute tubercle above it, and a small, triangular lateral. The left valve has two erect, subequal cardinals and a strong, triangular lateral.

Length 8.5, alt. 8, diam. 6 mm.

Hirado, Hizen. Type No. 86,266, A. N. S. P., from No. 1,011*a* of Mr. Hirase's collection.

In *K. japonica* Pils. the teeth are all much more delicate and the shell is less inflated. The hinge of *K. japonica* is figured for comparison, pl. XLI, fig. 21.

Solecardia vitrea japonica n. subsp. Pl. XLI, fig. 6.

Shell resembling *S. vitrea* Quoy and Gaimard (*Scintilla aurantiaca* Desh.) in shape, but smaller and white.

Length 10.3, alt. 5, diam. 3 mm.

Hirado, Hizen. Types No. 86,276, A. N. S. P., from No. 1,544 of Mr. Hirase's collection.

Myodora reeveana Smith. Pl. XLI, figs. 7, 8, 9, 10.

Shell small, solid, yellowish-white, with the right valve quite convex and projecting beyond the other below, the left valve flat and smaller. Behind the beaks the dorsal valve-margins are concave and excavated, in front of them they are slightly convex. The basal margin is strongly arcuate, the posterior end truncate and biangular, and the anterior end narrowly rounded. Both valves are irregularly sculptured with coarse wrinkles, the convex valve more strongly so. The pallial sinus is small and triangular. In the right valve the anterior lateral tooth is a long, perfectly straight ridge, the posterior tooth is very small and narrow, largely overhung by the concave valve margin. In the left valve there is a small erect anterior lamella, and a curved posterior one.

Length 7, alt. 5, diam. 2 mm.

Hirado, Hizen. Figured specimens are No. 86,301, A. N. S. P., from No. 914 of Mr. Hirase's collection.

A peculiar, very asymmetrical little species, originally described from China. *Myodora proxima* Smith, 1880 (=*triangularis* "A. Ad." Dkr., 1882), has also been taken by Mr. Hirase at Hirado, Hizen. These two with *M. fluctuosa* Gld. are the only species of the genus yet reported from Japan.

Ostrea circumpicta n. sp. Pl. XL, figs. 12, 13.

The shells of this oyster are very irregular and rough, showing a few radial ridges on the upper valve, and rough lines of growth-arrest. Nearly the whole lower valve has been attached. The exterior is gray or with some purple pencilling. Both valves have long, projecting beaks, and are usually about equally concave within. The interior is bluish-white or dirty white, extensively olive-stained, and often with some purple stains. The borders are smooth or nearly so near the hinge, and smooth or finely, irregularly scalloped elsewhere, and the distal and lateral margins are in part or wholly painted with a rather wide border of purple or groups of purple lines. The length of a well-grown shell is 87, breadth 56 mm.

Hirado, Hizen. Types No. 80,448, A. N. S. P., from No. 500 of Mr. Hirase's collection.

O. inæquivalvis Sowb.,[2] from Madagascar and Mauritius, is similar in internal coloring. *O. vitrefacta* Sowb.[3] also resembles this species somewhat, but that is conspicuously crenate within.

Arca kobeltiana n. sp. Pl. XL, figs. 16, 17, 18, 19.

Arca ocellata? Kobelt, Conchylien Cabinet, *Arca*, p. 87, Pl. 24, figs. 1–4. Not *A. ocellata* Reeve.

This is a deep, narrow *Arca*, with a strong diagonal keel and another defining the posterior border of the ligament-area. The surface where unworn is many-ribbed and densely hirsute, but this sculpture and covering persists only at the edges of the specimens before me. The ventral margin gapes rather widely. The wide ligament-area is marked off into concentric lozenges by very numerous ligament-filled diagonal broadly V-shaped sulci, of which I count 11 in a shell 44 mm. long, 17 in one 55 mm. long. The hinge-line is narrow, the teeth fine, close

[2] *Conch. Icon.*, XVIII, *Ostrea*, fig. 82.
[3] *Conch. Icon.*, XVIII, *Ostrea*, fig. 80.

and vertical in the middle, somewhat irregular there and anteriorly, but posteriorly they become coarse and very oblique, and strongly crenulate on the upper edges. The count of teeth in three shells is as follows, the anterior end preceding:

23, 17 = 40 teeth; length of shell 44 mm.

18, 26 = 44 teeth; length of shell 44 mm.

15, 30 = 45 teeth; length of shell 53 mm.

The interior is dirty white, sometimes with brown stains, the edges crenulate and brown.

Length 53, alt. 24, diam. 26 mm.

Length 44, alt. 21, diam. 23 mm.

Co-types No. 78,750, A. N. S. P., from the east coast of Japan, collected by Miss Anna C. Hartshorne (fig. 17), and No. 58,082, received in a lot of shells from northern Japan, probably Yesso, but the exact locality is unknown.

I take these shells to belong to the species described by Kobelt in his excellent monograph cited above, and referred by him with great doubt, and on the authority of Mr. E. A. Smith, to *A. ocellata* Reeve, described from Singapore. Having before me topotypes of *A. ocellata*, as well as several Japanese specimens which agree with them, I am compelled to regard the two species as entirely distinct, and not even closely related, although they agree in general shape. The ligament-area in *A. ocellata* is smooth, scored by only a few, usually imperfect ligament grooves, there being a large oblique triangle posteriorly and an erect triangle between the beaks free from them. The two oblique triangles marked by grooves are usually covered with a smooth yellow (or in some Japanese shells, blackish) cuticle, while the rest of the area is whitish. This is well shown in the dorsal aspect of a specimen of *A. ocellata* from the province of Suruga (No. 71,041, A. N. S. P.), drawn in fig. 21 of pl. XL.

Arca ocellata does not attain nearly the size of *A. kobeltiana*, an adult Singapore shell measuring, length 26, alt. 12.5, diam. 13 mm. The Japanese specimens with unworn surface are somewhat more regular in growth than those from Singapore, and have a very narrow ventral gape. One measures, length 20.5, alt. 11.6, diam. 10.6 mm. The diagonal keel is very acute.

Reference to Plates XXXIX–XLI.

Plate XXXIX, Figs. 1, 2, 3.—*Mactra carneopicta* Pils.
Figs. 4, 5, 6.—*Spisula bernardi* Pils.
Figs. 7. 8, 9.—*Pitar sulfurea* Pils.
Figs. 10, 11.—*Cytherea crispata amicta* Pils.

PLATE XL, Figs. 12, 13.—*Ostrea circumpicta* Pils.
Figs. 14, 15.—*Cardium hungerfordi undatopictum* Pils.
Figs. 16, 17, 18, 19.—*Arca kobeltiana* Pils.
Fig. 20.—*Cardium annæ* Pils.
Fig. 21.—*Arca ocellata* Reeve.

PLATE XLI, Figs. 1, 2.—*Chione hizenensis* Pils.
Fig. 3.—*Tellina hirasei* Pils.
Figs. 4, 5.—*Chione micra* Pils.
Fig. 6.—*Soletellina vitrea japonica* Pils.
Figs. 7, 8, 9, 10.—*Myodora reeveana* Smith.
Figs. 11, 12.—*Tellina fabrefacta* Pils.
Figs. 13, 14.—*Cardium hungerfordi stigmaticum* Pils.
Figs. 15, 16.—*Codakia bella delicatula* Pils.
Fig. 17.—*Cardium hungerfordi* Sowb.
Figs. 18, 19, 20.—*Kellia porculus* Pils.
Fig. 21.—*Kellia japonica* Pils.

NOTES ON ORTHOPTERA FROM ARIZONA, NEW MEXICO AND COLORADO.

BY JAMES A. G. REHN.

The specimens mentioned in the following pages are almost all contained in the collection of the Academy, and chiefly represent collections made in the summer of 1902 in central Arizona, northern New Mexico and central Colorado by C. F. Oslar, and in the summer of 1903 by C. R. Biederman, at Florence, Pinal county, Arizona. A few specimens from Yuma county, Arizona, belonging to the Hebard Collection, have also been studied in this connection.

Family FORFICULIDÆ.

Labia melancholica Scudder.

Florence, Pinal county, Arizona. (C. R. Biederman.) Seven specimens of both sexes.

This species, described from either Waco or near Austin, Texas, has apparently been unrecognized since the original description until the capture of the above-recorded individuals.

Family BLATTIDÆ

Periplaneta americana (Linnæus).

Florence, Pinal county, Arizona. (C. R. Biederman.) Numerous individuals.

Family MANTIDÆ.

Litaneutria minor (Scudder).

Florence, Pinal county, Arizona. July 26, September 20 and October 9, 1903. (C. R. Biederman.) Three males, three females.

Two of the females show decided traces of a rich vermilion coloration, which apparently suffused the entire abdomen, thorax and limbs.

Stagmomantis carolina (Linnæus).

Florence, Pinal county, Arizona. July 13, 1903. (C. R. Biederman.) Two males.

Stagmomantis limbata (Hahn).

Florence, Pinal county, Arizona. July 26, August 10 and September 4, 1903. (C. R. Biederman.) One adult and two immature females.

Family **ACRIDIDÆ.**

Mermiria bivittata (Serville).

Albuquerque, Bernalillo county, New Mexico. July 16, 1902. (Oslar.)

Salt Lake Valley, Utah. August 2, 1896. One male.

Acrolophitus hirtipes (Say).

Raton, Colfax county, New Mexico. August 1, 1902. (Oslar.) Four females.

Bootettix argentatus Bruner.

Florence, Pinal county, Arizona. July 13, 1903. (C. R. Biederman.) One adult female and four nymphs.

Chlœaltis abdominalis (Thomas).

Truchas Peak, Rio Arriba county, New Mexico. August 4, 1902. (W. P. Cockerell.) One female.

Inseparable from a female individual from Manitoba, Canada.

Horesidotes cinereus Scudder?

Yuma county, Arizona. September, 1903. One male. Coll. Morgan Hebard.

This specimen probably belongs to this genus and species, but several characters, such as the proportions of the prozona and metazona, do not agree with the description. These parts are said to be "of subequal length," while in the specimen at hand the metazona is decidedly shorter than the prozona. Generally, however, the specimen agrees very well with the description.

Gomphocerus clepsydra Scudder.

Truchas Peak, Rio Arriba county, New Mexico. 13,000–14,000 feet elevation and above timber line. August 2, 1902. (W. P. Cockerell.) One male, two females.

I am not prepared to make any critical remarks on the standing of the several American "species" of this genus, and accordingly the use of *clepsydra* as a full species should not be considered an expression of opinion, but simply the utilization of a term to designate a type the validity of which is, to say the least, doubtful.

Boopedon nubilum (Say).

Thumb Butte, Arizona. July 11, 1902. (Oslar.) One male.

Ligurotettix kunzei Caudell.

Florence, Pinal county, Arizona. July 1, 1903. (C. F. Biederman.) One male.

Arphia arcta (Scudder).

Jerome, Yavapai county, Arizona. June 26, 1902. (Oslar.) Two males, two females.

Albuquerque, Bernalillo county, New Mexico. July 12, 1902. (Oslar.) One female.

I cannot agree with Caudell[1] in uniting *A. teporata* with this species. They appear to me quite distinct, and separable by the length of the tegmina and wings in the female, and in the form of the vertex. In this connection I have examined thirty-seven specimens of the two species.

Arphia canora n. sp.

?1902. *Arphia nietana* Scudder and Cockerell, Proc. Davenport Acad. Sci., IX, p. 28. (Not of Saussure.)

Types: ♂ and ♀; Salt Lake City, Utah (♂), and Albuquerque, Bernalillo county, New Mexico. (Oslar: July 15, 1902.) (♀)

Allied to *A. nietana* Saussure, but differing in the slenderer form, the narrower vertex, the more vertical face, the longer metazona and the slenderer posterior femora.

♂.—Size medium; form somewhat slender. Head with the occiput bearing several longitudinal rugæ, the median one extending forward to the tip of the scutellum of the vertex; scutellum pyriform, longer than broad, very slightly excavated, margins moderately high, the median carina broken centrally; lateral foveolæ elongate, subtrigonal, not strongly marked; frontal costa broad and subequal inferiorly, at the ocellus expanded and slightly and shallowly excavated, above the ocellus distinctly constricted, subequal, apex truncate, this portion with a distinct median carina; eye not prominent and about equal in length to the infraocular portion of the genæ; antennæ about equal to the head and pronotum in length. Pronotum with the median carina rather low, even, distinctly cut by the last sulcus; anterior margin very obtuse-angulate; posterior margin acute-angulate with the angle rounded; surface of the disk rugoso-granulate; lateral lobes of the pronotum subequal, deeper than wide. Interval between the metasternal lobes slightly longer than broad. Tegmina moderately long; apex obliquely truncate; greatest width about median. Wings not elongate, two-thirds as wide as long. Posterior femora robust, reaching to the apex of the abdomen, superior and inferior margins equally arcuate.

♀.—Similar to the male with the following important exceptions: Scutellum of the vertex broad, about as broad as long; frontal costa

[1] *Proc. U. S. Nat. Mus.*, XXVI, p. 785.

distinctly sulcate below the ocellus; antennæ somewhat shorter than the head and pronotum. Median carina of the pronotum lower than in the male; posterior margin of the pronotum rectangulate with the apex rounded. Intervals between the metasternal lobes very slightly broader than long.

General color blackish-brown, sprinkled with small obscure blackish maculations. Abdomen and under surface dull yellowish in the male, varying from yellowish-brown to dark wood-brown in the females, and the paler specimens of the latter sex have the abdomen with regular lateral blotches of brownish-black. Tegmina of the general color. Wings with the disk flame-scarlet, the fuscous bar rather dark but fading on the posterior margin of the wing; apex suffused with fuscous; tænia rather broad, solid, but not reaching the base of the wing; costal margin of the color of the disk. Posterior femora externally with traces of several transverse dark bars, the apical one of which is fairly apparent and somewhat contrasts a weak pregenicular annulus of ochraceous; genicular region blackish; internal face with the pregenicular annulus yellowish and distinct, the remainder black with the superior and inferior margins cut by two broken bars of yellowish. Posterior tibiæ greenish-yellow (♂) or dull brown, dark apically; spines tipped with black.

Measurements.

	♂	♀
Length of body,	24 mm.	27 mm.
Length of pronotum,	6 "	6 "
Greatest width of pronotum,	4.1 "	4.5 "
Length of tegmina,	24 "	26.5 "
Greatest width of tegmina,	5 "	5.5 "
Length of wing,	19.5 "	23 "
Length of posterior femora,	13.7 "	14.2 "

The series of this species examined comprises twelve specimens from the following localities: Salt Lake City, Utah (three males); Silver Lake, Utah [Skinner] (two males); Albuquerque, New Mexico [Oslar] (two females); Jerome, Arizona [Oslar] (three males and two females). The most striking variation exhibited by the series is in color, size being quite constant. The ground color in some individuals is almost uniform, in others strongly maculate, while several have the posterior margin and the entire lateral lobes of the pronotum conspicuously barred with the two primary shades. In several specimens the axillary field of the tegmina is straw-colored, while a great amount of variation is exhibited in the intensity of the external bars of the posterior femora. The color of the disk of the wings appears to be constant.

Arphia pseudonietana (Thomas).

Las Vegas, San Miguel county, New Mexico. (Oslar.) One male, one female.

Albuquerque, Bernalillo county, New Mexico. July 14, 1902. (Oslar.) One male.

Jerome, Yavapai county, Arizona. (Oslar.) One male, two females.

Encoptolophus subgracilis Caudell.

Florence, Pinal county, Arizona. May 8, July 10 and August 25, 1903. (C. R. Biederman.) Four females.

One of these specimens is considerably smaller than the others, but otherwise they are structurally uniform. The disk of the pronotum, top of the head and the posterior femora are pea-green in one specimen; the others have these parts of the brownish shades noted in the original description.

Camnula pellucida (Scudder).

Prescott, Yavapai county, Arizona. (Oslar.) One male.

Thumb Butte, Arizona. (Oslar.) One immature female.

Hippiscus zapotecus (Saussure).

Pecos, San Miguel county, New Mexico. June 20, 1902. (W. P. Cockerell.) One female.

Las Vegas, San Miguel county, New Mexico. July 20, 21 and 25, 1902. (Oslar.) Nine females.

Hippiscus cupidus Scudder.

Jerome, Yavapai county, Arizona. June 27, 1902. (Oslar). Two males.

Prescott, Yavapai county, Arizona. May 19, 1902. (Oslar.) One female.

Leprus elephas Saussure.

Reef, Cochise county, Arizona. October 29, 1903. (C. R. Biederman.) One female.

This specimen is inseparable from individuals from the state of San Luis Potosi.

Dissosteira carolina (Linnæus).

Gallinas Cañon, San Miguel county, New Mexico. July 23, 25 and 26, 1902. (Oslar.) One male, one female, four nymphs.

Sapello Cañon, San Miguel county, New Mexico. July 26, 1902. (Oslar.) One male.

Las Vegas, San Miguel county, New Mexico. July 21, 22 and 23, 1902. (Oslar.) Three males, three females.

Albuquerque, Bernalillo county, New Mexico. July 12, 15, 16 and 17, 1902. (Oslar.) Five males.

Spharagemon inornatum Morse.

Gallinas Cañon, San Miguel county, New Mexico. July 21, 1902. (Oslar.) One female.

Derotmema laticinctum Scudder.

Florence, Pinal county, Arizona. (C. R. Biederman.) One male.

Derotmema haydeni (Thomas).

Gallinas Cañon, San Miguel county, New Mexico. July 21, 29 and 30, 1902. (Oslar.) Six females.

Santa Fé, Santa Fé county, New Mexico. July 19, 1902. (Oslar.) One male.

Cerro del Corazon, New Mexico. July 16, 1902. (Miss Alice Blake.) Three females.

Trepidulus rosaceus McNeill.

1901. *Trepidulus rosaceus* McNeill, Proc. U. S. Nat. Mus., XXIII, pp. 394, 398. January 19, 1901. [San Bernardino, Cal.]
1901. *Aræopteryx penelope* Caudell, Canad. Entom., XXXIII, p. 102. April, 1901. [Prescott, Arizona.]

Florence, Pinal county, Arizona. July 26 and August 10, 1903. (C. R. Biederman.) One male, one female.

The above synonymy is evident after studying each description. It is unfortunate that the exceedingly poor and insufficient description of *T. rosaceus* should have precedence over the excellent one of *Aræopteryx*, but the law of priority leaves us no other course.

Mestobregma kiowa (Thomas).

Raton, Colfax county, New Mexico. (Oslar.)

This is apparently the first New Mexican record.

Conozoa acuminata Scudder?

Florence, Pinal county, Arizona. June 8 and July 9, 1903. (C. R. Biederman.) Two males.

Phœnix, Maricopa county, Arizona. April 22, 1902. (Oslar.) One male.

There is a little doubt as to the identity of these specimens, but they fit this form better than any other.

Trimerotropis laticincta Saussure.

Gallinas Cañon, San Miguel county, New Mexico. (Oslar.) One male, one female.

These specimens are grayer than a female individual from Sidney, Nebraska, received from Prof. Bruner. The female has the tegmina decidedly longer than in the Nebraskan example.

Trimerotropis vinculata Scudder.

Raton, Colfax county, New Mexico. (Oslar.) Two males, one female.

Albuquerque, Bernalillo county, New Mexico. (Oslar.) Three males, one female.

Florence, Pinal county, Arizona. May 3, 5 and 8 and August 18, 1903. (C. R. Biederman.) Two males, two females.

Phœnix, Maricopa county, Arizona. April 10, 17, 19, 22, 24 and 28, 1902. (Oslar.) Four males, six females.

Prescott, Yavapai county, Arizona. May 7, 1902. (Oslar.) Two males, one female.

Trimerotropis rubripes n. sp.

Type: ♀; Albuquerque, Bernalillo county, New Mexico. July 15, 1902. (Oslar.)

Allied to *T. agrestis* McNeill, but differing in the longer wings and tegmina, the weaker lateral fastigial carina and the darker coloration.

Size rather large. Head with the interspace between the eyes moderately broad; scutellum of the vertex slightly longer than broad, but slightly excavated and without a median carina; lateral foveolæ minute, subtrigonal; frontal costa not reaching the clypeus, faintly expanded inferiorly, superior portion subequal, all moderately sulcate; eye moderately prominent, rather small, decidedly less than the infra-ocular portion of the genæ in length; antennæ slight. Pronotum with the disk flat, median carina distinctly carinate anteriorly, but very weak posteriorly; prozona about half the length of the metazona; anterior margin very obtuse-angulate, posterior margin acute-angulate; lateral lobes of the pronotum subequal in width, the inferior margin posteriorly with a small angulate process. Interval between the meta-sternal lobes shallow and strongly transverse. Tegmina long, over five times as long as the greatest width; apex obliquely truncate. Wings slender, considerably more than half again as long as wide; apex somewhat falcate. Posterior femora robust, the inferior margin distinctly more arcuate than the superior.

General color ecru-drab, suffused more or less strongly with russet. Head and pronotum strongly infuscate and punctulate with russet. Tegmina with two transverse bars poorly represented by groups of russet annuli and small maculations, these almost limited to the discoidal field, one median in position and the other equidistant from this and the base; distal portion of the tegmina hyaline except in the costal region. Wings with the disk about as broad as long, sulphur-yellow in color; fuscous bar broad, one-fourth as broad as the length of the wing, clove-brown in color; ulnar tænia broad but short, and not reaching half way to the base of the wing; apical third hyaline, except for the proximal portion of the costal margin, which is brownish. Posterior femora pale cinnamon externally, the carinæ dotted with blackish, and the superior face with traces of two fuscous bars; internally ecru-drab with a rather narrow preapical band and a broad mediobasal blotch of black; inferior sulcus orange-vermilion with a preapical bar of black; genicular region blackish internally. Posterior tibiæ orange-vermilion, the basal portion externally hoary; spines narrowly tipped with black.

Measurements.

Length of body, ...	33.5 mm.
Length of pronotum, ...	7 "
Greatest width of pronotum, ...	5.5 "
Length of tegmina, ...	36 "
Greatest width of tegmina, ...	6 "
Length of wings, ...	32 "
Width of wings, ...	18.5 "
Length of posterior femora, ...	15.8 "

The type is the only specimen of this species examined.

Trimerotropis cyaneipennis Bruner.

Prescott, Yavapai county, Arizona. July 5, 1902. (Oslar.) Two males.

Circotettix undulatus (Thomas).

Beulah, San Miguel county, New Mexico. 1902. (W. P. Cockerell.) One male.

Albuquerque, Bernalillo county, New Mexico. July 12 and 13, 1902. (Oslar.) One male, two females.

It is quite possible that some point more elevated than the immediate vicinity of Albuquerque is the real locality from which these latter specimens were taken.

Circotettix suffusus (Scudder).

Las Vegas, San Miguel county, New Mexico. July 21, 1902. (Oslar.) One female.

Albuquerque, Bernalillo county, New Mexico. July 15, 1902. (Oslar.) One female.

The remarks made under the previous species apply with equal force to the above records.

Hadrotettix trifasciatus (Say).

Raton, Colfax county, New Mexico. August 1, 1902. (Oslar.) One male.

Las Vegas, San Miguel county, New Mexico. July 23, 1902. (Oslar.) One female.

Copper Basin, Arizona. (Oslar.) One immature male.

Heliastus aridus (Bruner).

Quartzsite, Yuma county, Arizona. April 20, 1903. Four females.

These specimens agree very well with a large New Mexican series.

Paropomala virgata Scudder.

Yuma county, Arizona. September, 1903. Three males, seven females. Hebard Coll.

The great amount of color variation noticed by Scudder is also evident in this series, the range of general color being from chalky-white and brownish to dull greenish.

Schistocerca shoshone (Thomas).

Florence, Pinal county, Arizona. July 10, 25 and 26 and October 9, 1903. (C. R. Biederman.) Two males, four females.

Schistocerca vaga (Scudder).

Florence, Pinal county, Arizona. May 8, 31; June 4, 8, 24; July 23, 26; August 25; September 20, 1903. (C. R. Biederman.) Six males, seven females.

Hesperotettix festivus Scudder.

Florence, Pinal county, Arizona. August 10 and September 20, 1903. (C. R. Biederman.) Two males, three females.

These individuals fully agree with a series from Phœnix, Arizona. All five specimens possess reddish pregenicular annuli.

Hesperotettix viridis (Thomas).

Gallinas Cañon, San Miguel county, New Mexico. July 21, 1902. (Oslar.) One female.

Jerome, Yavapai county, Arizona. June 27, 1902. (Oslar.) One female.

The collection also contains a short-winged individual, apparently similar to the ones mentioned by Scudder, from Ruby Valley, Nevada, which I have doubtfully referred here. It was taken at Prescott, Arizona, July 5, 1902, by Oslar.

Melanoplus herbaceus Bruner.

Florence, Pinal county, Arizona. June 2 and August 10, 1903. (C. R. Biederman.) Two females.

Melanoplus flavidus Scudder.

Florence, Pinal county, Arizona. August 25 and October 3, 1903. (C. R. Biederman.) One male, one female.

Mr. Caudell has compared these specimens with U. S. National Museum material and regards them as *flavidus*. From specimens of *flavidus* from Wyoming, determined by Bruner, they differ in the slenderer form, in which respect they are approaching *M. elongatus*, but the structure of the cerci are not as in that species.

Melanoplus excelsus Scudder.

Truchas Peak (at timber-line, 13,000–14,000 feet), Rio Arriba county, New Mexico. August 2, 1902. (W. P. Cockerell.) Two males.

Melanoplus atlanis (Riley).

Florence, Pinal county, Arizona. May 8, 18, and 20 and September 20, 1903. (C. R. Biederman.) Three males, one female.

Las Vegas, San Miguel county, New Mexico. July 10, 1902. (Oslar.) One male.

Melanoplus aridus (Scudder).

Florence, Pinal county, Arizona. July 13, September 20 and October 3, 1903. (C. R. Biederman.) One male, two females.

Melanoplus altitudinum (Scudder).

Raton, Colfax county, New Mexico. August 1, 1902. (Oslar.) One female.

Prescott, Yavapai county, Arizona. June 9, 1902. (Oslar.) One male.

Copper Basin, Arizona. July 7, 1902. (Oslar.) Two females.

The above individuals fully agree in structure with a series from the Big Horn Mountains, Wyoming, but are slightly smaller: in this respect similar to several specimens from the Sacramento Mountains, southern New Mexico.

Melanoplus sapellanus Scudder.

Truchas Peak, Rio Arriba county, New Mexico. August 2, 1902. (W. P. Cockerell.) Three females.

Melanoplus femur-rubrum (DeGeer).

Prescott, Yavapai county, Arizona. June 7, 1902. (Oslar.) One male.

Melanoplus canonicus Scudder?

Florence, Pinal county, Arizona. September 20, 1903. (C. R. Biederman.) One female.

There is some doubt attached to the identification of this specimen.

Melanoplus minor (Scudder).

Pecos, San Miguel county, New Mexico. June 28, 1902. (Grabhens.) One male.

Prescott, Yavapai county, Arizona. June 9, 1902. (Oslar.) One male.

These specimens are inseparable from eastern individuals. This is the first record of the species from Arizona.

Melanoplus differentialis (Thomas).

Albuquerque, Bernalillo county, New Mexico. July 15, 1902. (Oslar.) One male.

Melanoplus bivittatus (Say).

Sapello Cañon, San Miguel county, New Mexico. July 26, 1902. (Oslar.) One female.

Albuquerque, Bernalillo county, New Mexico. July 12, 1902. (Oslar.) One male.

Pœcilotettix sanguineus Scudder.

Bill Williams Fork, Mohave–Yuma counties, Arizona. August. (F. H. Snow.) One male, one female.

Dactylotum pictum (Thomas).

Arrayo,[2] Pecos river, New Mexico. July 18, 1902. (Oslar.) One male, three females.

Cerro del Corazon, New Mexico. July 16, 1902. (Miss Alice Blake.) One male, three females.

Family TETTIGONIDÆ.

Hormilia elegans Scudder.

Florence, Pinal county, Arizona. June 8, 14; July 13, 23, and September 20, 1903. (C. R. Biederman.) Two adult males, five adult females, four nymphs.

This species is exceedingly variable in coloration and slightly so in structure. The typical form of Scudder is represented more or less closely by five of the specimens in the collection, but the two adult males have the basic color of the tegmina olivaceous, and the "herringbone" pattern of the typical form replaced by regularly disposed patches of glaucous green, while the distal portion of the posterior

[2] Apparently an error for arroyo, *i.e.*, torrent-bed or gully.

femora and the proximal portion of the posterior tibiæ are ornamented with a broad ring of glaucous green. The lateral carinæ of the pronotum also vary considerably in strength.

Conocephalus ensiger Harris.

Rio Grande river, New Mexico, July 17, 1902. (Oslar.) Three males.

This is the first record of the species from New Mexico, and while the data is vague, it is evident they were taken in northern New Mexico.

Xiphidion fasciatum (DeGeer).

Rio Grande river, New Mexico. July 15 and 16, 1902. (Oslar.) Two males.

Capnobotes fuliginosus (Thomas).

Jerome, Yavapai county, Arizona. June 27 and 28, 1902. (Oslar.) One male, one female.

Drymadusa arizonensis n. sp.

Type: ♂; Florence, Pinal county, Arizona. 1903. (C. R. Biederman.) Acad. Nat. Sci. Phila.

This specimen is unquestionably a member of the Palearctic genus *Drymadusa,* and is closest related to *D. limbata* Brunner,[3] from Asia Minor, but is easily separated by the much smaller size and slenderer tegmina, as well as the more apparent maculations of the same.

Size rather large; form considerably elongate. Head with the occiput rounded transversely, not elevated sloping gradually to the rather narrow, partially sulcate fastigium, which latter is deflected and touches the frontal process, width of the fastigium less than that of the first antennal joint; eyes wide apart, prominent, subglobose; antennæ as long as the tegmina. Pronotum selliform; anterior margin shallowly emarginate, posterior margin broadly and evenly rotundate; lateral lobes with the inferior margin rather narrowly rounded; posterior sinus very slight. Tegmina elongate, exceeding the apex of the abdomen by half their length, the greatest width is contained six and a half times in the length, apex obliquely truncato-rotundate, costal expansion regular but not marked, greatest basally and narrowing gradually toward the apex. Wings equal to the tegmina in length. Abdomen somewhat compressed; supra-anal plate triangular, deeply and very narrowly divided into two elongate acute lobes; cerci rather short, the apical portion with two distinct hooks on the internal face; subgenital plate compressed, deep, inferiorly carinate, apical margin triangularly incised. Anterior femora longer than the pronotum,

[3]*Prodr. Europ. Orth.*, p. 314.

internal inferior margin with three to four very distinct spines; tibiæ with two spines on the external superior margin. Median femora slightly longer than the anterior, external inferior margin with one or two spines; tibiæ with two spines on the external superior margin and three internal superior margin. Posterior femora slightly shorter than the head and body, apical half slender and subequal, basal half moderately expanded; tibiæ slightly longer than the femora, compressed quadrate in section, regularly spined above, except basally, where the spines are fewer, inferior face with seven pairs of spines and several odd ones, upper inner calcar much exceeding the external in size; posterior tarsi of the type usual in the genus.

General color ochraceous buff (probably greenish in life) washed with apple-green on the tegmina. Head darker above than below; eyes hazel. Pronotum with an hour-glass-shaped figure on the median portion of the disk and a line along the posterior portion of the lateral lobes approximately parallel to the margin blackish-brown; posterior margin of the disk of the pronotum broadly bone-white. Tegmina with a distinct median longitudinal series of subcircular opaque whitish spots, flanked above by a short series not so distinct, a few poorly defined blotches along the anal margin and an irregular jumbled series in the costal field.

Measurements.

Length of body,	29	mm.
Length of pronotum,	6.8	"
Greatest dorsal width of pronotum,	5	"
Length of tegmina,	41	"
Greatest width of tegmina,	6.5	"
Length of posterior femora,	24.5	"

The type is the only specimen which has been examined.

Ateloplus notatus Scudder.

Jerome, Yavapai county, Arizona. June 26, 1902. (Oslar.) One immature male.

Florence, Pinal county, Arizona. July, 1903. (C. R. Biederman.) One female.

The immature specimen was studied by Mr. Caudell, and compared with the type. This species was originally described from San Diego, California.

Ceuthophilus arizonensis Scudder.

Jerome, Yavapai county, Arizona. June 26, 1902. (Oslar.) One male.

Sapello Cañon, San Miguel county, New Mexico. July 25, 1902. (Oslar.) One female.

The only previous New Mexican record of this species is from Fort Wingate.

Family GRYLLIDÆ.

Nemobius neomexicanus Scudder.

Florence, Pinal county, Arizona. July, 1903. (C. R. Biederman.) One female.

Gryllus personatus Uhler.

Florence, Pinal county, Arizona. September 5, 1903. (C. R. Biederman.) One female.

Flagstaff, Coconino county, Arizona. July 12 and 13, 1903. (Oslar.) Eight males.

Phœnix, Yavapai county, Arizona. April 23, 1902. (Oslar.) One male.

All the specimens of this species examined are macropterous.

Gryllus pennsylvanicus Burmeister.

Florence, Pinal county, Arizona. July 12, 1903. (C. R. Biederman.) One female.

Flagstaff, Coconino county, Arizona. July 12, 1902. (Oslar.) One female.

Gallinas Cañon, San Miguel county, New Mexico. July 21, 1902. (Oslar.) One male, one female.

Miogryllus lineatus (Scudder).

Florence, Pinal county, Arizona. June 8, 1903 [one]. (C. R. Biederman.) All more or less immature, four males, two males.

The two females are much larger than the other individuals and have the heads solid blackish-brown.

Œcanthus fasciatus Fitch?

Florence, Pinal county, Arizona. July 26 and September 20, 1903. (C. R. Biederman). Two females.

These individuals are referred here with considerable doubt.

ON A COLLECTION OF BIRDS AND MAMMALS FROM MOUNT SANHEDRIN, CALIFORNIA.

BY WITMER STONE.

(WITH FIELD NOTES BY A. S. BUNNELL.)

The Academy of Natural Sciences of Philadelphia has recently secured a valuable collection of Californian birds and mammals, formerly the property of Mr. A. S. Bunnell, of Berkeley. Mr. Bunnell collected most of his specimens in the neighborhood of Berkeley and about Mount Tallac in the Sierras, both of which localities have received considerable study of late years, especially with regard to their avifauna. The most interesting portion of the collection, however, comes from Mount Sanhedrin, in Mendocino county, and as practically nothing has been published upon the fauna of this region, it seems desirable to present the results of Mr. Bunnell's work. In reply to my request for information as to the nature of the country, he has very kindly furnished me with the following account, which I quote in full.

"I was located at Lierlie's ranch, 2,100 feet elevation, which is a cluster of cottages on the north side of a range of spruce-covered hills that rise from Thomas creek, a tributary of Eel river. On the opposite side of this creek from the ranch rises Mount Sanhedrin, which attains an elevation of about 5,000 feet. The whole country is covered with Douglass Spruce and Bull Pine forests on the north sides of the hills, with a few cedars in the shady parts. In more level places there are madronos and black oaks, and on exposed sunny slopes either manzanita and other brush or else grassy clearings. Where the forests are not deep there is much underbrush, and along Thomas creek are alders and willows. The creek is a wild trout stream about twenty feet in width, tumbling throughout its length, while Eel river is about thirty yards wide. There is an abundance of water, although the region lies east of the humid coast belt, and there are no redwoods to be found.

"The ranch is in the transition zone, apparently nearly on the boundary, as one can hear at the same time the songs of the Russet-back and Dwarf Hermit Thrushes and the calls of the Valley Quail and Plumed Partridge. Mount Sanhedrin runs up into the Hudsonian, and on its top, where the snow disappears in May, are found the Thick-billed Sparrow, Golden-crowned Kinglet and Mountain Chickadee. The top of the mountain is mostly covered with low snow-crushed spiny brush, while White-barked Firs grow on the north side."

The specimens were collected on two trips made in 1897 and 1899, during the months of May, June and July.

MAMMALS.

Twenty-one species of mammals were secured by Mr. Bunnell, and eleven others are reported by him as occurring in the vicinity. For the identification of the bats I am indebted to Mr. J. A. G. Rehn, while Mr. W. H. Osgood has kindly examined several of the other species and compared them with specimens in the collection of the U. S. Biological Survey. Species reported by Mr. Bunnell but not represented in the series are marked with an asterisk.

Citellus grammurus douglasii (Richardson). Columbian Spermophile.

Two males. June 11 and July 14. Central shoulder patch jet black, and sides very bright silvery gray.

Eutamias hindsi (Gray). Hinds' Chipmunk.

A male and female, May 30 and June 28, are in the dull pelage, but another pair secured July 8 have patches of bright rusty hairs cropping out on the back and sides.

Sciurus douglasii albolimbatus Allen. Sierran Chickaree.

One female example, June 30, which seems absolutely identical with central Sierra specimens and shows no tendency toward *mollipilosus* of the redwood belt.

Sciurus griseus Ord. Oregon Gray Squirrel.

Six specimens, June 1 to July 24.

Reithrodontomys longicauda (Baird).

One specimen, a female, June 11. Measurements as follows: Length 115 mm., tail 37 (partly lost), hind foot 19, ear 15. Apparently identical with Berkeley specimens.

Peromyscus gambelii (Baird). White-footed Mouse.

Represented by a full series of specimens.

Peromyscus truei (Shufeldt). Big-eared Mouse.

Four adults in tawny pelage, May 29 to June 14; two probably younger, June 13 and 14, much less tawny, and five young, May 29–June 14, in mouse gray pelage, some of them with buff patches on the sides, showing the molt into the preceding stage.

I was at first inclined to think that some of these were *P. boylii*, but comparison with specimens of the latter, kindly loaned by Mr. D. G.

Elliot from the collection of the Field Columbian Museum, convinces me that they all belong to the present species.

Neotoma fuscipes Baird. Round-tailed Wood Rat.

Two adults and two young, June 13–15. These seem identical with Berkeley specimens, and it is noticeable that one from each locality has a partly bicolor tail. In this and other respects this rat seems subject to much individual variation, and I cannot but think that some of the recently established forms which do not seem to have any distinctive geographic range will prove to have been based upon unstable characters.

Microtus californicus (Peale). California Vole.

One specimen, identical with those from Berkeley.

Phenacomys longicaudus True.

One female example of this rare mouse was found dead in a road, June 30, 1899 (No. 11,625, Coll. Acad. Nat. Sci. Phila.). The occurrence of this species so far south of its previously known habitat in Oregon is of particular interest, apart from the fact that this is, so far as I am aware, only the third specimen that has been secured.[1]

In color this specimen is pale rusty, with an admixture of grayish-white hairs, especially about the head and shoulders, and with long rather inconspicuous black hairs scattered over the whole upper surface, beneath grayish-white with the plumbeous bases of the hairs showing through, feet pale rusty above, grayish-white below, tail dark brown with a mixture of silvery white hairs below which make it appear indistinctly bicolor.

Length 170 mm., tail 70, hind foot 19.

The skull resembles that of *P. preblei* (the only one available for comparison) in general appearance, but is relatively narrower. Basilar length 20 mm., zygomatic breadth 14, occipito-nasal length 24, length of nasals 7. The teeth have been described in detail by Mr. Miller. Those of the present specimen are considerably worn.

Thomomys bottæ (Eydoux and Gervais). California Gopher.

Three specimens.

Lepus bachmani Waterhouse. Bachman's Rabbit.

Two specimens, a female and young male, July 6 and June 14.

***Lepus californicus** Gray. California Jack Rabbit.

Jack rabbits are reported as abundant in Mr. Bunnell's notes.

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[1] Cf. Miller, *Proc. Biol. Soc. Wash.*, XI (1897), p. 85.

Odocoileus columbianus (Richardson). Columbia Black-tailed Deer.

Mr. Bunnell states that black-tailed deer are abundant, but no mule deer are to be found. Old elk horns have sometimes been found in the region.

Myotis lucifugus longicrus (True).

Male. July 15.

Myotis californicus caurinus Miller.

Three males and two females. May 26 to July 8.

Myotis evotis (H. Allen). Big-eared Bat.

Male. July 25.

Lasionycteris noctivagans (LeConte). Silver-haired Bat.

Three examples. June 4 to 16.

Pipistrellus hesperus (H. Allen).

Female. July 21.

Eptesicus fuscus (Beauvais). Large Brown Bat.

Male and female. July 21 and 25. These specimens are identical with topotypes of *E. fuscus* from Philadelphia.

***Mephitis occidentalis** Baird. Large Skunk.

Skunks are reported as "very common."

Spilogale phenax Merriam. Little Skunk.

Also "very common." One specimen secured seems to be typical of this species.

***Lutreola vison energumenos** Bangs? Pacific Mink.

Minks are "common."

***Mustela caurina** Merriam ? Pacific Marten.

Martens are reported as occurring sparingly.

***Lutra canadensis** Schreber. Otter.

"Fairly common."

***Putorius xanthogenys** (Gray).

"Brindled weasel common," presumably this species.

Procyon psora Merriam? Raccoon.

"Common." One specimen obtained.

***Ursus americanus** Pallas. Black Bear.

"A few, especially on the mountain."

***Canis ochropus** Eschz.? Coyote.

"A few are found."

***Urocyon californicus** (Mearns). California Gray Fox.

"Common."

***Felis oregonensis** Rafinesque. Oregon Puma.

"Fairly common," presumably this form.

***Lynx** sp. Wildcat.

"Common."

BIRDS.

The collection of birds contains representatives of fifty-six species, all of which, from the time of capture, may be regarded as breeding. To these Mr. Bunnell has added thirty-three species observed, but not secured. These are marked with an asterisk. The collection has been carefully identified with reference to subspecific differences, as the locality is to some extent on the borderland of the humid coast, the Sierran and the Upper Sonoran faunas. The field notes are entirely from Mr. Bunnell's journal.

***Aix sponsa** (Linn.). Wood Duck.

Occurs on Eel river.

***Ardea herodias** Linn. Great Blue Heron.

On Eel river.

Actitis macularia (Linn.). Spotted Sandpiper.

On Eel river.

Lophortyx californicus vallicola (Ridgw.). Valley Partridge.

Abundant. Birds are quite typical.

Oreortyx pictus plumiferus (Gould). Plumed Partridge.

Abundant, range overlaps that of the preceding.

***Dendragapus obscurus fuliginosus** Ridgw. Sooty Grouse.

Numerous, especially in the spruce forests of the higher ridges.

***Zenaidura macroura** (Linn.). Mourning Dove.

Very common, especially at deer salt licks.

***Cathartes aura** (Linn.). Turkey Vulture.

Everywhere, collecting by the dozen on dead trees to roost.

Accipiter velox (Wils.). Sharp-shinned Hawk.

Young hatched July 1, in nest in small spruce in timber.

Accipiter cooperi (Bonap.). Cooper's Hawk.

Trapped in chicken yard.

Accipiter atricapillus striatulus Ridgw. Western Goshawk.

Male, August 1, 1899.

***Buteo borealis calurus** (Cass.). Western Redtail.

Abundant.

*Falco sparverius phalæna (Lesson) Desert Sparrow Hawk.

Not common.

*Haliætus leucocephalus (Linn.). Bald Eagle.

Rare.

*Aquila chrysaëtos (Linn.). Golden Eagle.

Rare.

Otus asio bendirei (Brewster) California Screech Owl.

Abundant. Young hatched June 29.

*Asio magellanicus subsp. Horned Owl.

In spruce woods.

Glaucidium gnoma californicum (Scl.). California Pigmy Owl.

Fairly common. Note a prolonged trill. It sometimes kills quail, and one was observed being mobbed by a large mixed flock of birds.

*Ceryle alcyon (Linn.). Belted Kingfisher.

On Eel river.

Dryobates villosus hyloscopus (Cab.). Cabanis's Woodpecker.

Numerous on oaks and spruces. The specimens approach *harrisii*, but are nearer to *hyloscopus*.

Dryobates pubescens turati (Malherbe). Willow Woodpecker.

Numerous. Two specimens obtained show a decided tendency toward *gairdneri*. In one the tertials are unspotted, in the other those of one side are spotted, while those of the other are not. The superciliary stripe and back are pure white.

Sphyrapicus ruber (Gmel.). Red-breasted Sapsucker.

More common on the higher ridges. The only specimen obtained is typical.

Ceophlœus pileatus abieticola Bangs. Northern Pileated Woodpecker.

Not common. The specimen obtained is small, perhaps indicating a diminution in size, such as we find in the Southern States on the Atlantic coast. It is a female and measures wing 8.75 ins., culmen 2 ins. A female from Vernon, B. C., shows wing 9.20, culmen 2.25, while one from Alva, Florida, has wing 8.80, culmen 1.94.

*Melanerpes formicivorus bairdi Ridgw. Californian Woodpecker.

Rather common.

Colaptes cafer collaris (Vig.). Red-shafted Flicker.

A few specimens are a trifle darker than other examples in the Academy's collection, but are not *saturatior*.

Phalænoptilus nuttalli californicus Ridgw. Dusky Poor-will.

In scrub oak brush on high ridges. Two eggs found on a bare rock, July 23.

*Calypte anna (Less.). Anna's Hummingbird.

Common.

*Selasphorus alleni Hensh. Allen's Hummingbird.

Common.

Tyrannus verticalis Say. Arkansas Kingbird.

Numerous, nesting in the oaks.

Myiarchus cinerascens (Lawr.). Ash-throated Flycatcher.

Common, in small groves.

*Sayornis nigricans (Sw.) Black Phœbe.

Along creek and river.

Nuttallornis borealis (Sw.). Olive-sided Flycatcher.

In rather thinly wooded localities, perching on top of small firs.

Contopus richardsonii (Sw.). Western Wood Pewee

In open timber or clearings.

Empidonax difficilis Baird. Western Flycatcher.

Occurs with the last.

Aphelocoma californica (Vig.). California Jay.

Fairly numerous.

Cyanocitta stelleri carbonacea Grinnell. Coast Jay.

Range overlaps that of the preceding. All the specimens are very brown on the back, but I attribute this to the wear of the plumage. Altogether the specimens are nearest to *carbonacea*, though they exhibit much variation in the development of the frontal spots. In one they are barely appreciable, in two moderately developed and blue, while in one they are strongly developed and tipped with white.

*Corvus brachyrhynchos hesperis Ridgw. California Crow.

Rare.

*Sturnella magna neglecta (Aud.). Western Meadow Lark.

Does not range above Potter Valley.

Agelaius phœniceus caurinus Ridgw. Northwestern Redwing.

Abundant in a small tule swamp, where they return every night to roost and fill the evenings with their notes.

Euphagus cyanocephalus (Wagl.). Brewer's Blackbird.

Abundant in oaks and swamps, nesting in the former.

Icterus bullocki (Sw.). Bullock's Oriole.

Common, nesting in the oaks.

Carpodacus purpureus californicus Baird. California Purple Finch.

A few.

*__Carpodacus mexicanus frontalis__ (Say). House Finch.

A few.

__Astragalinus psaltria__ (Say). Arkansas Goldfinch.

Common.

__Spinus pinus__ (Wils.). Pine Siskin.

Common. Habits similar to the goldfinch.

*__Passer domesticus__ (Linn.). English Sparrow.

Reached Potter Valley in 1900.

*__Chondestes grammacus strigatus__ (Sw.). Western Lark Sparrow.

Only in Potter Valley.

__Spizella socialis arizonæ__ Coues. Western Chipping Sparrow.

Everywhere.

__Junco oregonus thurberi__ (Anthony). Thurber's Junco.

Common, especially on Mount Sanhedrin.

__Melospiza cinerea samuelis__ (Baird). Samuel's Song Sparrow.

Nest in swamps. Only one specimen secured which is rather more rusty than *samuelis*, and possibly inclines toward *cleonensis*.

*__Passerella iliaca megarhyncha__ (Baird). Thick-billed Sparrow.

Only on the top of Mount Sanhedrin and adjoining ridge, in the brush.

*__Oreospiza chlorura__ (Aud.). Green-tailed Towhee.

Associated with the preceding species.

__Pipilo maculatus megalonyx__ (Baird). Spurred Towhee.

Common in brush. Specimens are somewhat intermediate, the bill is distinctly narrower than in true *oregonus*, and there is more white above and on the outer rectrices. Compared with *megalonyx* from Arizona, there is not nearly so much white and the brown is decidedly paler.

*__Pipilo fuscus crissalis__ (Vig.). California Towhee.

Common.

__Zamelodia melanocephala__ (Sw.). Black-headed Grosbeak.

Very common, and destructive to blackberry crop

__Cyanospiza amœna__ (Say). Lazuli Bunting.

Common.

__Piranga ludoviciana__ (Wils.). Lousiana Tanager.

Very common in spruces and oaks.

*__Hirundo erythrogaster__ Bodd. Barn Swallow.

Only observed in Potter Valley.

Petrochelidon lunifrons (Say). Cliff Swallow.

Common.

*__Iridoprocne bicolor__ (Vieill). Tree Swallow.

A few.

*__Tachycineta thalassina lepida__ (Mearns).

Common, full-grown young July 22.

Riparia riparia (Linn.). Bank Swallow.

On Eel river.

Vireo gilvus swainsonii (Baird). Western Warbling Vireo.

Common.

Vireo solitarius cassinii (Xantus). Cassin's Vireo.

Common.

Vireo huttoni Cass. Hutton's Vireo.

One specimen, July 8.

Helminthophila rubricapilla gutturalis Ridgw. Calaveras Warbler.

Rather numerous. Found nest under the bank of a stream.

Helminthophila celata lutescens (Ridgw.). Lutescent Warbler.

One secured June 5.

Dendroica æstiva (Gmel.). Yellow Warbler.

Common.

*__Dendroica auduboni__ (Towns.). Audubon's Warbler.

Only on Mount Sanhedrin.

Dendroica nigrescens (Towns.). Black-throated Gray Warbler.

Common.

Geothlypis tolmiei (Towns.). Macgillivray's Warbler.

Abundant.

Icteria virens longicauda (Lawr.). Long-tailed Chat.

Common and often heard singing at night.

Cinclus mexicanus Sw. American Dipper.

Very common on Eel river and Thomas creek. Many full-grown young in June, and by this month the old birds have stopped singing, simply making a loud rattle.

*__Thryomanes bewicki spilurus__ (Vig.). Vigor's Wren.

Fairly common.

Troglodytes ædon parkmani (Aud.). Parkman's Wren.

Fairly common.

Certhia familiaris occidentalis Ridgw. California Creeper.

Common.

Sitta carolinensis aculeata (Cass.). Slender-billed Nuthatch.

Common.

Parus gambeli Ridgw. Mountain Chickadee.

Only on the mountain.

Parus rufescens Towns. Chestnut-backed Chickadee.

Common about the ranch. Four specimens too worn for satisfactory comparison. They seem, however, to be fairly intermediate in character between *rufescens* and *neglectus*.

*__Chamæa fasciata__ subsp.? Wren Tit.

A few in the brush.

Psaltriparus minimus (Towns.). Bush Tit.

A few in the manzanita. One specimen obtained seems to be true *minimus*.

Regulus satrapa olivaceus Baird. Western Golden-crowned Kinglet.

Some young observed in the firs on Mount Sanhedrin and a speci men secured.

Polioptila cœrulea obscura Ridgw. Western Gnatcatcher.

Not common.

*__Hylocichla ustulata__ (Nutt.). Russet-backed Thrush.

Edge of timber and about the house.

*__Hylocichla guttata nana__ (Aud.). Dwarf Hermit Thrush.

In high timber. Sings all day, but the song is not so beautiful as that of the Sierran bird.

Merula migratoria propinqua Ridgw. Western Robin.

Common, especially on Mount Sanhedrin.

*__Sialia mexicana occidentalis__ (Towns.). Western Bluebird.

Common at a little lower elevation, but rare about the ranch.

*__Sialia arctica__ Sw. Mountain Bluebird.

Only on Mount Sanhedrin. Nests in holes in trees.

NOTES ON A COLLECTION OF CALIFORNIAN MAMMALS.

BY WITMER STONE.

The following list of mammals, obtained by Mr. A. S. Bunnell in the neighborhood of Berkeley and in the Sierras, and now forming part of the collection of the Academy of Natural Sciences of Philadelphia, is published as a contribution toward our knowledge of the distribution of the various species and subspecies. The bats have been studied and identified by Mr. J. A. G. Rehn.

Berkeley Collection.

Citellus grammurus beecheyi (Rich.).

A series from Berkeley.

Neotoma fuscipes Baird.

A number of specimens from Berkeley; two have partly bicolor tails and the color of the adults varies considerably, some being much redder than others. In view of this individual variation it would seem that the *N. fuscipes affinis* of Elliot and probably some of the other races recently proposed will, with *N. monochroura* of Rhoads, be eventually relegated to synonymy.

Peromyscus gambelii (Baird).

A series from Berkeley.

Peromyscus californicus (Gambel).

A number from Berkeley. Through the kindness of Mr. D. G. Elliot I have received from the Field Columbian Museum topotypes of his *P. dyselius* and certain other specimens, including *P. boylii,* for comparison with the above series. The result is that I find in the Berkeley lot typical specimens of both *P. californicus* and *dyselius* and others that appear to be equally referable to either, and my conclusion is that the latter form is based upon younger or smaller examples of *californicus*. Rhoads' *P. major* is likewise a synonym of *californicus,* as shown conclusively by a comparison of the types in the Academy collection. Mr. Bunnell got no specimens of *P. boylii* at Berkeley—that is, none of the form so identified by Mr. Elliot (*Field Col. Mus. Publ., Zool. Ser.,* I, No. 10, p. 206).

Microtus californicus (Peale).

A series from Berkeley.

Lepus bachmani Waterhouse.

A number of specimens from Berkeley and Belmont.

Lepus floridanus audubonii (Baird).

Two specimens. Belmont, November 28, and Berkeley, August 27.

Lepus californicus Gray.

Belmont, November 26.

Dipodomys californicus Merriam.

Belmont, April 2.

Reithrodontomys longicauda (Baird).

Berkeley; a series.

Thomomys bottæ (Eyd. and Gerv.).

A series; Berkeley.

Sorex californicus Merriam.

One specimen. Berkeley, December 19.

Sorex montereyensis Merriam

Several from Berkeley.

Scapanus californicus Ayres.

Several from Berkeley and San Francisco.

Antrozous pallidus pacificus Merriam.

Berkeley, September 17.

Myotis evotis (H. Allen).

Belmont, November 4.

Lasiurus cinereus (Beauv.).

A pair. Berkeley, April 2.

Nyctinomus cynocephalus californicus (H. Allen).

A series. Belmont. These specimens have the forearm considerably longer than in the Eastern *cynocephalus*, and differ appreciably in color, though the latter is rather uncertain as few skins of *cynocephalus* are available for comparison. A skin of *cynocephalus* appears decidedly brownish when compared with *californicus;* the upper parts are mummy brown against seal brown with a grayish suffusion in *californicus*, the under parts are raw umber compared with sepia suffused with ashy gray in *californicus*.

The relationship with *N. mexicanus* (Saussure) it is not possible to ascertain, as too little material is available.

Comparative measurements are as follows:

	Average of nine specimens of *cynocephalus*[1]	Average of five specimens of *californicus*.
Total length,	99.7 mm.	102.8 mm.
Length of forearm,	39.5 "	42.6 "

Canis ochropus Eschz.

Belmont, March 23, 1900.

Lynx fasciatus oculeus Bangs.

Belmont, March 14, 1900.

Sierran Collection.

These specimens were all secured in June and July, 1898 on a trip to Mount Tallac. Some specimens obtained to the east of the mountains as well as a few from western Nevada, are included.

Ammospermophilus leucurus (Merriam).

July 18. Gardnerville, Nevada. Rather pinker than any of our *leucurus* series, but the latter are all winter specimens, which possibly accounts for the difference in tint.

Colobotis beldingi (Merriam).

A series from Mount Tallac.

Citellus grammurus beecheyi (Rich.).

Two females. Mount Tallac, July 4 and 6. A silver suffusion extends across the central dark band on the hind neck and shoulders, nearly obliterating it, thus tending toward *fisheri*.

Callospermophilus chrysodeirus (Merriam).

A series from Mount Tallac shows great variation in the depth of color on the head and shoulders.

Eutamias senex (Allen).

A series from Mount Tallac. Several of the July specimens show rusty spots in the pelage.

Eutamias minimus pictus (Allen).

Gardnerville, Nevada, July 11.

Eutamias amœnus (Allen).

Six specimens. Mount Tallac and Mount Sugar. One taken July 17 is bright rusty red on the sides and more red above, being well advanced in the molt to the post-breeding pelage.

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[1] Bangs, *Proc. Bost. Soc. Nat. Hist.*, XXVIII, p. 218.

Sciurus douglassii albolimbatus Allen.

Two from Pyramid Peak, June 22, and one from Mount Tallac, June 27.

Sciuropterus alpinus lascivus Bangs.

Two topotypes. Mount Tallac, July 6 and 8. While these agree with Bangs' diagnosis, they are certainly very close to *S. a. californicus* Rhoads, of which I have the type before me.

Arctomys flaviventer Aud. and Bach.

Two from Mount Tallac, June 13 and July 4.

Neotoma desertorum Merriam.

Gardnerville, Nevada. Eight specimens.

Neotoma cinerea (Ord.).

A series from Mount Tallac.

Peromyscus texanus deserticola (Mearns).

A large series from Mount Sugar and Gardnerville, Nevada, seem referable to this race.

Peromyscus texanus artemisiæ (Rhoads).

A number of specimens from Slippery Ford, El Dorado county, agree well with Rhoads' type series.

Zapus trinotatus alleni Elliot.

A series from Mount Tallac and Slippery Ford.

Microtus mordax (Merriam).

One from Mount Sugar, Nevada, kindly identified by Mr. Vernon Bailey.

Thomomys monticola Allen.

Three specimens from Slippery Ford, El Dorado county, one of which is changing from the purplish-brown pelage to a bright yellow-brown.

Thomomys aureus perpes Merriam.

Four specimens from Mount Sugar, Nevada.

Lepus arizonæ (Allen).

Gardnerville, Nevada, One specimen, July 12.

Lepus californicus Gray.

Valley Springs, June 2.

Ochotona schisticeps (Merriam).

Three from Mount Tallac, June 12, June 26 and July 8.

Sorex obscurus (Merriam).

One specimen. Slippery Ford, June 8.

Myotis yumanensis (H. Allen).

One specimen, Mount Tallac. July 6.

Eptesicus fuscus melanopterus Rehn n. subsp.

Type.—Mount Tallac, California. ♂. July 10, 1898. No. 11,685, Coll. Acad. Nat. Sci. Phila. Collected by A. S. Bunnell.

General Characters.—Similar to *E. fuscus osceola* Rhoads in size and cranial characters, but differing in the darker upper surface, the grayer under parts and the blacker membranes. From *fuscus* it may immediately be differentiated by the more reddish-brown upper surface and less silvery under parts.

Distribution.—Specimens from the type locality only have been examined.

Size.—In general proportions *fuscus*, *f. osceola* and *f. melanopterus* seem almost identical. The average of five specimens of each shows that *f. melanopterus* has the forearm averaging almost three millimeters longer than in *fuscus*, while *osceola* is considerably smaller than the former, and very slightly less than the latter.

Color.—Above rather dark cinnamon, lightest on the top of the head and at the shoulders. Under surface reddish wood brown. Membranes and face deep blackish. In true *fuscus* the upper surface is drab, below pale isabella color. In *fuscus osceola* the upper parts are much the same tint as in *melanopterus*, but not as rich in tone, while the under parts are more of a yellowish-brown, and not as ashy in tint. The membranes of *fuscus osceola* are much paler in coloration than in *melanopterus*.

Skull.—Identical with the typical form.

Teeth.—The last upper molar in *melanopterus* appears to be broader than in *fuscus* or *f. osceola*. Otherwise the dental series seem to be identical.

Remarks.—The form from Mount Tallac is no doubt closest related to *f. osceola* than any of the form of *fuscus*. The original series of the former has been examined in this connection, and the differential characters were drawn from it. The relationship with true *fuscus* is not so close as an examination of a series of thirty specimens from, or within a radius of, twenty miles of the type locality shows. No close relationship exists with *E. f. bernardinus* Rhoads, which is a very pale type quite different from any of the forms here considered. From *f. osceola* the new form may be easily distinguished by the richer color of the upper parts and the more smoky under surface, as well as the more blackish membranes.

Measurements.—Type: Total length 104 mm., length of tail vertebræ

40 mm., length of ear 12 mm., length of tibia 17 mm., extent 314 mm.

Specimens Examined.—Type and four paratypes (skins).

Comparative Measurements.

	Average of five topotypes of *fuscus*.	Average of five topotypes of *f. osceola*.	Average of five specimens of *f. melanopterus*.
Total length,	114.6 mm.	113.6 mm.	112.6 mm.
Length of forearm,	44.2 "	43.2 "	47 "
Length of tibia,	17 "	17.8 "	18 "
Length of tail vertebræ,	42.2 "	45.4 "	43.8 "

Lasiurus borealis teliotus (H. Allen).

Linden, San Joaquin county, California. ♀. June 2, 1898.

On comparison with Eastern specimens of *borealis*, this specimen has the under surface much paler and more of a pale buff tint. This does not seem to have been noticed by Miller (*North Amer. Fauna*, No. 13, pp. 110–111) in summarizing the differential characters of the race.

ON CERTAIN RHACHIGLOSSATE GASTROPODA ELIMINATED FROM THE AQUILLIDÆ.

BY H. A. PILSBRY AND E. G. VANATTA.

Among the smaller species described by the older authors as "Tritons," and referred by Tryon and others to the subgenus *Epidromus*, there exists some diversity in shell characters, and a much greater difference in the soft anatomy. Mörch many years ago eliminated his Muricid genus *Aspella* from this assemblage, and Kesteven, in an able and interesting paper, has recently shown an Australian species, *Triton speciosus* Angas, to belong to *Trophon*, figuring its operculum and teeth.[1]

Another Muricid genus is represented by *Triton bracteatus* Hinds, and its allies, characteristic and widespread littoral Polynesian species. This group may be called

MACULOTRITON Dall.[2]

The shell is acuminate-oblong, longitudinally plicate and spirally tuberculate-lirate, with a smooth trochoidal nucleus of about 3½ whorls. Aperture ovate, the outer lip thick, dentate within, and strengthened by a rounded varix outside, another varix often developed opposite it on the last whorl. Anterior canal open, very short. A small posterior sinus is defined by a low callous on the parietal wall. Operculum with basal nucleus.

[1] *Proc. Linn. Soc. N. S. Wales* for 1902, p. 479, fig. 3.

[2] In a paper issued last February, one of the present authors suggested that *Colubraria* Schum., which had always been associated with the Tænioglossate *Triton*, might prove to be Rhachiglossate, and remarked that "a series of Antillean and Pacific species referred to this division by Tryon and others, of which *decapitatus* Reeve and *bracteatus* Hinds are typical, belongs to the Rhachiglossa, as Mr. Vanatta and the writer will elsewhere show." In a paper on the Tritons and Frog-shells just issued, Prof. W. H. Dall adopts but does not define a family *Colubrariidæ* to include *Colubraria*, the groups we had indicated as Rhachiglossate, and one or two others. He anticipates the appearance of the data promised by us, by giving names to the groups we had indicated as Rhachiglossate. It remains, therefore, for us to substitute in our proof-sheets the names given by Dall for those we had written, and to expose the true characters and family relationships of the gastropods in question.

As to the "Family *Colubrariidæ*," the typical genus *Colubraria* is as yet known by the shell alone. The other groups referred to it by Dall, of which the dentition is known, belong without any doubt to the *Muricidæ* and *Buccinidæ*. Is science advanced by the formation of family groups upon such grounds?

The radula is Muricoid, the rhachidian tooth very wide, straight, with a long curved central cusp inserted far forward, and on each side there are two adjacent side cusps, the outer ones larger. Lateral teeth with a single slender cusp.

Type, *M. bracteatus* (Hinds).

The shell in this genus has much the appearance of the Buccinoid *Tritonidea.*

Maculotriton differs from *Ocenebra* (type *erinacea* L.) in the form of the central teeth of the radula, which in *Ocenebra* have a very characteristic structure. The dentition in our new genus agrees with that of *Trophon clathratus* as figured by Troschel;[3] but the conchological characters of these Indo-Pacific snails bar their entrance into *Trophon* or *Boreotrophon.*

Fig. 1.—Apex of *Maculotriton digitalis* (Rve.), Viti Is.

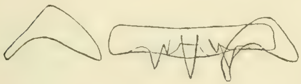

Fig. 2.—*Maculotriton digitalis* (Rve.), Hahajima, Ogasawara (87,491, A. N. S. P.).

Fig. 3.—*Maculotriton bracteatus* (Hds.) var., Hilo, Hawaii (85,843, A. N. S. P.).

The following species belong to *Maculotriton:*

Maculotriton digitalis (Rve.). *Triton digitalis* Reeve, *Conch. Icon.*, II, Pl. 19, fig. 86.

Maculotriton bracteatus (Hinds). *Triton bracteatus* Hinds, *Zool. "Sulphur,"* Moll., p. 11, Pl. 4, figs. 5, 6.

Maculotriton bracteatus lativaricosus (Rve.). *Triton lativaricosus* Reeve, *Conch. Icon.*, II, Pl. 19, fig. 90.

Maculotriton bracteatus longus Pils. See below.

Some other species will doubtless be added to the group. *Cantharus puncticulatus* Dkr. as figured by Sturany[4] has much the appearance of our group, but its dentition is unknown. *Cantharus waterhousiæ* Braz.,[5] recently figured by Hedley,[6] may also belong here.

[3] *Das Gebiss der Schnecken*, Pl. 11, fig. 17.

[4] Gastropoden des Rothen Meeres, in *Denkschr. der math.-naturwiss. Cl. der K. Akad. der Wissenschaften*, LXXIV, p. 242 (34), Pl. 7, fig. 4. Tryon has suggested that *Buccinum seriale* Desh. is identical with *puncticulatus*.

[5] *Proc. Linn. Soc. N. S. Wales* XXI, 1896, pp. 345, 818.

[6] *Proc. Linn. Soc. N. S. Wales*, 1899, p. 434, fig. 7.

BUCCINIDÆ.

Another series of species, formerly placed in *Triton*, proves to belong to the *Pisania-Tritonidea* group of *Buccinidæ;* and for them a new subgenus of *Tritonidea* may be erected.

CADUCIFER Dall.

The shell in this group resembles that of *Tritonidea* in sculpture and characters of the aperture, but it is more slender than in that genus. The teeth resemble those of *Euthria lineata* as figured by Troschel. The teeth of the central row have a group of three cusps springing from a short, arcuate basal-plate. The laterals have large curved cusps at the outer and inner margins, with a smaller intermediate cusp near the inner one.

Type *T. truncata* (Hinds).

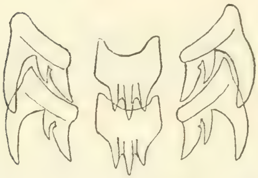

Fig. 4.—*T. decapitata* (Rve.), Mauritius (58,058, A. N. S. P.).

Fig. 5.—*T. parva* C. B. Ad., Port Antonio, Jamaica (62,041, A. N. S. P.).

This group comprises the following species:

**Tritonidea* (*Caducifer*) *decapitata* (Rve.). *Triton decapitatus* Rve., *Conch. Icon.*, II, *Triton*, Pl. 18, fig. 85.

Tritonidea (*Caducifer*) *cylindrica* (Pse.). *Triton c.*, Pease, *Amer. Jour. Conch.*, IV, p. 94, Pl. 11, fig. 9.

**Tritonidea* (*Caducifer*) *truncata* (Hinds). *Triton truncatum* Hinds, *Zool. "Sulphur,"* p. 11, Pl. 4, figs. 9, 10.

Tritonidea (*Caducifer*) *eximia* (Rve.). *Triton eximius* Rve., *Conch. Icon.*, II, Pl. 18, fig. 77.

**Tritonidea* (*Caducifer*) *parva* (C. B. Ad.). *Triton parvus* C. B. Adams, *Contrib. to Conch.*, No. 4, p. 59.

Tritonidea (*Caducifer*) *parva intricata* (Dall). *Phos parvus* var. *intricatus* Dall, *Trans. Wagner Inst.*, III, p. 131.

The dentition has been examined in the three species marked with an asterisk, the third species being the type. The other forms mentioned have been added from their close conchologic resemblance to those known to belong together. Probably some other species will be found to belong here. Some of the species lose their early whorls in the adult stage, and are abruptly truncate, an unusual condition in the *Buccinidæ*. The group is not closely related to *Phos* (type *P. senticosus*) or to *Nassaria*.

Triton decollatus Sowb., *Conch. Icon.*, *Triton*, Pl. 18, fig. 82, left in *Epidromus* by Tryon, is identical with *Pisania strigata* Pease, *Amer. Jour. of Conch.*, IV, Pl. 11, fig. 6, which Tryon correctly includes in the genus *Pisania*. [Dall has erected a section *Tæniola* for it in his heterogeneous genus *Colubraria;* but it clearly belongs to *Pisania.*]

Maculotriton bracteatus longus n. subsp.

The shell is much more slender than *M. bracteatus*,[7] gray-white with a band of black-brown spots at the periphery on the tubercles of every rib, another on the base extending into the concavity, and an irregular series of more widely spaced spots below the suture. The single varix strengthens the lip. Sculpture as in *M. bracteatus*, the ribs coarser than in *M. digitalis*.

Length 11.5, diam. 4.7 mm.

Tanabe, Kii. Types No. 86,288, A. N. S. P., from No. 1,400 of Mr. Hirase's collection. Also Hachijo-jima, Izu, Hirase, No. 1,393.

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[7] *Triton bracteatus* Hinds, *Zool. "Sulphur,"* p. 11, Pl. 4, figs. 5, 6. Type locality Marquesas Islands. A series of several hundred specimens collected there by C. D. Voy agrees closely with the type figures in size and coloration. East Indian and some Polynesian specimens are often larger.

VARIABILITY AND AUTOTOMY OF PHATARIA.

BY SARAH P. MONKS.

Phataria (*Linckia*) *unifascialis* Gray, var. *bifascialis* is a starfish that is remarkable for the variability in the size and number of its rays. Regularity is the exception. In over 400 specimens examined not more than four were symmetrical and no two were alike. Fig. 13, Pl. XLII, is a nearly symmetrical six-rayed star, but one of its rays has been broken off and renewed.

The plate shows the great variability in size of stars, number of rays and different breaking places.

The animals vary in size from four to seventeen centimeters. This difference may in some measure be due to age, but there is evidently also considerable difference in size in adult specimens.

The normal number of rays is five, but some specimens have only one, while others have four, six, seven, or even nine; four, five or six being most common numbers. Of 248 specimens examined 29 had one ray, 34 four rays, 135 five rays, 44 six rays, 5 seven rays and 1 nine rays.

There is a marked irregularity in the size of the rays, for the breaking and renewing occur at all ages, or, at least, at all sizes. Single living rays without any external sign of disk are not uncommon. Twenty-two in a lot of 240 were single. In animals measured the rays varied in length from 22–75 mm., and were in all conditions, from specimens which showed by the raw surface that the breakage was recent, through all grades of healing surfaces to stars where new rays appeared as mere buds, to the comet series and to the various rays of adult Phatariæ.

Comets are frequently found; there were forty-one of them in 240 specimens. These are stars with one long ray and a number of small rays extending from a minute disk. They are rays that have made a new body. In Pl. XLII, 3–11 are comets. The long ray is from 2–7 cent. in length. On account of their small size the single rays and comets are more easily overlooked by collectors.

This species of *Phataria* is mottled reddish-brown and ash color, with the tips of the rays and the small new rays, or new portion of the ray, a brighter and uniform red. It is easy to distinguish new parts by this growth "color," even when the line of breakage is obliterated.

From the great discrepancy in the size of the rays it follows that one or two rays may be sexually mature, while others are small or even buds. In two individuals sexually mature August 4, 1901, the measurements of rays show: ♂, 77.70.58.20 mm.; ♀, 70.65.52.13 mm.

This species generally has two or more madreporites and two or more ani.

There is a great difference in the size of the madreporic body and frequently, but not always, it is larger in large specimens. In 174 specimens 6 had one, 154 had two, 11 had three, 2 had four and 1 had five madreporites.

The ani are only visible in live animals. In 68 specimens 15 had one, 48 had two, 3 had three, 1 had four ani.

There may be some connection, as has been suggested, between madreporites and breaking plane, but I have failed to find anything satisfactory on the subject. Sometimes the largest ray, or a large ray, is between two madreporic bodies. In 132 specimens 87 long arms and 45 short arms were between the madreporites.

There is a further irregularity in this species in the place from which the reproductive material finds exit. Usually in asteroids it comes from the angle between rays, but in *Phataria* the sperm and ova may come from any part of the inner two-thirds of a ray.

I have also found this year (August, 1904) that a *Phataria* may have two mouths. In fig. 22 there is a mouth at each meeting point (*A* and *B*) of the ambulacral furrows. In No. 11 there are also indications of two mouths, and in another specimen I have, but owing to the rareness of the peculiarity I have not wished as yet to destroy these two specimens in order to prove the surmise.

The want of symmetry in this *Phataria* suggests the belief that the ability to break and regenerate is greater in this species than in ordinary Asteroidea, and that it is a common factor in the life of the species. Most starfish can lose their rays and make new ones, but it is a generally accepted opinion among zoologists that a ray cannot make a new body unless some portion of the disk is present. In *P. bifascialis* Gr. there is a suggestion that a ray can regenerate a body, although the evidence is inconclusive. The suggestion is seen in the series of figs. 1–11 in the plate.[1]

[1] Since writing the above in 1901 I have been fortunate in a series of experiments extending to the present time, August, 1904, in having a number of single rays, cut at various places, regenerate the disk and other rays. I cut off rays, and in that way the stretching of the pyloric cæca and the consequent loss of

This suggestion springs from various facts: The extent of the "growth color" in comets, the apparent absence of disk in single rays, and the constant place of breaking in the pyloric cæca.

The breaking place in the skeleton may occur near the disk, from 6–12 mm. from the angle of the ray, or at almost any point on the ray. I have never seen a break that was decidedly inside the disk.

In 18 specimens with 26 regenerating rays, 4 were less than 3 mm., 20 were from 3–6 mm., and 2 were 35 and 45 mm. from angle.

The cause of breaking is obscure. Unlike Ophiurians they are exceedingly tough. At touch *Phataria* becomes hard, tough and rigid, and when it is thus contracted it requires considerable strength to pull it asunder, and it is a difficult matter even to cut among the ossicles.

If any external force bears a part in breaking the animal it is probable that the creature is surprised when limp and relaxed, but I am inclined to think that *Phataria* always breaks itself, no matter what may be the impulse. They may break when conditions are changed, sometimes within a few hours after being placed in jars, or a few days, or even not for months. Some never break, but stand all kinds of inconvenience of heat and cold and stagnant water.

There is no season for the breaking, for they are found newly broken in the sea in all seasons of the year. The sensitiveness of this species to our cold spells in winter and hot spells in summer has put an end to many promising experiments. Whatever may be the stimulus the animal can and does break of itself.

During the years 1901–04 I have watched more than fifty starfish disunite. There is a regularity about the matter that indicates that the breaking is not an accident, or the fancy of a day, but a habit of the species. The breaking is automatic. Experiment confirms the inference that naturally arises on seeing a large number of specimens together that the irregularity is due to an inherent character of this species of *Phataria*. The process is deliberate. It is not a breaking in the proper sense of the word, but a drawing or pulling asunder. It requires from half an hour to three or four hours, with resting spells, and the motions are perceptible.

The ordinary method is for the main portion of the starfish to remain fixed and passive with the tube feet set on the side opposite the departing ray, and for this ray to walk slowly away at right angles to

time for its withdrawal were avoided and after a number of months the ray had reached the comet stage. In one case two arms started to grow from the place from which one had been cut. The photograph and statement of facts appeared in *Proc. Acad. Nat. Sci. Phila.*, May, 1904.

the body, to change position, twist, and do all the active labor necessary to the breakage. If there are more rays than are needed to resist the pulling arm they take a negative part and position. Frequently they hang limp with their ambulacræ withdrawn.

There seems to be the same coördination in this work as in the walking of Asteroidea, for in the six or eight positions taken during the severing of a ray the larger portion of the star always keeps pulling in a direction opposite that of the parting ray, and not in any, or all, of the four, five or six directions of radiation.

The skeleton breaks in one of two ways. In one way the ray swells about its midpoint and grows smaller at its proximal portion as it pulls away from the body. In the region of strain the ossicles become separated for a space of about 25 mm., so that the white connective and muscular tissues shine between them till finally, just before parting, they stand out like beads on a network of shiny white floss. There is much more elasticity in the animal at this time than would seem possible in a starfish.

Immediately after the break the ossicles recover their compact position and the two parted edges show a more or less jagged surface. This way is rapid, the body wall being pulled apart in from three to thirty minutes after the arm becomes narrowed.

In the other way of breaking only a small area is affected by the strain, and the breaking place shows from the first as a fracture. There is no narrowing of the ray, no strained surface and no gradual separation of ossicles. A small opening, something like a crack, appears on the dorsal side of the ray, and this increases with an uneven edge till the body wall is parted around the entire ray. The first visible evidence of this kind of division is, either the ray is in a strained position opposite the body or it lops over and hangs limp, letting its weight act as the pulling power. The invariable method in *Phataria* I have watched, after the body wall breaks, is: The arm walks away; the pyloric cæca are pulled out of the arm, sometimes for 83 mm., and kept very tense; then a break occurs in the tube connecting the pyloric cæca with the stomach; the pyloric cæca are withdrawn into the arm and the small portion of the tube into the body and the arm is free. The parting of the soft tissues is not abrupt, is accomplished by sundering strands thread by thread. The pyloric cæca and tube are wonderfully elastic. Sometimes the tube is stretched till it appears as the finest thread.

After breaking the pyloric cæca coil up, and as they are retracted to their ordinary position an occasional spasmodic jerk is seen in them.

Sometimes they are withdrawn immediately, but frequently an arm crawls around for hours, or days, trailing the cæcum till it is withdrawn or falls away.

Probably if the cæca are not taken in within a few hours the muscles ose their elasticity and the cæca decay and drop off. Occasionally these organs are left on the disk and sometimes the tube is broken in such a manner as to leave them hanging like two coiled trails. After freeing itself the ray crawls up the glass and stations itself with the broken part downward and remains so for a long time. This is the attitude of a single ray till all, or nearly all, the pyloric cæcum assumes its normal position.

After one arm is separated, or even when it is going, another may break away. I saw one animal try to break the disk apart after having lost two rays. It took many positions, strained the tissues and worked for hours, but died before the disk was broken.

The results of my observations are: The breaking is automatic and is effected by pulling apart or fracture without strain; there is coördination of parts in producing the separation; the tissues relax at the plane of rupture; this plane may be near the disk or a variable distance from it on the ray; the pyloric cæca are always pulled out and much stretched; the break of the cæcum occurs at the tube connecting the stomach and glandular portion; the pyloric cæcum is generally taken back into the arm; the severed ray may live more than a week, even under adverse circumstances, without signs of regeneration; and, from my experiments extending over a period of three years, I have found that rays cut various distances from the disk make disks, mouths and new rays in about six months.

Explanation of Plate XLII.

The plate shows growth-series and comets; variability in number and size of rays, in size of animal and in breaking places; color distribution and general characteristics of species; and all except figs. 17 and 18 are as they were found.

Fig. 1.—Side view, recently healed.

Fig. 2.—Oral view, showing growing down of aboral surface. This also shows in fig. 7.

Fig. 3.—Oral view, new rays and mouths.

Figs. 3–10.—Comets.

Fig. 11.—Eight new rays, probably two mouths.

Figs. 12 and 15.—Five-rayed, showing new arms as "buds."

Figs. 14 and 16.—Four-rayed; fig. 16 shows color arrangement.

Figs. 17 and 18.—Cut '03 and died '04, a new ray on fig. 17 and a new body on fig. 18.

Fig. 19.—A large *Phataria* with 2 madreporites, *A* and *B*.

Figs. 13 and 20.—Twenty-three six-rayed.

Fig. 21.—Shows four distinct break planes and has only one good ray. This is a type of the thick specimens.

Fig. 23.—Is a type of the thin species.

Fig. 22.—Shows two mouth places, *A* and *B*.

THE COMPARATIVE AGE OF THE DIFFERENT FLORISTIC ELEMENTS OF EASTERN NORTH AMERICA.

BY JOHN W. HARSHBERGER, PH.D.

The historic element must be considered in a phytogeographic study of any country. Many questions concerning the present distribution of plants depend upon the character and extent of the past distribution of the species of any region or formation. The degree of invasion of new species into a region is determined by the presence or absence of vegetation. If vegetation is present, then the botanist is compelled to account for its presence by a consideration of the physiographic history of that part of the earth's surface, the association of species and the probable origin of these species, whether indigenous or derived. The determination of the indigenous and derived species of a formation or larger division is of the utmost importance, as it enables us to retrace the steps by which the formation has reached its present condition and association of species, and to reconstruct formations that have long since disappeared.

The methods which must be adopted in scrutinizing the flora of a country are several:

1. The botanist must determine the past and present physiography of the region concerned.

2. He must determine, if possible, the geologic time at which the recorded physiographic changes took place.

3. He must recognize the indigenous species by eliminating the derived.

4. A study of the distribution of species will enable him to determine to some extent the age of the different floristic elements, and the application of the following criteria will also aid him in the solution of questions such as are considered here.

a. Location of greatest differentiation of type.

b. Location of dominance or great abundance of individuals.

c. Location of synthetic and closely related forms.

d. Location of maximum size of individuals.

e. Location of greatest productiveness and its relative stability.

f. Continuity and convergence of lines of dispersal.

g. Location of least dependence upon a restricted habitat.

h. Continuity and directness of individual variations, or modifications radiating from the centre of origin along the highways of dispersal.

i. Direction indicated by biogeographic affinities.[1]

5. Old regions, botanically speaking, may be determined where the number of specific forms of single genera is small, and new regions may be determined where the number of species of single genera is ordinarily very large.

6. Drude's classification of endemic plants, as corresponding and as relict, is of great assistance to the botanist in determining the age of floristic elements. Plants are corresponding when the original continuous area of a variable species has been interrupted in such a way as to form several smaller areas occupied by subspecies or new species, while relicts are those species originally of extensive distribution able to maintain themselves in a limited area only on account of changed conditions of life. Having enunciated these general principles, I will endeavor to apply them in the determination of the age of the different floristic elements of eastern North America.

All of eastern America north of the great terminal moraine which marks the southern boundary of the great ice sheet, with the exception of the nunataks, has been tenanted by plants which have migrated into the territory abandoned by the great continental glacier. Geologists believe, from evidence afforded by the time that it has taken for the river to cut the gorge at Niagara, that 10,000 or 15,000 years have elapsed since the close of the glacial period. If their deductions are sound, then the flora of the northern part of eastern America cannot be older than 15,000 years at the outside. Some of its elements may be much older, and we have reason to believe that many boreal plants existed as such on the nunataks, which were unglaciated areas above the great ice sheet. The first wave consisted of the distinctly glacial flora, which skirted the border of the ice sheet. The second wave, younger as a floristic element of the North, consisted of boreal plants, many of which, as bog plants, tenanted the bogs and margins of the glacial lakes that were formerly much more abundant in the North than at present. These bog and tundra types pushed early into the barren ground left by the retreating ice. The tundra was closely followed by the coniferous forests on the western and eastern sides of the glaciated areas and these trees constitute a third floristic element, much younger in point of the time in which they have occupied the North. These trees, and those forming a still younger element, surrounded the bog plant societies which were trapped by the surround-

[1] Adams, Chas. C., *Biological Bulletin,* III : 122.

ing tree vegetation, and as the bog was gradually transformed by biologic influences into firmer ground gradually encroached on the bog plant associations. Present bog habitats are continuations of similar habitats which existed in early postglacial times, when tundra conditions and tundra vegetation were dominant.[2] The fourth element just mentioned consisted of deciduous shrubs and trees, oaks, hickories and the like, which at present are south of the great coniferous belt of forest. In the East, among the highlands, exceptional circumstances were afforded for the preservation of the northern forms.

The flora of Mount Washington is perhaps an exception to this. During the glacial period it was a nunatak, and during this time it was tenanted by such plants as *Silene acaulis* L., *Arenaria grœnlandica* Spreng., *Geum radiatum* Michx., *Solidago virga-aurea* L. var. *alpina* Bigel., *Prenanthes bootii* Gray, *Cassiope hypnoides* Don, *Bryanthus taxifolius* Gray, *Diapensia lapponica* L., *Oxyria digyna* Hill, *Salix phylicifolia* L., *Salix uva-ursi* Pursh, *Salix herbacea* L., *Phleum alpinum* L., *Lycopodium selago* L., etc., which have remained as permanent tenants of this mountain. If we take Mount Washington as a mountain, the summit flora is older than that of the lower alpine slopes of the mountain above timber-line, and the flora, therefore, of these slopes is in turn older than that of such gorges as Tuckerman's Ravine, Huntingdon Ravine and Great Gulf, which probably supported local glaciers for many centuries after the great ice sheet had retreated from the Presidential Range.

Mount Katahdin, 161 miles northeast of Mount Washington, has a less number of alpine plants than that mountain, and most geologists believe it to have been buried entirely beneath the glacial ice sheet. If that is so, then the alpine flora of Mount Katahdin is, as a floristic element, much younger in point of time than that of Mount Washington. The same differential arrangement of the plants on Mount Katahdin is found as on Mount Washington. The place where the boreal flora, upon the retreat of the continental ice sheet, encroached upon Mount Katahdin is determined largely by the physiography of the mountain. The glaciers occupying the various basins of the mountain retarded the revegetation of the mountain, but with a favorable opportunity the encroachment perhaps began from the southwest and west. This idea seems to be confirmed by the present distribution of the spruce and fir which ascend higher on this side and their apparently greater age. As to the east side of the mountain,

[2] TRANSEAU, E. N., *Botanical Gazette*, XXXVI: 401.

and in particular the basins, it seems probable that the great basin[3] was first tenanted by plants, and that the North Basin opposed this migration a much larger time for the reason that this basin, which presents a scene of desolation, was the seat of a local valley glacier which was, perhaps, the last to disappear. As a consequence, the basin presents an appearance even more xerophytic and alpine than some of the upper parts of the mountain itself. The pucker bush (Krummholz) reaches here an unusual development, with the trees lying in most places prostrate and gnarled and twisted to a high degree.

The swamp societies of the northern America stand in contrast to the bog societies made up of more southerly forms, and must be considered to be the normal hydrophytic vegetation of present climatic conditions. The swamps of the North have had a much later origin than the bogs, for we find that if the depressions provided with water have existed since the days of the tundra they may show a bog flora to-day; if they are of recent origin the plants will correspond to the normal swamp plants of the present climatic conditions.

Another interesting problem which presents itself is that of the presence of typical seashore plants on the coasts of the Great Lakes. Such plants as *Ammophila arundinacea* Hast., *Sabbatia angularis* Pursh, *Lathyrus maritimus* Bigel., *Hudsonia tomentosa* Nutt., *Cakile americana* Nutt., *Hibiscus moscheutos* L., *Gerardia purpurea* L., *Euphorbia polygonifolia* L., *Myrica cerifera* L., *Strophostyles peduncularis* Ell. are found not only on the shores of the Great Lakes, but some of them near the Lake of the Woods. The most satisfactory explanation seems to be that in post-glacial times the valleys of the St. Lawrence, Hudson, Lake Champlain, and probably also Lakes Ontario and Superior, were then occupied by the sea, because of the northeasterly depression of the land. During this period of submergence the typical seashore plants gained access to the interior of the continent.

The country south of the great ice sheet shows some interesting problems of geographic distribution in line with the subject of this paper. The northward extension of the pine barren flora on Long Island and Staten Island is a case in point.[4]

The soil of the region is generally sandy, but is occasionally more firm where strata of clay approach and form the surface. The geological formations to the south and southeast of a line drawn from a point below Long Branch to another near the head of Delaware Bay

[3] Harvey, L. H., "A Study of the Physiographic Ecology of Mount Katahdin, Maine," *University of Maine Studies*, No. 5, December, 1903.

[4] Cf. N. L. Britton, on the "Northward Extension of the N. J. Pine Barren on Long and Staten Islands," *Bulletin Torrey Botanical Club*, VII, 81, July, 1880.

are Tertiary, while those to the north of it are Cretaceous. The Tertiary soils extend southward along the Atlantic to Florida. As the soil over both the Cretaceous and Tertiary is composed of similar materials, it is impossible to say, from surface indications, where one ends and the other begins. We will deal with the flora of the northern extension of these sandy stretches of Cretaceous age. On Staten Island these strata are exposed in its extreme southern portion. They doubtless extend over the entire southern and eastern sections, but are mostly covered by a layer of material of variable thickness derived from the glacial drift. On Long Island, the great terminal moraine occupied a position marked by a range of hills extending throughout its whole length at an average distance of ten miles from the Atlantic. South of these hills sandy plains prevail, the material composing them having been formed partly from the modified drift of the hills, partly from the underlying Cretaceous strata. Those species detected on the Cretaceous soils of Staten Island, and not on the drift, are thirty-four in number: *Magnolia glauca* L., *Hudsonia ericoides* L., *Ascyrum crux-andreæ* L., *Arenaria squarrosa* Mich., *Polygala lutea* L., *Tephrosia virginiana* Pers., *Desmodium lævigatum* D. C., *Desmodium viridiflorum* Beck, *Rubus cuneifolius* Pursh, *Cratægus parvifolia* Ait., *Eupatorium rotundifolium* L., *Aster nemoralis* Ait., *Aster concolor* L., *Chrysopsis mariana* Nutt., *Gnaphalium purpureum* L., *Gaylussacia dumosa* J. and G., *Andromeda mariana* L., *Kalmia angustifolia* L., *Ipomœa pandurata* Meyer, *Phlox subulata* L., *Asclepias obtusifolia* Michx., *Euphorbia ipecacuanhæ* L., *Quercus nigra* L., *Quercus prinoides* Will., *Quercus phellos* L., *Spiranthes simplex* Gray, *Juncus scirpoides* Lam. var. *macrostemon*, *Xyris flexuosa* Muhl., *Cyperus cylindricus* N. L. B., *Stipa avenacea* L., *Glyceria obtusa* Tin., *Panicum verrucosum* Muhl., *Andropogon macrourus* Michx., *Lycopodium inundatum* L. var. *bigelovii* Tuck. Of these the following four have been detected in Suffolk County, Long Island: *Desmodium viridiflorum* Beck, *Rubus cuneifolius* Pursh, *Ipomœa pandurata* Meyer, *Phlox subulata* L. In addition to the above list, however, the following sixteen additional species have been detected in Suffolk county, Long Island: *Drosera filiformis* Raf., *Ascyrum stans* Michx.. *Eupatorium hyssopifolium* L., *Eupatorium leucolepis* T. and G., *Eupatorium album* L., *Aster spectabilis* Ait., *Solidago puberula* Nutt., *Chrysopsis falcata* Ell., *Helianthus angustifolia* L., *Coreopsis rosea* Nutt., *Utricularia subulata* Le Conte, *Cupressus thyoides* L., *Juncus pelocarpus* E. Meyer, *Xyris caroliniana* Walt., *Eleocharis melanocarpa* Torr., *Sporobolus serotinus* Gray. Thus it appears that thirty-four of these characteristic pine barren plants grow in the southern part of Staten Island, and that forty-six of them have been detected in Suffolk county, Long Island.

It would seem that these species have a tendency to follow the course of the two more recent geologic formations throughout their whole extent along the Atlantic coast. Another fact which stands out prominently in this connection is that not a single one of the above-mentioned plants, growing, as we have seen, along the edge of the glacial drift, is native of Europe, but belong to a true American flora, which had its origin in the southern part of the continent and migrated northward into Staten Island and Long Island at the close of the great ice age. In contrast to this fact we have another one, equally prominent, and that is, that of the species of plants growing on the morainic material about one-third are common to northern Europe and America, thus pointing to a common origin of each in the territory now occupied by the ice and snow of the Arctic regions. The flora north of the morainic line in Staten Island and Long Island clearly antedates in point of occupancy of the country the more southern and American pine barren flora, which migrated northward at a date subsequent to the migration of the flora with strong European affinity.

Another interesting illustration of the historic factors instrumental in plant distribution is afforded by the peculiar flora of the Kittatinny or Shawangunk mountains of northwestern New Jersey. This mountain chain forms a wall of almost constant altitude, averaging over 1,200 feet in height, along the eastern side of the Delaware river from Port Jervis to the Delaware Water Gap. Its summits and western slopes are composed of a coarse or fine, very hard silicious conglomerate or sandstone, with little soil but that derived from the limited disintegration of these rocks, and it is therefore highly silicious. While the mountain sides are extensively glaciated there is very little glacial drift on the ridge.

On these mountains exist a number of plants which are also found in great numbers in sandy soil along the Atlantic coast. Among the species which are thus noteworthy, as discovered by N. L. Britton, are: *Juncus greenii* Oakes and Tuckerm., *Solidago puberula* Nutt., *Orontium aquaticum* L., *Tephrosia virginiana* Pers., *Lespedeza hirta* Ell., *Lupinus perennis* L., *Quercus ilicifolia* Wang., *Corema conradii* Torrey. At Culver's Gap were found by Britton: *Polygala polygama* Walt., *Gerardia pedicularia* L., *Lechea racemulosa* Michx., all abundant in sandy soil along the coast, and *Prunus pumila* L. At Sunfish Pond, northwest of the Water Gap, occur *Juncus militaris* Bigel., *Lycopodium inundatum* L., *Viburnum nudum* L. While all along the mountains grow

Aster linariifolius L., *Quercus ilicifolia*, *Gaylussacia resinosa* Tott and Gray, *G. frondosa* Torrey and Gray, *Vaccinium vacillans* Sol., *Epigæa repens* L., *Gaultheria procumbens* L., *Cassandra calyculata* Don and *Rhododendron viscosum* Torrey. Another peculiarity is the substitution of *Pinus rigida* Mill on the mountains for the *Pinus strobus* L. of the surrounding country.

The ridges of the Green Pond system, known at Greenwood Lake as Bearfort and Bellvale mountains, and in New York as the Skunnemunk, have a somewhat similar summit flora, consisting of *Quercus ilicifolia* Wang., *Solidago puberula* Nutt., *Tephrosia virginiana* Pers., *Lespedeza hirta* Ell., *Arctostaphylos uva-ursi* Spreng, *Aster linariifolius* L., various huckleberries, blueberries and other sand plants.

The reason for the somewhat remarkable similarity of the pine barren and summit mountain floras is usually attributed to the similarity of the soil on the mountains to that of the plains bordering the coast. It is probably true that the plants occupy these areas because they have adapted themselves to growing in soils of silicious sands, but to say that the soil is the prime factor in their distribution is putting the case too strongly. The writer believes, from an investigation that he has made of the problems involved, that the flora of the mountains is peculiarly an endemic one, showing relict endemism, and that the flora of the pine barren is a derived one, and is an illustration of Drude's principle enunciated above. The crest of the Kittatinny Mountains represents the level of a plain that existed prior to the great period of erosion which carved out the mountain ranges and has been several times elevated and depressed. During the period of its more extensive plain character, the plants above mentioned were distributed over the area now represented by the crests of the Shawangunk Mountains in New Jersey and the Skunnemunk Mountains in New York. With the wearing away of the plain this more ancient flora remained in a relict form on the summits of the mountains mentioned. This antedated many years the upheaval of the New Jersey coast plain, which was, after its appearance above the surface of the sea, an open field for the migration of plants from nearby formations. The pioneers into the elevated coastal plain were those species nearest at hand and most mobile and, by reason of occupancy of a similar soil, well adapted to meet the new conditions of environment. If we apply these principles to the problem in hand, we naturally reach the conclusion that certain plants of the coastal flora are derived from the formations nearest at hand which present similar environmental conditions, and are, therefore, for the coastal region comparatively new, so that the summit flora of the mountains may be looked upon as relatively older in point of time than that occupying the territory along the sea coast.

An interesting confirmation of this position is found in a study of the succession of the floras on the Pocono Mountain plateau, following the destruction of the original forest by lumber operators. The original vegetation of this plateau consisted, as far as I have been able to determine, of four elements, viz.: a forest of pitch pine, *Pinus rigida* Mill., which covered the looser morainic material of the great terminal moraine in the eastern and southern parts of the plateau; the broad-leaved deciduous forest with its oaks and associated species on the eastern slopes and edge of the tableland; the chestnut and black locust forest which occupied Laurel Ridge along the western rim of the plateau, and a forest of white pine with a thicket of *Rhododendron maximum* L. beneath, mixed in many places with the black spruce, *Picea nigra* Link, the red maple and other plants characteristic of the Catskill mountains and farther north, grading over to a hemlock forest in the region of Tobyhanna. The open sphagnum bogs culminated in the presence of the larch, *Larix americana* Michx., with which were associated *Kalmia glauca* Ait., *Ledum latifolium* Ait., *Rhododendron rhodora* Don, and other northern plants. With the destruction of the white pine, hemlock and pitch pine forests, the vegetation of this tableland has undergone an entire change. The succession of the species has not been worked out in detail, but what has been observed is instructive. The botanist is impressed by the general appearance of the landscape. The flora over the eastern half of the plateau in aspect resembles that of the pine barren regions of southern New Jersey, from which the original pitch pine and Jersey pine have been cut. A study of the species shows that this appearance is due to the close similarity of the flora in the plant species which constitute the two regions. We have an instructive example of mass invasion of such plants as *Quercus ilicifolia* Wang., *Pinus rigida* Mill., *Gaylussacia resinosa* Torr. and Gray, *Vaccinium vacillans* Solander, *Epigæa repens* L., *Gaultheria procumbens* L., *Rhododendron viscosum* Torr., *Kalmia angustifolia* L., *Lilium philadelphicum* L., *Amianthium muscætoxicum* Gray, *Lycopodium inundatum* L., etc., from the morainic hills westward into the region occupied by the white pines. We naturally inquire from what locality the pitch pine formation has proceeded, and it seems to me we are forced to conclude that this association of species has been derived, not from the barrens of New Jersey, but from the nearby mountains northwest of the Delaware Water Gap which, as previously mentioned, support such a flora. This relict flora on the Kittatinny and other highlands has been under unusual stress of circumstances, and when more favorable, but on the whole similar, edaphic conditions were supplied, a mass invasion from these mountain highlands took place at two different and widely divergent periods of time in two directions. After the uplift of the Jersey pine barrens region, the nearby flora of the upland plateaus being edaphically better adapted to the new region, supplied the barren ground with a vegetable covering. Similarly, when the glaciers retreated a mass invasion of pitch pines and associated species moved from the unglaciated Kittatinny Mountains on to the sandy gravelly soil of the great moraine, and when the lumbermen disturbed the forest these plants, adapted to growing in sandy soils and exposed to xerophytic conditions, supplied the constituent elements of the present flora in the greater part of the eastern half of the plateau.

A consideration of the strand flora of New Jersey, upon which I have spent considerable study, reveals the fact that the time element is important in an explanation of the distribution of the seashore plants. If we contrast the character of the association on the northern and southern shore of New Jersey, we find that the formations on Barnegat beach, for example, are usually open, while those on Wildwood beach are closed and have culminated in the forest type of vegetation. This argues for a greater age of the strand flora of Wildwood, as compared with that, for example, at Sea Side Park in the north. This conclusion is substantiated by the fact that the bays behind the sandy sea islands are converted into salt marshes in the south, while in the north they are wide and still open bays of brackish or salt water. Physiographically and botanically the coast line from Bay Head south to Ocean City is younger than the coast south of the latter place extending to Cape May.

The latest periods of submergence and uplift had a powerful influence on the distribution of sea-coast species. The present distribution of the swamp rose-mallow, *Hibiscus moscheutos,* in the Atlantic coastal plain illustrates this. The plant normally occurs in brackish marshes from Massachusetts to Florida and Louisiana and on lake shores in saline situations locally in the interior to western Ontario. When it occurs in fresh-water swamps it is reasonably certain that these swamps represent a converted salt marsh present during a former time of submergence. New Jersey shows this best. During the Pensauken submergence southern central New Jersey was an extensive sea island separated from northern New Jersey by Pensauken Sound. *Hibiscus moscheutos* in its present distribution in New Jersey follows the former shore line of that ancient island, for it occurs in the salt marshes of the coast, on both banks of the Delaware river to the head of tide water, and also in fresh-water marshes along the New York Division of the Pennsylvania Railroad between Trenton and Newark, the roadbed between these cities being laid upon the geologic site of the Pensauken Sound.

South of New Jersey the region, including southeastern Pennsylvania, may be divided historically according to the age of the flora into several well-marked divisions.

1. The flora of the Southern Appalachians and its northeastern extension into southern and southeastern Pennsylvania. The facts presented in two former papers[5] all argue for the great antiquity of the flora of North Carolina and southeastern Pennsylvania, because this flora, in all probability, represents the more or less modified descendants of that characteristic flora which in later Eocene or Miocene time extended to high northern latitudes.

2. The flora of the coast plain occupied by the long leaf pine with its associated species, which probably represent the ultimate stages of successions initiated at the time of the final elevation of the sea bottom along the coast line. These plants probably entered the elevated coastal region by a mass invasion from a circumscribed area contiguous to the Atlantic shore line, for it has been established that contiguous vegetation furnishes 75–90 per cent. of the constituent species of an initial formation. The reason for this is to be found not only in the fact that adjacent species have a much shorter distance to go and hence will be carried in greater quantity, but also in that species of the formations beyond must pass through or over the adjacent ones. In the latter case, Clement states that the "number of disseminules is relatively small on account of the distance, while invasion through the intermediate vegetation, if not entirely impossible, is extremely slow, so that plants coming in by this route reach the denuded area only to find it already occupied."[6]

3. Plants of probable Neotropic origin which have, according to Kearney, in all likelihood made their first appearance in the Appalachian region in geologically very modern times, probably after the close of the so-called glacial epoch.

[5] Harshberger, J. W., "An Ecologic Study of the Flora of Mountainous North Carolina," *Botanical Gazette*, XXXVI, 241–258, 368–383, 1903, and "A Phytogeographic Sketch of Extreme Southeastern Pennsylvania," *Bulletin Torrey Botanical Club*, XXXI, 125–159, March, 1904.

[6] Clements, Frederick E., "Studies of the Vegetation of the State, III.—The Development and Structure of Vegetation," *Botanical Survey of Nebraska*, 1904.

4. A relict flora of a former widespread plateau region, similar to the one mentioned for northeastern Pennsylvania, in which we find a close similarity between the flora of some of the higher mountain summits and the flora of the coastal plain. We have previously mentioned in the physiographic changes which have taken place in this mountain region an explanation of such peculiarities of distribution. The presence of *Hudsonia montana* Nutt. on the summit of the Table Rock is probably thus explained, for Table Rock represents an undenuded remnant of a former peneplain. It is likely, therefore, that *Hudsonia montana* Nutt. was once more extended in its distribution, but has been isolated by the erosion of the plain on which it formerly grew in abundance. The presence of *Leiophyllum buxifolium* Ell., *Xerophyllum asphodeloides* Nutt., *Amianthium muscætoxicum* Gray on the mountain summits and on the coastal plain is also similarly explained.

5. The distribution of plants in the southern extremity of Florida is an interesting confirmation of the historic development of a flora. Seven plant formations can be recognized, viz.: (1) The sea-strand formation; (2) The mangrove swamp formation; (3) The everglade formation; (4) The grassland ("prairie") formation; (5) The savanna formation; (6) The pine-land formation; (7) The hummock-land formation. Historically the sea-strand formation and the hummock-land formation are the oldest, floristically speaking. The strand flora, consisting of such plants as *Uniola paniculata, Panicum amarum, Ipomœa pes-capræ, Batatas littoralis, Iva imbricata, Cakile maritima, Agave decipiens* (ontropic section), has existed as an element of the flora of peninsular Florida since the land was elevated above the sea, and perhaps was derived from an earlier seashore flora which existed along the shore of the mainland or the coasts of the larger and more elevated sea islands.

Nearly all the tropic species recently added to the flora of the United States were discovered in or about the hummocks, which are essentially duplicated by similar formations in the West Indies. The total area of the hummock-land is relatively insignificant when compared with the pine-lands, yet the flora, as shown in the enumeration below, is as rich, if not comparatively richer:

Pine-lands, ...	43 per cent.
Hummocks, ...	42 "
Everglades, ...	15 "

The hummocks consist of isolated groups of hardwood trees, shrubs and vines. These hummock formations with an overlying soil thicker than the pine-lands, due without doubt to the accumulation of vegetal detritus, vary in size from an acre to many hundred acres, and are scattered as islands in the everglades and pine forests instead of surrounded by the ocean, as they formerly were before the sea bottom between them became dry land by elevation. The trees, shrubs and woody vines harbor an almost incredible growth of plants of various categories. The growth of epiphytes is especially striking, for in numerous cases the tree trunks and branches are completely clothed with air plants, and so prolific are the orchids and bromeliads that many individuals are forced to growth on the ground and on the neighboring pine trees.[7] Here occur the great majority of flowering plants now known to be common both to the West Indies and the mainland of North America. As the rock of New Providence Island, of the Bahama group, is essentially identical with that of the Florida south of Miami, and as there are many trees and shrubs common to the two regions, as well as to Cuba, while many species are endemic to each of the three regions, we are forced to conclude from the evidence that the flora gives that geologically and to a certain extent floristically the hummock-lands formed originally part of the Antillean region. The hummock-lands, perhaps, represent part of the ancient system of Keys which existed at the time when the Gulf Stream left the American Mediterranean through a channel which existed across the northern half of Florida. It was when these islands formed an extended archipelago coextensive with the Bahamas that the hummocks were occupied by their present flora, which, therefore, shows the closest relationship to that of the nearby Bahama islands. With the elevation of the land through the epeirogenic movements of the earth's crust, through the agency of coral polyps, vegetation, ocean and wind currents, the Gulf Stream was directed into its present channel and the sea islands which now exist in south Florida in the form of hummocks were connected by dry land or by partially submerged banks to form the present peninsula of Florida.

With the appearance of level plains by the removal of the shallow sea over a sandy bottom, the isolated trees and herbaceous plants which associated together constitute the savanna formation appeared and clothed the ground. Imperceptibly these savannas were transformed by the appearance of trees into the pine-land formation. This formation is characterized by a scattering growth of *Pinus heterophylla*

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[7] Consult the articles by J. K. SMALL, and N. L. BRITTON, in *Journal New York Botanical Garden,* III, No. 26, February, 1902; IV, No. 39, March, 1903; V, No. 51, March, 1904; V, No. 55, July, 1904; V, No. 56, August, 1904, to which the writer is indebted for many facts herein set forth under the new cloak of generalization.

and numerous shrubs, shrubby herbs and herbaceous perennials, together with a few annuals. Four species of palms belonging to the genera *Sabal*, *Serenoa*, *Coccothrinax*, and the Sago palm, *Zamia floridana*, are prominent representatives of the pine-land formation. These pine-lands are light and airy, with comparatively thin soil. The growth of timber is scattered and the plants found in this formation are not duplicated in the West Indies. Relatively, then, the flora of the pine-land formation is younger than that of the hummocks, and may be older or younger than the everglade formation, according to whether this association of species encroached on elevated plain land or whether it captured grassland or an everglade formation. The evolution of the pine woods may be represented for sake of clearness diagrammatically as follows:

Very Shallow Water

Dry Elevated Sea Bottom — Swamps

Savanna — Grassland

Pine Woods

The culmination from either condition has been a pine forest.

The everglades, then, historically speaking, may be older than the pine woods, or they may be younger. Whatever their position in point of time, they cover an area of about one hundred miles wide and perhaps one hundred and fifty miles long, the elevation being about eighteen feet above sea-level. This area consists of an extended saw-grass swamp traversed by winding river channels, and covered with scattered hummock-lands. Its flora consists of grasses, sedges and other herbaceous plants, among which are many aquatic and mud-inhabiting plants. The vegetation of the everglades is of a more northern character than that of the hummock-lands.

The mangrove formation represents an important element in the flora of southern Florida. The mangrove swamps are particularly abundant along salt or brackish shores and along the sea islands, the so-called Florida Keys.[8] Their vegetation is confined almost exclusively to the mangrove trees and such few Tillandsias and orchids as grow upon their branches. Frequently on the borders of these swamps occurs a large showy species of *Acrostichum* with leaves often six to eight feet long. The area shut off from the sea by the fringe of man-

[8] PHILLIPS, O. P., "How the Mangrove Tree adds New Land to Florida," *The Journal of Geography*, II, 1–14, January, 1903.

groves becomes dry ground and eventually grassland (in Florida "prairie").

The results of this survey as to the southern extremity of Florida may be arranged below:

Ancient Strand Flora — Ancient Sea Island Flora

Northern Element

Mangrove Flora — Plain Flora — Everglade Flora — Swamp Flora

Savanna Flora — Grassland

Present Strand Flora — Pine-land Flora — Present Hummock Flora

Lastly are the ruderal plants and weeds that, introduced by the hand of man, have become established in America. The history of the introduction and spread of many of these plants is known to an exactness, whereas many have appeared and become established the history of which is involved in considerable doubt. The time which has elapsed since the advent of these outsiders does not exceed two or three hundred years, and yet in that time many American varieties of common European plants have by mutation or otherwise arisen to demarcate the American from the European forms.

I have endeavored to present in this paper the fact that the component elements of the flora of eastern North America have had an historic development, and I have attempted to give the methods of determining their relative or comparative age, as well as the philosophic reasons underlying their distribution. The outcome of these observations may be tabulated and arranged as follows, the top of the table representing the oldest elements of our flora:

Chart Illustrating Comparative Age of the different Floristic Elements in the Flora of the Eastern North America.

Great Miocene Flora

Old Sea Coast Flora

Appalachian and Piedmont Floras

Arctic Flora

Hummock-land Flora of Florida

Southern Plateau Flora

Forest Flora

Northern Plateau Flora

Tundra Bog Flora

Southern Coastal Plain Flora, including Prairie and Savanna in Florida

(i) Summit Coniferous Forest, (ii) Deciduous Forest of Slopes

(Southern)
Present Sea Coast Flora of the Atlantic States
(Northern)

Pine Barren Element in New Jersey

Interglacial Arctic Flora

First Floral Wave into Barren Land North of Terminal Moraine

Present Flora of Alpine Summits of Mountains

Second Floral Wave into Barren Land north of Terminal Moraine and higher Mountains of Pennsylvania, New York and New England, including original Pocono Flora

Modern Bog Flora

Third Floral Wave into Barren Land north of Great Terminal Moraine

Neotropic Element

Modern Swamp Flora

Modern Pocono Flora

DESCRIPTIONS OF NEW LAND SNAILS OF THE JAPANESE EMPIRE.

BY H. A. PILSBRY and Y. HIRASE.

In January of this year collecting was begun in Tokuno-shima, Ōsumi, in the Riukiu chain, by Mr. NAKADA, whose laurels as a collector have been won by his able campaigns in the Islands of Izu (1903) and other parts of the empire. His work was continued in the islands southward, Okinoerabu-shima and Yoron-jima, completing the chain from Ōshima to Okinawa or Riukiu. Kume-jima, Riukiu, an islet west of Okinawa, was then visited. No land mollusks had been collected from any of these islands; and Mr. Nakada's results, as they are studied, are found to add enormously to our zoogeographic data on the Riukiu group. The Miyakojima subgroup of the Southwestern islands was also further explored, and some remarkable species of genera or subgenera new to the fauna were obtained, such as *Plectopylis hirasei*, a species of Chinese type, and *Diplommatina vespa* P. and H.

The *Clausiliidæ* obtained by Mr. Nakada greatly enlarge our knowledge, about doubling the number of Riukiuan species, and adding several new endemic groups, especially to the Zaptychoid phylum.

Meantime Mr. AZUMA has been collecting in southern Kyushu, chiefly in Satsuma and its islands, particularly the Koshikijima group. His results are good, although, as was expected, the number of new species discovered was not great. Some unexpected forms were found, such as *Sitala rimicola* Bens., a Himalayan species, and *Clausilia azumai*, a fine snail belonging to the Riukiuan group *Luchuphædusa*.

A collector has also been sent to Kita-iwo-jima, of the Sulphur group, near Ogasawara-jima, but the results were disappointing. It seems to be, from the faunal indications, a very recent volcanic island. It will be remembered that Mr. Hatai lost his life a few years ago in an attempt to collect upon these remote islets.

The present paper deals only with the new species and subspecies received, exclusive of the *Clausiliidæ*.

CYCLOPHORIDÆ.

Japonia tokunoshimana n. sp.

Shell turbinate-conic, umbilicate, olive-brown, somewhat shining. Sculpture of close fine growth-striæ, and fine spiral striæ with much larger threads at intervals, becoming much weaker on the penultimate and earlier whorls. Whorls 4½, the last tubular, bearing a series of flat paddle-shaped cuticular processes at the shoulder and another at the periphery. Aperture circular, the peristome simple, interrupted a short distance where it touches the previous whorl.

Alt. 3.75, diam. 4 mm.

Tokunoshima, Ōsumi. Types No. 87,512, A. N. S. P., from No. 1,206 of Mr. Hirase's collection.

This form is a little larger than *J. barbata* Gld. of Ōshima, Ōsumi, and has not the two more conspicuous spiral ridges described for that species.

The flat spatulate cuticular processes upon the last whorl are very readily lost, and probably never perfectly preserved in adult shells.

Alycæus purus n. sp.

Shell much depressed, oblong in contour, white, the first whorl rufous tinted. Whorls 3⅓, convex, those of the spire nearly smooth, the last whorl very closely, finely and delicately rib-striate as far as the neck, which is decidedly constricted and smooth, the whorl enlarging and striate again beyond it. The last half of the last whorl is much enlarged and straightened, making the umbilicus oblong. The sutural tube is long. The aperture is oblique, circular; the peristome is thin, with a small delicate collar close to the edge.

Alt. 1.7, diam. 3 mm.

Tokunoshima, Ōsumi. Types No. 87,683, A. N. S. P., from No. 1,219 of Mr. Hirase's collection.

The sculpture is much finer than in *A. tanegashimæ*, and the neck is more constricted. It is more depressed than most Japanese species, and it is more oblong in outline, viewed from above.

Alycæus tokunoshimanus n. sp.

Shell depressed, light red. Whorls 3½, the first smooth and glossy, the following ones nearly smooth to the last whorl, which is very densely and finely rib-striate, the striæ weak or wanting on the neck. The last half of the last whorl is much enlarged and somewhat straightened, moderately constricted at the neck, enlarged beyond it and deeply deflexed. The aperture is oblique, circular; the peristome continuous, thickened outside and bevelled to the edge.

Alt. 2.3, diam. 3.7 mm.

Tokunoshima, Ōsumi. Types No. 87,505, A. N. S. P., from No. 931*a* of Mr. Hirase's collection.

This shell is sculptured much as in *A. purus*, and is nearly as depressed as that species, but it is larger, colored, less oblong in peripheral outline, with the neck nearer the aperture and the peristome stronger. The sutural "tube" is long, as in *A. purus.*

Alycæus lævicervix n. sp.

The shell is rather depressed, light olive greenish. Whorls 3½, the first projecting and smooth, the rest finely rib-striate and latticed by lower, finer spiral striæ. The last half of the last whorl is swollen, with closer rib-striæ, the spirals becoming obsolete. The sutural "tube" is short and irregular. The neck is moderately contracted, and *smooth* to the aperture. Aperture oblique, circular, the peristome somewhat thickened, with a low thin rib close to the edge.

Alt. 3.7, diam. 4 mm.

Kuchinoerabushima, Ōsumi. Types No. 87,699, A. N. S. P., from No. 1,280 of Mr. Hirase's collection.

This species is related to *A. satsumanus,* but it is larger, with a shorter sutural "tube," a smooth neck, and more prominent spiral striæ.

Pupinella oshimæ tokunoshimana n. subsp.

The shell is dirty white, more slender than *P. oshimæ,* and umbilicate, the umbilicus half covered by the lip, and bounded by a very strong keel. The upper or anal notch of the aperture is narrow, straight and oblique, its two bounding walls of nearly equal length, while in *P. oshimæ* the outer lip of the canal is decidedly shorter than the inner, and the canal is thus enlarged and opens more backwards. The parietal callous and that at the opening of the anal canal are less extensive than in *P. oshimæ.*

Length 9.3, diam. above aperture 4, greatest diam. 5 mm.

Tokunoshima, Ōsumi. Types No. 87,506, A. N. S. P., from No. 1,214 of Mr. Hirase's collection.

Cyclotus nudus n. sp.

Shell openly umbilicate, lusterless, whitish under a very thin slightly yellowish cuticle, readily lost, with an opaque whitish sutural margin from which short whitish streaks radiate. The surface is but slightly roughened by growth-lines, and an intermediate whorl of the spire is very finely, closely striate spirally; the last 1½ whorls hardly or not showing spirals. The spire is small and acutely conic. The first 1½ whorls are brown, project nipple-like, and are distinctly tilted. Whorls 4¼ to 4½, very convex, the last tubular, barely in contact with the preceding at the aperture. The aperture is circular, vertical, the peristome simple. The operculum is whitish and lodges just within the peristome, is concave externally, with a sunken smooth nucleus and a spiral lamella closely revolving on the other whorls.

Alt. 6, diam. 7.5 mm.

Alt. 5.5, diam. 7 mm.

Miyakojima, Riukiu. Types No. 87,633, A. N. S. P., from No. 1,296 of Mr. Hirase's collection.

This species has a more elevated spire than the related *C. minutus* of Formosa.

Cyathopoma iota n. sp.

Shell minute, umbilicate, conic, thin, yellowish corneous, subtranslucent. Surface glossy, nearly smooth. Whorls 3½, very convex, tubular, parted by a deep suture, the last whorl at the aperture barely in contact with the preceding. Aperture slightly oblique, circular, the peristome thin and simple. The operculum lodges a short distance within, is externally somewhat concave, cream-colored, concentrically delicately striate, with a large somewhat sunken glossy translucent central spot.

Alt. 1, diam. 1.3 mm.

Kumejima, Riukiu. Types No. 87,698, A. N. S. P., from No. 1,292 of Mr. Hirase's collection.

This species is intermediate in contour between the Japanese *C. micron* Pils. and *C. innocens* Sykes of Ceylon. It is much more elevated than the former species. This species and *Cyclotus micron* belong evidently to the subgenus *Jerdonia* of the genus *Cyathopoma*, the operculum being discoidal and somewhat biconcave, as in *Cyclotus*. Both *Cyathopoma* and *Jerdonia* are Indian groups, not hitherto reported from China or from any part of the Japanese Empire.

DIPLOMMATINIDÆ.

The Diplommatinas of Japan and the Riukiu Islands are very closely related to those of China. Besides *Adelopoma*,[1] two subgenera or sections of *Diplommatina* are represented.

I.—Constriction at the beginning of the last whorl, in front, or on the latter part of the penultimate whorl on the right side; a palatal plica and a parietal or "spiral" lamella developed in front of the constriction, to which the columellar lamella also extends, Section *Sinica* Mlldff.

II.—Constriction in the first part of the penultimate whorl, on the front or left side; the columellar lamella therefore nearly two whorls long; a palatal plica but no parietal lamella developed, Section *Angigaster*, type *D. vespa* P. and H.

Sinica[2] includes all of the known Japanese and Riukiuan species

[1] *Nautilus*, XVII, p. 59.

[2] *Vide Jahrb. D. Malak. Ges.*, XII, 1885, p. 369. The type of *Sinica* is *Diplommatina sculptilis* Mlldff., from the Chinese province Guang-dung.

except *D. vespa*, which represents a line of differentiation parallel to the Bornean *Paradiancta*.

Diplommatina tosana n. sp.

Shell imperforate, cylindric, the upper third conical, tapering; light red, darker red toward the apex, paler and sometimes more of a yellow tint toward the last whorl; closely, finely and delicately rib-striate throughout, the striæ becoming more widely spaced on the cone, the first whorl smooth. Whorls 6½, the last rounded below, ascending in front. The weakly marked constriction near the end of the penultimate whorl is close to the peristome, being immediately behind it. The aperture is round-ovate; peristome narrowly reflexed, strengthened by a "collar" or lamella a short distance behind it. The parietal callous extends nearly to the suture above. The columellar lamella is strong. Palatal plica long, visible through the parietal callous, and not extending beyond it.

Length 3, diam. 1.7 mm.

Nogawa, Tosa. Types No. 84,190, A. N. S. P., from No. 1,026 of Mr. Hirase's collection.

The constriction and palatal plica lie farther back than in *D. cassa*, which is also a more slender species.

Diplommatina tosanella n. sp.

This form is very similar to *D. kyushuensis* in contour and appearance. The last two whorls are dull red, the rest of the spire bright orange-red. Sculpture of fine close rib-striæ on the last two whorls, while on the spire the intervals between riblets are about twice as wide. Whorls nearly 6½, convex, the slight constriction being in the middle of the front side, visible externally as an oblique light line; the last whorl is rounded below. Aperture nearly circular, the peristome thickened outside. Parietal callous rather small, not approaching the suture above. The columellar tooth is small. Palatal plica short, wholly to the left of the parietal callous and situated as high as its upper edge. The columellar and spiral lamellæ and palatal plica are low inside, not nearly so strong as in *D. kyushuensis*.

Alt. 2.6, diam 1.3 mm.

Nogawa, Tosa. Types No. 87,642, A. N. S. P., from No. 1,026*a* of Mr. Hirase's collection.

D. cassa is decidedly more cylindrical and more evenly striate than this species.

Diplommatina gibbera n. sp.

Shell cylindric below, the upper half tapering in a rather long straight cone; varying from dull red with an orange lip to nearly white, with the lip pale yellowish Very delicately and evenly striate throughout. Whorls 6½, convex, the last whorl very obtusely angular at the base, *very much swollen on the ventral face* to the left of the parietal callous. It is distinctly constricted in front, at or shortly in front of the insertion of the outer lip. The aperture is very irregular in shape, the peristome strongly thickened outside, bevelled and obtuse, the back of the lip-thickening being white. Columellar margin straightened, vertical, the columella bearing a strong tooth. Parietal callous extending in a rather narrow lobe nearly to the suture. Palatal plica long, in large part overlaid by the parietal callous.

Alt. 3, diam. 1.6 mm.

Nomimura, Tosa. Types No. 87,643, A. N. S. P., from No. 1,027 of Mr. Hirase's collection.

This species is readily distinguished by the conspicuous swelling of the last whorl in front of the aperture. The tapering portion of the spire is longer than in most allied species.

Diplommatina goniobasis n. sp.

Shell cylindric below, tapering and conic above, dull red. Surface finely and evenly striate. Whorls 6¼, convex, the last ascending in front, becoming *biangular on its last half*, the angles obtuse, one near the suture, the other bounding the flattened basal area, the surface between the angles being flattened. The constriction is at the termination of the outer lip. The aperture is very irregular in shape, the lip heavily thickened with a wide but rather thin external rib. Columella vertical, short, with a very strong horizontal lamella. The palatal plica is short and wholly covered by the parietal callous, which extends nearly to the suture.

Alt. 2.7, diam. 1.4 mm.

Irazuyama, Tosa. Types No. 87,646, A. N. S. P., from No. 1,178 of Mr. Hirase's collection. Also a variety from Ōnomura, Tosa (1,027*a*).

This species is very distinct by its irregular aperture, strong columellar lamella and peristome, and the biangular last whorl. It is related to *D. gibbera*.

D. g. onoensis n. subsp.

The specimens from Ōnomura, Tosa, are dirty yellowish in color, with the two angles of the last whorl less strong and the constriction a little more receding, so that it falls behind the insertion of the outer lip.

Diplommatina kyushuensis n. sp.

Shell obesely fusiform, the penultimate whorl largest, those above tapering regularly, the last whorl also smaller. Pale yellowish-brown, sometimes whitish. Sculpture of very fine, low and delicate vertical striæ, obsolete on the front of the last whorl, and often largely lost by wear. Whorls 6½, convex, the constriction at the beginning of the last whorl, above the insertion of the outer lip; last whorl rounded below. Aperture vertical, subcircular, the peristome reflexed, thickened within, continuous in a delicate callous with raised edge across the parietal wall; somewhat angular at the junction of the columellar and basal margins. Columellar lamella strong at the mouth and opposite the palatal plica. Palatal plica strong and long, its inner end only under the parietal callous. Spiral lamella long but rather low.

Alt. 2.7, diam. 1.5 mm.

Kagoshima, Satsuma. Types No. 81,896, A. N. S. P., from No. 702 of Mr. Hirase's collection. It has been sent also from Kami-Koshikijima, Satsuma; Watarimura, Kiyoragi and Fukuregi in Higo; Saganoseki, Bungo; and Obi, Huga.

We formerly considered these forms to belong to *D. cassa;* but further study has shown them to be shorter and less cylindric than *cassa*, with a more ventrally situated and more distinct constriction. *D. cassa* has not yet been found in Kyushu, and *D. kyushuensis* has not occurred in Hondo or Shikoku. The form from Kami-Koshikijima, Satsuma, is slightly smaller and more slender. Most species of these islets show more or less modification.

Diplommatina tokunoshimana n. sp.

Shell conic above, cylindric below, dull reddish, rather closely, finely and delicately striate. Whorls 6½, moderately convex, the last rounded below, strongly ascending in front. Constriction slight, just in front of the upper insertion of the peristome. Aperture circular, with a notch at the base of the columella, the peristome thick, thickened outside. Columella straight. Columellar tooth strong. Parietal callous large, approaching the suture above. Palatal plica moderately long, situated under the parietal callous.

Length 3.3, diam. 2 mm.

Tokunoshima, Ōsumi. Types No. 87,649, A. N. S. P., from No. 1,217 of Mr. Hirase's collection.

Very peculiar by the spout-like base of the aperture, unlike any other species of Japan or the Riukiu Islands.

Diplommatina ventriosa n. sp.

Shell obese-fusiform, the penultimate whorl large and swollen, the spire conic, last whorl smaller; dull reddish-brown; evenly, closely and almost obsoletely striate. Whorls 6½, very convex, the last well rounded. Constriction slight, situated in front of the insertion of the outer lip. Aperture subcircular, the peristome expanded, thickened; baso-columellar margin rounded. Columellar tooth small. Parietal callous rather large. Palatal plica long, partially covered by the callous.

Length 2.8, diam. 1.6 mm.

Length 2.8, diam. 1.4 mm.

Kumejima, Riukiu. Types No. 87,629, A. N. S. P., from No. 1,288 of Mr. Hirase's collection.

Related to *D. oshimæ*, but the whole shell is wider and the back of the last whorl is convex, not flattened and tapering as in that species.

Diplommatina kumejimana n. sp.

The lower half of the shell is cylindric, the upper half tapering in a long cone; dull red; evenly, delicately striate. Whorls 7, convex, the last whorl convex below, ascending in front. The constriction is at the end of the penultimate whorl, close behind the upper insertion of the peristome. The aperture is circular; peristome thickened and reflexed. Columella arcuate, with a small columellar tooth. Parietal callous approaching the suture above. Palatal plica moderately long, wholly under the callous.

Length 3, diam. 1.4 mm.

Kumejima, Riukiu. Types No. 87,654, A. N. S. P., from No. 1,288*a* of Mr. Hirase's collection.

Related to *D. oshimæ*, but the sculpture of the spire is finer, and the constriction is behind the peristome, while in *D. oshimæ* it is in front, above the aperture.

Diplommatina lateralis n. sp.

The upper half of the shell is long-conic, the lower half cylindric, but the penultimate whorl is contracted on the right side. Dull brownish-yellow, evenly, delicately striate. Whorls 7½ to 7¾, convex, the last well rounded, somewhat ascending in front. *Constriction lateral*, on the penultimate whorl some distance behind the lip. Aperture subcircular, the lip thickened, expanded and reflexed. Columella bearing a quite small tooth. Parietal callous not extensive. The palatal plica is concealed by the suture, from its recession following the constriction.

Length 3, diam. 1.6 mm.

Miyakojima, Riukiu. Types No. 87,636, A. N. S. P., from No. 1,298 of Mr. Hirase's collection.

This species is well distinguished by the lateral constriction.

Diplommatina immersidens n. sp.

Shell convexly tapering above the penultimate whorl, dull red, evenly sculptured with delicate, not close rib-striæ. Whorls 7¾, convex, the last rounded below. Constriction slight, immediately in front of the upper insertion of the outer lip. Aperture subcircular, the peristome thin and reflexed, a little thickened within. Columellar tooth hardly visible in a front view, stronger within. Parietal callous extensive. Palatal plica long, partly under the callous, partly projecting beyond it.

Length 3.7, diam. 1.7 mm.

Miyakojima, Riukiu. Types No. 87,655, A. N. S. P., from No. 1,299 of Mr. Hirase's collection.

This is the largest *Sinica* of the Riukiu Islands which we have yet obtained. The columellar tooth is very small in a front view.

Diplommatina vespa n. sp.

Shell oblong, the upper third conic, the rest subcylindric; dull red or ashy brown. Sculptured with delicate rib-striæ which are fine and close on the cylindric portion of the shell, much more widely spaced upon the conic spire, the first 1½ whorls smooth. Whorls 8 to 8½, very convex. *The penultimate whorl abruptly contracts in front or on the left side* and continues narrow to the end, the last whorl being of normal proportions and very convex throughout. The aperture is subcircular, the lip broadly expanded and reflexed. The columellar lamella is rather small at the mouth, but larger inside. It ascends nearly two whorls, to the constriction, where there is also a rather small palatal plica, but no parietal spiral lamella.

Length 3.9, diam. 1.8 mm.

Length 3.7, diam. 1.7 mm.

Length 3.5, diam. 1.7 mm.

Miyakojima, Riukiu. Types No. 87,634, A. N. S. P., from No. 1,297 of Mr. Hirase's collection.

The closing apparatus recedes much more deeply in this than in other Japanese Diplommatinas, but it does not lie quite so far back as in a Bornean group of which *D. everetti* Smith is typical, called *Paradiancta*, and subordinated to the genus *Diancta* by von Möllendorff and Kobelt, whose classification of the *Diplommatinidæ* shows some strange groupings for which no reason is apparent. The section *Metadiancta* Mlldff., based upon a series of Diplommatinas from the northeastern frontier of India, has also some similarity. These forms as described by Godwin-Austin are characterized by the position of the constriction, which is on the side, near the end of the penultimate whorl, behind the peristome, as in *D. lateralis* and *kumejimana*, described above, but differing from them in the deficient internal armature.

It seems that in various places forms of *Diplommatina* have independently arisen having a tendency toward recession of the closing apparatus.

HELICINIDÆ.

Helicina verecunda degener n. subsp.

Similar to *H. verecunda* Gld., except that it is decidedly smaller and somewhat more elevated.

Alt. 3.2, diam. 4.3 mm.

Okinoerabushima, Ōsumi. Types No. 87,686, A. N. S. P., from No. 1,255 of Mr. Hirase's collection. Also Yoronjima, Ōsumi (1,255*a*).

HELICIDÆ.

Eulota (Ægista) friedeliana var. **humerosa** n. n.

This name is to replace that of *E. friedeliana goniosoma* P. and H., preoccupied.

Eulota (Ægista) omma n. sp.

The shell has the general shape of *E. oculus* (Pfr.). It is yellowish olivaceous-brown, densely obliquely striate above, more glossy and smoother below, the first two whorls nearly smooth. Whorls 7, but slightly convex, enlarging slowly and regularly; the last whorl slightly deflexed in front, obtusely angular at the periphery, the base very convex. The deep and ample umbilicus is nearly one-third the diameter of the shell; its last half-whorl enlarges more rapidly. The aperture is rather small, hardly larger than the umbilicus, oblique, rounded, the preceding whorl excising about one-fourth of the circle. Peristome narrowly reflexed throughout, the columellar margin very steeply ascending, hardly dilated.

Alt. 10.5, diam. 17 mm. (Taramajima, No. 87,574).

Alt. 11.5, diam. 19 mm. (Taramajima, fossil, No. 87,575).

Alt. 10, diam. 18 mm. (Riukiu, No. 83,917).

Taramajima, Riukiu. Types No. 87,574, A. N. S. P., from No. 998*a* of Mr. Hirase's collection. Also found fossil in sand at the shore, No. 87,575 (Hirase's No. 998*b*).

This species was at first thought to be the Formosan *Ægista subchinensis* 'Nevill' Mlldff.,[3] but further study of the description and the finding of a Formosan specimen in the collection of the Academy have shown that material differences exist between the Formosan and Riukiuan forms. In *subchinensis* the columellar margin slopes to the insertion instead of rising almost vertically as in *E. omma*—much more steeply in fact than in *E. oculus*, which is the most closely related species.

[3] *Jahrb. d. D. Malak. Ges.*, XI, p. 355, Pl. 7, fig. 8.

In each of the three lots examined a small form occurs with the larger shells. Three of these smaller specimens measure:

Alt. 7.5, diam. 14.4 mm.; whorls 6.

Alt. 9, diam. 15.5 mm.; whorls $6\frac{3}{4}$ (fossil).

Alt. 8, diam. 14.5 mm.; whorls 6.

The color also in the small form is concentrated, being of decidedly darker shade than in the larger shells.

The names *E. omma* and *E. oculus* allude to the appearance of the basal aspect of the shell—a dark pupil-like umbilicus surrounded by a brownish band, like the iris of the eye.

Eulota (Euhadra) okinoerabuensis n. sp.

Shell very narrowly umbilicate, moderately depressed with conoidal spire. The specimens are fossil, white with a narrow reddish band above the periphery. The surface in the best preserved specimens is glossy, sculptured with weak wrinkles along growth-lines, and very fine, faint, close spiral striæ. Whorls about $5\frac{3}{4}$, slowly increasing, convex, the last rounded below and at the periphery, very slightly deflexed in front. The aperture is slightly oblique, lunate, the lip thin, narrowly expanded, slightly reflexed, dilated at the axis, half covering the small umbilicus.

Alt. 21, diam. 27.5 mm.

Alt. 19.5, diam. 26 mm.

Okinoerabu-shima, Ōsumi, in sand on the seashore. Types No. 87,542, A. N. S. P., from No. 1,252 of Mr. Hirase's collection.

This is a small, elevated member of the group of *E. mercatoria*, as yet only found fossil. The very small umbilicus and elevated spire give it something the appearance of the large form of *E. submandarina* of Yakushima.

Eulota callizona montivaga n. subsp.

This race resembles *E. c. minor* Gude in general appearance, but it is more conic, less globose. The aperture consequently is lower and wider.

The color is (1) either yellow, with a light reddish-brown peripheral belt, a darker streak at the back of the lip, and some tinting with the same color around the umbilicus, or (2) greenish-yellow, with three blackish-brown bands, the first one very narrow, bordering the suture, the second wide, at the periphery, and the third is a circular area covering the greater part of the base. The lip is purplish in all specimens seen.

Alt. 23, diam. 28.5 mm.

Alt. 19, diam. 24 mm.

Irazuyama, Tosa. Types No. 85,740, A. N. S. P., from No. 1,100 of Mr. Hirase's collection.

Eulota (Acusta) despecta ikiensis n. subsp.

A small, rather thin, globose race, less depressed than *E. d. kikaiensis*, thinner, and with no roseate streaks, the peristome not pink-lipped, though the columella is pale flesh-tinted. It is weakly, irregularly wrinkle-striate, showing traces of spiral striation in places; pale yellowish-corneous or greenish, with narrow yellowish-brown streaks, the early whorls delicately flesh-tinted.

Whorls 5 to 5⅓.

Alt. 15, diam. 15 mm.

Alt. 14, diam. 14 mm.

Yawata, Iki. Types No. 84,881, A. N. S. P., from No. 1,087 of Mr. Hirase's collection.

Eulota (Acusta) despecta prætenuis n. subsp.

This form is *very thin* and light, like *E. sieboldiana*, from which it differs by the decidedly open umbilicus (like that of *E. despecta*) and by being distinctly decussate throughout, with close spiral striæ crossing the oblique, irregular growth-wrinkles. Whorls 5½. Color light greenish-yellow or yellowish-green.

Alt. 20.5, diam. 25 mm.

Alt. 21, diam. 23.5 mm.

Kuchinoerabu-shima, Ōsumi. Types No. 87,559, A. N. S. P., from No. 394*a* of Mr. Hirase's collection.

This is one of those perplexing forms which unite characters of two very distinct species. It might be treated as a subspecies of *E. sieboldiana*, of *E. despecta*, or a distinct species, according to the weight one places upon this or that feature. Indeed, one of us had provisionally ranked it under *sieboldiana* as a variety. Its geographic location is between the areas of the two Japanese Acustas—*E. sieboldiana* ranging from Kyūshu north, and *E. despecta* inhabiting the Riukiu Islands.

Eulota nioyaka n. sp.

Shell umbilicate, globose-depressed, thin, glossy, pale yellowish-corneous, faintly marked with fine growth-wrinkles. Spire low conoid; whorls 5, convex, the last rounded peripherally, convex below, slightly descending in front. Aperture roundly lunate, oblique, the peristome white, thin, expanded and narrowly reflexed.

Alt. 6, diam. 8.6, width of umbilicus 1.5 mm.

Alt. 6, diam. 8 mm.

Alt. 5.8, diam. 7.6 mm.

Toba, Shima. Types No. 87,656, A. N. S. P., from No. 5*a* of Mr. Hirase's collection.

This is a larger species than *E. commoda* A. Ad., with less conic spire and better developed peristome.

Trishoplita nitens n. sp.

Shell umbilicate, depressed, with very low conoid spire, obtusely angular periphery and convex base; thin, glossy, rather bright greenish-yellow, the earlier whorls denuded and bluish-white. Surface weakly marked with wrinkles along growth-lines, and showing some very faint spiral striæ on the base. Whorls 5, slowly increasing, the last wide, slightly deflexed in front. Aperture oblique, oval-lunate, the peristome thin, narrowly expanded.

Alt. 6.5, diam. 11.5, width of umbilicus 2 mm.

Tokunoshima, Ōsumi. Types No. 87,598, A. N. S. P., from No. 1,231 of Mr. Hirase's collection.

A very bright, glossy and depressed species, of a genus not before reported from any island south of Kyūshu.

Chloritis obscurus n. sp.

Shell umbilicate, somewhat depressed, the spire low-conoidal; thin, and dull, dark brown. Surface lusterless, slightly striate and indistinctly punctate in places, the points bearing no hairs and rather irregularly spaced. Whorls nearly 5, the last about double the width of the preceding, very slightly descending at the aperture, rounded at the periphery. Aperture broadly lunato-oblique, the peristome thin, brown, narrowly expanded throughout, more broadly dilated at the umbilical insertion.

Alt. 9, greater diam. 13, lesser diam. 11.3 mm.; umbilicus 1.8 mm. wide.

Tokunoshima, Ōsumi. Type No. 1,227 of Mr. Hirase's collection.

Surface × 25 ; one square millimeter indicated.

A small, dull species, known by a single specimen, but very unlike any other Riukiuan or Japanese species yet known. The convex spire and expanded lip, as well as the very obscure punctulation, are its more prominent characteristics.

The surface under a strong magnification is seen to be very densely, microscopically, irregularly granulate (this sculpture too small to be shown in the figure), and set with low, rounded or oblong grains arranged more or less obviously in oblique lines, in most places less regular than where the figure was taken, on the upper part of the last whorl, a short distance behind the aperture. The whitish apical whorl seems to be slightly rugose, but not punctate.

Chloritis tosanus osumiensis n. subsp.

This form agrees in shape and color with *C. tosanus*, but it differs in being smaller, with the hairs a little more widely spaced. The spire is somewhat convex, with the apex turned down; whorls 4; lip thin and sharp.

Alt. 9, diam. 14.5 mm.

Koneshima, Ōsumi. Types No. 87,339, A. N. S. P., from No. 1,248 of Mr. Hirase's collection.

Koneshima is a place on the western coast of Ōsumi, on Kago-shima Bay, about opposite the southern extremity of Satsuma.

Ganesella tokunoshimana n. sp.

Shell narrowly umbilicate, globose-conoidal, thin, the outlines of the spire convex, apex very obtuse. Yellow, with (1) four black-brown bands, a narrow one below the suture, a wide one at and above the periphery, a narrower band midway between periphery and umbilicus, and a fourth band inside the umbilicus, or (2) very pale reddish-brown fading to yellowish near the suture and on the base, with a narrow light band at the periphery.

Surface glossy, the first 2 whorls smooth; then faint growth-lines and spiral striæ appear; these become progressively stronger, the last whorl being covered with close incised spirals. Whorls $5\frac{1}{2}$, convex, the last but slightly or not deflexed in front, angular or subangular at the periphery in front, becoming rounded on the last half or third, convex beneath. The aperture is oblique, widely lunate, colored within like the outside. The lip is thin, narrowly reflexed, white, at least at the edge, dark at the ends of the bands, the columellar margin dilated.

Alt. 21, diam. 26 mm.

Alt. 22, diam. 26.2 mm.

Tokunoshima, Ōsumi. Type No. 87,595, A. N. S. P., from No. 1,213 of Mr. Hirase's collection.

This beautiful species stands close to *G. adelinæ* of Ōshima and *G. sororcula* of Kikaiga-shima, but differs from both in the obtuse spire, the early whorls being depressed. It is less closely related to *G.*

largillierti of Okinawa, that species having the umbilicus far smaller, no noticeable spiral striation, and a conic spire.

Ganesella myomphala okinoshimana n. subsp.

Shell imperforate, smaller than *G. myomphala,* with a much wider (1.5 to 2 mm.) peripheral dark band. Whorls $6\frac{1}{4}$ to $6\frac{1}{2}$.

Alt. 23.5, diam. 31 mm.

Alt. 18.5, diam. 28 mm.

Okinoshima, Tosa. Types No. 80,822 and 87,644, A. N. S. P., from No. 583 of Mr. Hirase's collection.

Like *G. m. minor* Gude, of Awaji, this is a small insular form, but doubtless independently evolved.

Ganesella selasia textilis n. subsp.

Similar to *G. selasia* in the somewhat triangular aperture and rather large umbilicus, but differing in the following respects: The spire is lower, more convexly conoidal; the surface is very minutely, obsoletely and irregularly granulose in places, and there are irregular spiral lines on the base, especially near the umbilicus; just above the periphery there is a very faint brown band; and, finally, the lip is white and thicker than in *selasia.* Whorls about $5\frac{1}{2}$, the last slightly deflexed in front and noticeably contracted behind the peristome.

Alt. 12.5, diam. 17 mm.

Alt. 12.7, diam. 16.5 mm.

Arakura, Tosa. Types No. 84,778, A. N. S. P., from No. 1,035 of Mr. Hirase's collection.

Ganesella selasia zonata n. subsp.

The shell is much more depressed than *G. selasia* or *G. s. textilis,* openly umbilicate, with low, convexly conoid spire and depressed last whorl, which is almost angular in front. Surface glossy, very minutely and densely but subobsoletely granulose. Whorls about $5\frac{1}{4}$, the last wide, slightly deflexed in front, and usually somewhat contracted behind the peristome. The aperture is subtriangular, the lip white and somewhat thickened. The shell is light brown or corneous-brown, with a narrow brown band immediately above the periphery, and ascending the spire just above the suture.

Alt. 14, diam. 19.6 mm.

Alt. 13, diam. 18 mm.

Amasaki, Tosa. Types No. 85,728, A. N. S. P., from No. 1,107 of Mr. Hirase's collection.

The low spire gives this subspecies an appearance very different from *G. selasia.* It is much more closely related to *G. s. textilis;* and it has affinity to *G. wiegmanniana,* also a Shikoku species; but both *zonata* and *textilis* differ from *wiegmanniana* in minute sculpture and in the somewhat triangular shape of the mouth—characters allying them to *selasia* of Kii. It is quite impossible at present to fix definitely the status of many of these forms, which often have affinities with several very dissimilar species. In the series of *selasia, textilis, zonata* and *wiegmanniana* the umbilicus is much larger than in *G. japonica, G. ferruginea* and the forms grouping around them.

STREPTAXIDÆ.

Ennea iwakawa miyakojimana n. subsp.

This race resembles *E. i. oshimana,* but the parietal lamella is longer and more slender and approaches nearer to the upper palatal tubercle. The striation is finer and closer. Whorls 8.

Length 4, diam. 1.7 mm.

Miyakojima, Riukiu. Types No. 87,637, A. N. S. P., from No. 1,300 of Mr. Hirase's collection.

VERTIGINIDÆ.

Vertigo hirasei glans n. subsp.

Shell shorter than *V. hirasei,* with the suture less impressed. Teeth practically typical.

Okinoerabushima, Ōsumi. Types No. 87,689, A. N. S. P., from No. 1,261 of Mr. Hirase's collection.

Vertigo hirasei okinoerabuensis n. subsp.

Shell larger than *V. hirasei,* with 4½ whorls. There is an upper palatal plica developed in addition to the teeth present in *V. hirasei.* Color pale brownish-corneous, translucent. Length 1.7 mm.

Okinoerabushima, Ōsumi. Types No. 87,690, A. N. S. P., from No. 1,261*a* of Mr. Hirase's collection.

Pupa insulivaga n. sp.

Shell very small, *cylindrical,* obtuse at the ends, ashy-brownish, thin and smooth. Whorls 6⅓, convex, separated by an impressed suture. Aperture truncate-ovate, with an obtuse, wide, deeply seated columellar prominence, and a short lower palatal fold in the throat. The peristome is thin, just perceptibly expanded at the edge; right margin straightened in the middle, arcuate above.

Length 1.7, diam. .8 mm.

Yoronjima, Ōsumi. Types No. 87,624, A. N. S. P., from No. 1,264 of Mr. Hirase's collection.

This minute, cylindrical species is very unlike any hitherto known from the region, but closely resembles *P. minutissima* Hartm. of central

Europe. The latter, however, is a slightly larger species with strongly striate surface, while *insulivaga* is smooth. The palatal plica also differentiates the snail of Yoronjima from its European relative.

ZONITIDÆ.

Trochomorpha cultrata n. sp.

Shell openly umbilicate, much depressed, the spire low-conic, base convex; light reddish-brown, rather thin. Surface slightly shining, very minutely striate, the lower surface most minutely decussate with spiral striæ. Whorls $6\frac{3}{4}$, the first two convex, the rest convex below the suture, concave above the following suture. Last whorl very acutely carinate, concave above and below the keel, distinctly angular around the conic umbilicus. Aperture small, oblique, rhombic, with thin, unexpanded peristome.

Alt. 7, diam. 20 mm.

Tokunoshima, Ōsumi. Types No. 87,502, A. N. S. P., from No. 631*a* of Mr. Hirase's collection.

This species is much more depressed than *T. gouldiana*, with much more widely open umbilicus. *T. horiomphala* Pfr. is a still more depressed species, with a distinct keel around the umbilicus.

Trochomorpha cultrata esuritor n. var.

Similar to *T. cultrata*, but decidedly smaller, and somewhat less depressed.

Alt. 6, diam. 16.5 mm., whorls $6\frac{1}{2}$.

Okino-Akimejima, Ōsumi. Types No. 87,518, A. N. S. P., from No. 1,246 of Mr. Hirase's collection.

Sitala insignis n. sp.

Shell imperforate, trochiform, thin and fragile, pale yellowish. Surface minutely striate spirally, and with rather coarse, low wrinkles of growth. Whorls nearly 3, the first $1\frac{1}{2}$ very convex, the rest flatly sloping, the last whorl acutely carinate, base convex. Aperture large, very oblique, angular at the position of the keel, the peristome thin and simple.

Alt. 1, diam. 1.7 mm.

Irazuyama, Tosa. Types No. 87,530, A. N. S. P., from No. 1,179 of Mr. Hirase's collection.

This is a remarkable species, not like any other Japanese or Indian *Sitala* known to us. Though very small, it seems to be mature, and could not be the young of any known species of the region.

Sitala latissima conica n. subsp.

Similar to *S. latissima*, but paler and more elevated.

Yoronjima, Ōsumi. Types No. 87,573, A. N. S. P., from No. 953*b* of Mr. Hirase's collection.

Kaliella kikaigashimæ n. sp.

Shell imperforate, thin, pale yellowish, somewhat translucent, glossy; trochiform, the outlines of the spire nearly straight, the periphery rounded, and the base convex. Whorls nearly 5, convex, parted by a deeply impressed suture. Aperture broadly crescentic, the columella subvertical, with reflexed edge.

Alt. 3, diam. 3.5 mm.

Kikaiga-shima, Ōsumi. Types No. 87,578, A. N. S. P., from No. 1,063 of Mr. Hirase's collection.

This species is quite unlike any reported hitherto from the Riukiu Islands. It is much larger than *K. bimaris*, the most nearly related of the Riukiu species, the color is paler and the aperture a more ample crescent. It is the first *Kaliella* to be found on Kikaiga-shima.

Kaliella humiliconus n. sp.

Shell perforate, amber-colored, somewhat dull above, glossy beneath; conic above the spire with nearly straight, slightly convex lateral outlines and obtuse apex, the periphery carinate, base convex. Whorls 5½, convex, separated by an impressed suture. Aperture truncate-crescentic, the columella vertical, its edge dilated and reflexed.

Alt. 2.6, diam. 3.6 mm.

Gokashomura, Ise. Types No. 87,928, A. N. S. P., from No. 1,169 of Mr. Hirase's collection.

This species is closely related to *K. sororcula*, but is smaller and has a vertical, not sloping columella. It is not so elevated as *K. higashiyamana*.

Kaliella okinoshimana n. sp.

Shell imperforate, trochoidal, elevated, amber colored, subtranslucent, glossy. The outlines of the spire are very slightly convex, nearly straight. Apex obtuse; the periphery has a delicately projecting acute keel, and the base is convex. Whorls 6½, slightly convex. Suture narrowly margined above. The aperture is squarish-oblong, a little curved. Columella short, subvertical, with dilated edge.

Alt. 4, diam. 4.7 mm.

Okinoshima, Tosa. Types No. 87,929, A. N. S. P., from No. 1,182 of Mr. Hirase's collection.

This species stands near *K. sororcula*, but it has a more glossy surface and the columella is vertical. It is a larger and more elevated shell than *K. humiliconus*.

Kaliella bimaris n. sp.

Shell small, subperforate, brownish-yellow, rather dull above, glossy beneath; trochiform, the outlines of the spire slightly convex, the periphery rounded, base convex, deeply indented in the middle. Whorls $5\frac{1}{3}$, very convex, parted by a deeply impressed suture. Aperture lunate, the columellar margin broadly dilated and reflexed.

Alt. 2.1, diam. 2.3 mm.

Naha, Okinawa Island, Riukiu. Types No. 87,580, A. N. S. P., from No. 1,160 of Mr. Hirase's collection.

This species is intermediate in shape between *K. pagoduloides* and *K. modesta.*

Kaliella gudei persubtilis n. subsp.

Similar to *K. gudei* of southern Yesso, but perceptibly lower and wider.

Alt. 5, diam. 7 mm.

Toshima, Izu. Types No. 85,766, A. N. S. P., from No. 1,091*a* of Mr. Hirase's collection. Also Kōzujima, Izu, No. 1,091.

The islands of Izu have a fauna of great interest, though it is not rich in species. Some forms, like *Zaptyx* in the Clausiliidæ and the varieties of *Eulota submandarina*, show close affinity to the Riukiu fauna, and can scarcely have reached these islands in any other way than by drift along the Black Current. Others, like the present species, are related to Yesso forms, and probably indicate a former extension southward upon the main island of species now northern in distribution.

Kaliella pallida Pils.

This species was described from Hachijo-jima, Izu, in error. It comes in reality from Mizuma-mura, Izumi. The types are 83,378, A. N. S. P., from No. 952 of Mr. Hirase's collection.

Microcystina vaga n. sp.

Shell almost imperforate, depressed trochiform, amber-colored, subtransparent, smooth and glossy. Spire low-conic with convex outlines. Whorls 6, convex, slowly increasing, the last subangular at the periphery, convex beneath. Aperture lunate, the columella thickened with a white callous within, dilated and reflexed above.

Alt. 3.1, diam. 4.3 mm.

Muya, Awa, Shikoku. Types No. 84,439, A. N. S. P., from No. 1,006 of Mr. Hirase's collection. Also from Iwaya, Awaji (No. 1,006*a*), Midzuma, Idzumi (606*c*), Gojo, Yamato (606), and Hakusan, Kaga (973).

There are more whorls than in *M. tanegashimæ. M. obtusangula* is a more depressed species.

Microcystina lampra n. sp.

Shell perforate, depressed-trochiform, pale amber colored, subtransparent, smooth and glossy. Spire low-conoid, with slightly convex outlines; apex obtuse. Whorls $5\frac{1}{2}$, convex, slowly widening, the last rounded at the periphery, convex beneath. Aperture crescentic; columella arcuate, calloused within, the margin dilated and narrowly reflexed above.

Alt. 2.9, diam. 4 mm.

Yakushima, Ōsumi. Types No. 87,558, A. N. S. P., from No. 1,282 of Mr. Hirase's collection. Also No. 1,282*a* from Kuchinoerabushima, Ōsumi.

This species closely imitates *M. vaga*, but it is readily distinguishable by the rounded, not angular, last whorl. The whorls are more closely coiled than in *M. tanegashimæ*, and larger than *M. yakuensis*. Some specimens from Matsubara-mura, Echizen (Mr. Hirase's No. 606*b*), where *M. vaga* would be expected, seem to be *M. lampra*.

This group of species is somewhat difficult. *M. tanegashimæ* is a larger species than *M. yakuensis*, more depressed than *vaga* or *lampra*, with fewer whorls, the last one wider. *M. yakuensis* is probably identical with *M. nuda*, and both stand close to *M. hilgendorfii* Reinh.; but that is described as whitish—"albida"—while the others are yellow or amber colored. *M. circumdata* differs from all of the above species in being spirally striate.

Macrochlamys dulcis koshikijimana n. subsp.

This form has the shape and microscopic spiral striation of *M. dulcis* Pils., with the same number of whorls, but the spire is more elevated, and viewed from above it is wider.

Alt. 7, greater diam. 12, lesser 10.5 mm.; width of spire 7 mm.

Shimo-Koshikijima, Satsuma. Types No. 87,521, A. N. S. P., from No. 1,236 of Mr. Hirase's collection.

In a specimen of *M. dulcis* of the same diameter the spire is a millimeter narrower.

Macrochlamys subelimatus n. sp.

Shell perforate, depressed, pale yellow, translucent, smooth and glossy. Spire very low-conic. Whorls $4\frac{1}{2}$, slowly increasing, the last very wide, double the width of the preceding, rounded at the periphery and base, indented around the perforation. Aperture slightly oblique, lunate, the lip thin and simple, a trifle dilated at the columellar insertion.

Alt. 2.5, diam. 4 mm.

Tokunoshima, Ōsumi. Types No. 87,553, A. N. S. P., from No. 1,286 of Mr. Hirase's collection.

This species differs from *M. semisericatus* by the more glossy upper surface. It has a half whorl more, the last one embracing more of the preceding whorl, causing the aperture to be more narrowly lunar. The last whorl is much wider, viewed from above, than in the species of *Microcystina* of similar size.

Macrochlamys gudei inclytus n. subsp.

Shell similar to *M. gudei,* but larger.

Alt. 9, diam. 13.5 mm.

Tokunoshima, Ōsumi. Types No. 87,509, A. N. S. P., from No. 1,208 of Mr. Hirase's collection.

Zonitoides apertus n. sp.

The shell is depressed, widely, openly umbilicate, the spire but slightly convex. Pale greenish corneous-brown when fresh, "dead" shells light brown. Surface glossy, closely, deeply and a little irregularly striate throughout except the first whorl which is nearly smooth. There are no spiral striæ. Whorls 4, slowly increasing at first, the last whorl much wider, double the width of the penultimate, rounded at the periphery. Aperture oblique, oval-lunate, decidedly wider than high, the peristome simple as usual.

Alt. 2.1, diam. 4.7 mm.

Okinoerabushima, Ōsumi. Types No. 87,522, A. N. S. P., from No. 1,258 of Mr. Hirase's collection.

Very distinct by its discoidal form, wide last whorl and strongly striate surface.

Hirasea insignis n. sp.

Shell imperforate, depressed, with low-conic spire and convex base, impressed in the center. Brown. Very finely and regularly striate radially above, smooth below. Whorls 5, convex, very slowly widening. Aperture crescentic, narrow, the lip strengthened by a strong white rib within, abruptly stopping short of the upper insertion. A long, erect callous lamina stands at the edge of the parietal callous.

Alt. 2, diam. 3.5 mm.

Mukojima, Ogasawara. Types No. 87,514, A. N. S. P., from No. 1,194 of Mr. Hirase's collection.

Like *Brazieria* in its parietal barrier, and the only known Ogasawaran species with this structure.

ENDODONTIDÆ.

Punctum atomus n. sp.

Shell minute, moderately umbilicate, pale yellow, glossy, sculptured with sharp, close striæ and very fine spirals. Whorls 3, convex, separated by a deeply impressed suture, the last whorl well rounded at the periphery and beneath. Aperture rounded-lunate, the lip simple and acute.

Alt. .5, diam. 1 mm.

Nishigo, Uzen. Types No. 87,933, A. N. S. P., from No. 1,266 of Mr. Hirase's collection.

This species is the size of *P. japonicum* or somewhat smaller, but differs from that by its fine sculpture, without wide-spaced riblets.

Punctum rota n. sp.

Shell moderately umbilicate, pale greenish-corneous or olive-brown, shining, sculptured with delicate, wide-spaced oblique riblets, the intervals finely striate. Spire low-conic. Whorls $3\frac{1}{2}$, convex, the last rounded peripherally and beneath. Aperture quite oblique, rounded, nearly one-third of the circle excised by the penultimate whorl. Peristome thin, the columellar margin dilated at the insertion.

Alt. 1, diam. 1.7 mm.

Nishigo, Uzen. Types No. 87,930, A. N. S. P., from No. 1,191 of Mr. Hirase's collection. Also occurs at Kyoto, Yamashiro, No. 1,221 of Mr. Hirase's collection.

This form is more elevated and more rounded peripherally than *P. pretiosum* Gude. The umbilicus is larger than in *P. morseanum*. Very similar specimens, but of perceptibly darker brown color, were collected on Okinoerabushima, Ōsumi. Although so distant from the type locality, I can find no other distinctive characters.

ACHATINIDÆ.

Opeas brevispira n. sp.

Shell openly perforate, oblong, very short for the genus, corneous, translucent, glossy, finely wrinkle-striate, the striæ arcuate. Spire short, regularly tapering to the obtuse apex. Whorls $5\frac{1}{2}$, moderately convex. Aperture long, rhombic-ovate, the outer lip arched forward in the middle, columellar lip reflexed, not adnate except at the insertion, columella straight.

Length 6, diam. 3, length of aperture 2.6 mm.

Kashima, Harima (Mr. Y. Hirase). Types No. 79,097, Coll. A. N. S. P.

Similar to *O. kyotoensis* in the obtuse apex, open perforation and striation, but differing in being very much shorter and broader. The short contour is quite unusual in this genus.

Opeas kyotoensis n. sp.

Shell almost imperforate, turreted, translucent, waxen whitish, glossy, arcuately, inconspicuously wrinkle-striate, smoother below. General slope of the sides straight, apex very obtuse. Whorls $7\frac{1}{2}$, quite convex, separated by deeply impressed sutures. Aperture slightly oblique, somewhat effuse below; outer lip sinuous, thin; columella straight, vertical, the edge reflexed and appressed except for a minute umbilical chink.

Length 10, diam. 3.3, longest axis of aperture 3.3 mm.

Length 7, diam. 2.8, longest axis of aperture 2.7 mm.

Kyoto, Yamashiro. Types No. 78,757, A. N. S. P.

The chief character of this species is its blunt, rounded apex. It is very near *O. prestoni* Sykes of Ceylon, but that species is a little less striate and perceptibly more glabrous.

Opeas obesispira n. sp.

Shell minutely perforate, turreted, translucent, whitish corneous, the columella visible through the shell; glossy with faint, arcuate wrinkles. *Lateral outlines decidedly convex above.* Whorls about $8\frac{1}{2}$, moderately convex, separated by impressed sutures, which appear to have a translucent margin below. Aperture subvertical; outer lip thin, arched forward in the middle, somewhat retracted below. Columella subvertical, with a distinct spiral twist below; its edge reflexed above.

Length 12, diam. 3.3, longest axis of aperture 3.3 mm.

Riukiu. Types No. 79,093, A. N. S. P., from No. 456*b* of Mr. Hirase's collection.

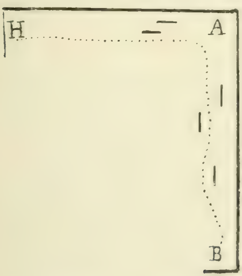
This species is smoother and less distinctly perforate than *O. gracile*, and the spire is thicker above, giving quite a different aspect to the shell. The columellar reflection is narrower than in *O. prestoni* Sykes. All of the shells seen contain rather large white eggs.

THREE ODD INCIDENTS IN ANT-LIFE.

BY ADELE M. FIELDE.

1. A case of hypnotism among ants?

I had a small artificial nest containing twelve workers of *Cremastogaster lineolata* that had spent the first month of their lives in a mixed colony of *Lasius latipes, Stenamma fulvum* and their own kind. They had then been transferred to their present abode, where they had lived for eleven months, never meeting ants of other species, except upon a few rare occasions when I introduced a visitor into their nest. On August 20, 1904, they were happily occupied in care of some promising pupæ from their old wild nest, when I dropped into their nursery a single *Lasius latipes*, somewhat larger and probably older than any of their number. She was a stranger from the wild nest of their quondam associates. As I dropped the strong-smelling, vigorous yellow worker into their nest, I glanced at my watch to note the minutes they would spend in slaying the intruder. When I looked back at the ants, I was at once impressed by the curious and sudden change in the positions of all the little black *Cremastogasters* and by the remarkable rigidity of five of them. Five were in the food-room, and they do not enter further into this narration; two were on the roof-pane of the nursery; and five were motionless under the touches of the *Lasius*, who, instead of fleeing or hiding, as do ants who are among enemies outnumbering them, was traversing two sides of the nursery at a leisurely-rapid pace from the hallway, marked H, to the corner marked A where there was a little pile of pupæ, and then on to the B corner where was a similar pile. She made more than eleven journeys to and fro, taking nearly the same track, sometimes walking over an ant or two, sometimes brushing the side of one as she passed, sometimes slightly varying her route so as to pass between two on the A B side of the nest. Whatever her course, every ant of the five swayed the abdomen slowly toward her as she passed, and swayed it back as soon as she had passed it. This swaying of the



The straight lines indicate the sides of the nest; the dotted line the path of the yellow ant; the dashes the positions of the five black ants.

abdomen, with slight movements of the antennæ, were the only signs of life given by any of the five ants during forty-five minutes. Meantime one of the other residents came down from the roof-pane, and while the yellow ant was at H with the heads of all the spellbound ones turned away from her, this solicitous sister went and touched three of the entranced ones, but failing to rouse them, she withdrew again beyond the line of the yellow visitor's march. I was observing the ants through a pane of orange-tinted glass which protected them from such light as they were aware of, and I several times lifted the pane, letting the daylight fall full upon them, but even this stimulant did not impel any of them to move.

During all this time none of the five ants that were in the food-room returned through the only ingress therefrom, the hallway H, and the young, ordinarily attended upon without intermission, were wholly neglected. The yellow ant finally stayed awhile in the hallway, and within the ensuing five minutes all the three ants between A and B began to walk slowly forward. I then shoved the other two with the end of a needle, and they also moved slowly about.

I did not again look into this nest until the following morning, when I found the yellow ant dead, and carried to the rubbish pile. I then introduced another ant of the same colony and of the same appearance, but this second ant was no Svengali, and only the expected thereupon happened.

Yet another, introduced later, came in like manner to an immediate and violent death.

2. A wolf in sheep's clothing?

I had in August, 1904, a nest of *Cremastogaster lineolata*, containing one queen, a hundred workers, and much young in the egg, larval and pupal stages. These ants had been in my care during all their lifetimes, and I know that they had never met *Lasius latipes* in active life. In the previous June I had introduced into their nest a half-teaspoonful of the larvæ of *Lasius latipes*, for them to use as food, and this alien larvæ had been taken care of, had become pupæ, and had gradually disappeared. On August 21 there hatched from what was perhaps the last of these alien pupæ a tiny *Lasius*, that the *Cremastogasters* permitted to live. Its bright amber-yellow body was very conspicuous among its jet-black associates. During several days the infant *Lasius*, of a different subfamily from its foster-sisters, shared their labors and passed unnoticed among them, and then it was nipped to death.

It is probable that this *Lasius*, having been long among the *Cremastogasters*, had acquired an overlaying of their inherent odor, concealing its own, and that it thereby escaped hostile attack until such time as it inherent odor became subject to the critical examination of an associate or of the queen. Then instinctive race-prejudice impelled the *Cremastogasters* to eliminate from their community one whose education had already been such as to secure them from injury through her misbehavior.

3. Can an ant remember acquaintances after lapse of three years or more?

In August, 1904, I had a nest of *Camponotus pennsylvanicus*, containing some larvæ and fourteen large workers, all of whom had hatched in my nests between May 1 and May 10, and who were therefore about three months old. They had spent the first two months of their lives with *Stenamma fulvum* ants who were from seven to nine months old, and they had not met ants of other species. They had been segregated about one month, when I dropped into their nest two *Formica lasiodes* of unknown age, several newly hatched *Stenamma fulvum* of the C colony, two adult *Stenamma fulvum* of the X colony and two *Stenamma fulvum* that were more than three years old, having been captured as adults and kept three years in one of my artificial nests, a section of the C colony. From the first introduction of these ants to the nest of *Camponotus*, one of the three-year-old Stenammas, who was of the same colony as were the early acquaintances of *Camponotus*, went freely and happily among them, apparently without fear and without reproach. She was permitted to stand among or upon the cherished larvæ, or on the backs of the resident ants. The affiliation between her and them was as complete as if she had always lived among them. Her odor may have become familiar to them in the nest of Stenammas where they had spent their early lives. But if this *Stenamma* had ever been acquainted with *Camponotus* it was at a time previous to her residence in my artificial nests, and more than three years since she had met any ant of other species than her own. The remarkable ease and friendliness of her intercourse with these ants, among whom she was as a brown pigmy among black bristly giants, is a fact requiring explanation; and the only explanation offered by known characteristics of ants lies in her recognition of an odor that she had previously encountered, and that she recognized the odor after the lapse of more than three years.

All the other ants introduced at the same time as was this *Stenamma* were killed by the resident *Camponotus* within a few hours. The *Stenamma* continued to live among the *Camponotus* until I removed her at the end of eight days.

The incidents were observed at the Marine Biological Laboratory at Wood's Hole, Massachusetts.

THE REACTIONS OF ANTS TO MATERIAL VIBRATIONS.

BY ADELE M. FIELDE and GEORGE H. PARKER.

While it is well established that some insects react to sound vibrations that reach them through the air, and in this sense may be said to hear, many competent authorities, such as Huber (1810), Perris (1850), Forel (1874, 1900), and Lubbock (1894), have admitted their inability to bring to light any evidence that ants are thus stimulated. Even the discovery of the so-called chordotonal organs in ants by Lubbock (1894) and Janet (1894) has not led to positive results, so far as the reactions of these animals to material vibrations are concerned, though two American investigators, Weld (1899) and Metcalf (1900), have claimed that ants are very sensitive to certain tones.

Because of these somewhat conflicting opinions, it seemed to us desirable to reinvestigate this question,[1] and for this purpose we carried out experiments on the following species of ants:

Camponotine ants:

Camponotus pennsylvanicus (Deg.), workers;
Formica sanguinea Latr., queens and workers;
F. fusca L., var. *subsericea* Say, queens and workers;
Lasius umbratus (Nyl.), queens and workers;
L. latipes (Walsh), workers.

Myrmicine ants:

Stenamma fulvum Roger, var. *piceum* Emery, queens and workers;
Cremastogaster lineolata (Say), queens and workers.

Ponerine ants:

Stigmatomma pallipes (Haldm.), workers.

All these ants had lived more than a month in the artificial nests in which they were tested. They had established their nest-odor, had their young in charge and were well domesticated in their respective abodes.

These ants were tested for two general classes of material vibrations: first, those that reached them through the air surrounding them, and, secondly, those from the solid base upon which the ants rested.

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[1] These investigations were made in the summer of 1903, at the Marine Biological Laboratory, Woods Hole, Mass.

As sources for air vibrations we used a piano, a violin, and a Galton whistle. The keys of the piano gave us a range from 27 to 4176 vibrations per second. The Galton whistle had a range from about 10,000 to about 60,000 vibrations per second, and was provided with a movable threaded core whereby any intermediate vibration could be obtained. The range from the highest note of the piano, 4,176, to the lowest one of the whistle, about 10,000, was bridged over by vibrations obtained from the violin. Thus a series of vibrations from 27 to 60,000 per second were available for experimental purposes.

In testing the ants with these vibrations the artificial nests were so arranged that their air was in free communication with the outer air in which the vibrations were produced, but this was carried out in such a way that draughts, to which ants are very sensitive, could not enter the nests. The nests were placed upon thick paper, so as to isolate them from vibrations that might reach them through the table upon which they rested. The observer then closely watched a quiescent ant under a hand magnifier, while a second person at several metres distance produced the vibrations as desired. As a rule, each key of the piano was struck ten times in slow succession. If the ant under observation seemed to respond, it was given a resting period, and then retested at the pitch to which it apparently reacted. The range of the whistle, 10,000 to 60,000 vibrations, was divided into sixty intervals, and these were treated as the keys of the piano, each note being blown ten times while an ant was under observation. Ants were also watched while the pitch of the whistle was gradually changed by slowly screwing the core either in or out. A gradual change of pitch was also produced on the violin.

All the species mentioned as tested by us were subjected to this range, 27 to 60,000 vibrations per second, and in no single instance was any unquestionable reaction observed. Now and then an ant would seem to respond to a given note, but in every case repetitions of the experiment gave a negative result. We, therefore, conclude that aerial vibrations between 27 and 60,000 per second give rise to no observable responses in the ants we worked upon, and as these included representatives of three subfamilies of the Formicidæ, it is highly probable that a like condition will be found among other ants.

Our results, then, agree with those of Huber, Perris, Forel and Lubbock, but are opposed to what is stated by Weld and by Metcalf. In one instance we worked upon the same species as Weld, namely, *Cremastogaster lineolata*, and tested it with a note approximately that used by Weld (4,096 vibrations), but obtained from the piano and from the violin instead of from a metal bar. Nevertheless we got no reaction. Weld does not make clear that his ants were always isolated from all except aerial vibrations, nor that their reactions were constant under repeated stimulation. It seems to us possible that his ants may have reacted at times to vibrations of the solid base upon which they rested and to which, as we shall show presently, they are very sensitive, or their supposed reactions may have been accidental. Certainly our own experimental evidence gives us not the least reason to suspect that ants are stimulated by sound waves in air.

Having reached this conclusion we next endeavored to ascertain whether ants would respond to vibrations of the solid base upon which they stood. When a nest containing *Stenamma fulvum* was held in the air within a centimetre or so of the woodwork of a piano, and the C, giving 261 vibrations per second, was struck, no response followed. When, however, the nest was allowed to rest on the woodwork and the note was again sounded, almost all the ants started forward simultaneously. Thus a vibration that comes to an ant through the air is not necessarily followed by a reaction, though the same vibration when it reaches the ant through a solid may be very stimulating. All the eight species of ants with which we experimented were thus stimulated, though they failed to react to the same vibrations in the air. The range of the different species was by no means uniform. All reacted to the 27 vibrations per second and to higher notes up to a certain pitch characteristic for each species. *Cremastogaster* reacted at 522, but to no higher note. The superior limit for *Formica fusca*, var. *subsericea* was 1,044, and for *Lasius latipes* and *Stigmatomma* 2,088. *Stenamma* always reacted at 2,088, usually at 3,915, but failed at 4,176. *Camponotus* regularly reacted at 3,480, but failed at 4,176. *Formica sanguinea*, which invariably responded at 2,088, occasionally did so at 4,176, a pitch regularly reacted to by *Lasius umbratus*. Thus each species seemed to have a characteristic superior limit for stimulating vibrations received through solids.

Ants are not only sensitive to the tones of a piano transmitted through a solid, but they are also sensitive to vibrations from other sources similarly transmitted. This is well seen in the following experiment on *Stenamma*. When the edges of two Petri dishes were rubbed against each other in the air, the ants did not respond; but when the edge of the dish in which the ants were held was rubbed even lightly by the edge of another dish, they reacted with great precision. These reactions occurred even when the Petri dish containing the ants was floating on water and the edge of the vessel containing the water was rubbed. Some idea of the delicacy of these reactions may be gained from the fact that ants in a Petri dish resting on a pine table-top reacted to the scratch of a pin on the table at a distance of ten feet from the dish. A measure of the stimulus necessary to call forth the most delicate reaction, usually a jerking movement of the antennæ, was obtained in the following way: A small artificial nest was built on the end of a long board clear of knots and, after the ants had become accustomed to their nest, stimuli were introduced by dropping a shot weighing half a gram on the board at different distances from the nest and from different heights. It was found that the ants reacted to a blow given to the board 4.3 metres (14 feet) from the nest when the shot fell from a height of 15 centimetres (6 inches), but that they did not react when it fell through only half that distance.

Ants not only react to material vibrations received through wood, glass, water, etc., but they will also react to such vibrations when resting on a bit of sponge in an artificial nest or on the soil in which they construct their nests. Thus ants within their natural earth nests may be stimulated by the vibrations of the material on which they stand, though they will not respond to similar vibrations in the air about them.

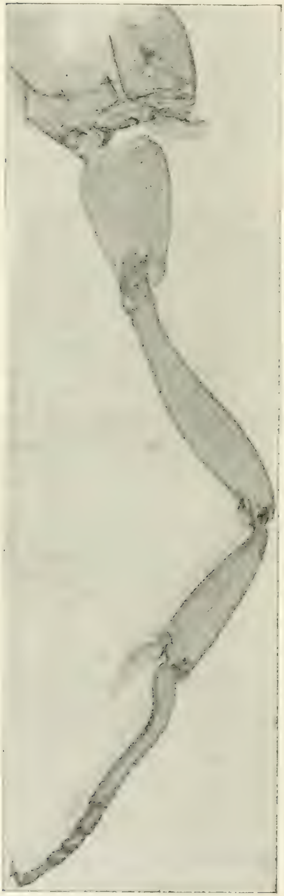
To ascertain what parts of the body of the ant are concerned in its reaction to the vibrations of non-gaseous materials, we performed experiments on a number of individuals of *Stenamma fulvum piceum* that had been deprived of portions of the body.

All the mutilated ants, except those lacking heads or abdomens, had undergone the necessary surgical operations so long as three or four weeks previous to the experiments, and had therefore had time for full recovery from shock-effects.

The irritability of workers deprived of their funicles, or of the whole of the antennæ, was such as to make it necessary to isolate each in order to prevent mutual slaughter, though all were of the same colony. This irritability continued even after they had recovered from shock-effect, had become alert and active, and had been more than a month without funicles, or without both funicles and scapes. Queens similarly mutilated were scarcely more irritable than when in normal condition, and nearly all of the thirty operated upon survived the operation more than two months and laid eggs.

Queens and workers deprived of only one antenna were no more irritable than normal ants, and hardly any deaths resulted from this mutilation, while not more than twenty per cent. of the workers survived the loss of either both funicles or both antennæ.

Queens and workers deprived of a pair of legs, the amputation being made at the coxal joint (see figure), lived in groups as amicably as do whole ants, and there was little loss of life through this operation. The delicate structure of the leg manifestly renders it a probable communicator of vibration from any solid with which it might be in contact.



Prothoracic leg of a young *Stenamma fulvum piceum.* × 48.

There was throughout a direct ratio between the degree of irritability produced and the percentage of deaths consequent upon the surgical operations. The operations were as far as possible carried out aseptically and careful nursing was attempted for all cases.

The mutilated ants were tested in Petri dishes, first by scratching together in the air the edges of two Petri dishes to ascertain whether the ants were stimulated by air vibrations, and next by gently scratching the edge of the dish in which the ants were. As might be expected, no reaction was ever obtained from mutilated ants submitted to air vibrations. The reaction of the ants to the vibrations of the dish containing them and the states of the ants, so far as the operations that they had undergone were concerned, are given in the following summary:

1. Queens from which both funicles had been removed reacted by slight locomotion, usually moving backward or sidewise, rarely forward.

2. Queens from which one antenna had been removed reacted like normal queens by forward, backward or sidewise locomotion.

3. Queens deprived of the whole of both antennæ reacted by moving backward or sidewise.

4. Workers deprived of both funicles moved forward, backward or turned sidewise.

5. Workers deprived of one antenna moved forward or turned sidewise, as did the normal workers.

6. Workers without antennæ moved forward or backward or turned sidewise.

It is thus evident that the antennæ are not essential to the reactions of these ants to vibrations from a solid, for the ants invariably reacted irrespective of the conditions of the antennæ, and the slight differences in the nature of their reactions seem to us insignificant of the function of hearing in parts removed. This opinion, that the antennæ are not essential to these reactions, is in accord with certain observations on normal ants. When a normal ant in a Petri dish was resting with its antennæ high in air, it was observed to react vigorously to a slight scraping on the edge of the dish, without, however, bringing the antennæ in contact with the dish.

7. Decapitated queens and workers reacted by movements of the legs, without, however, showing any determinate form of locomotion.

8. Queens and workers deprived of their abdomens reacted by moving forward or sidewise.

9. Queens deprived of any one pair of legs reacted by moving forward, backward or sidewise.

10. Workers deprived of any one pair of legs reacted by moving forward or turning sidewise.

11. Queens and workers deprived of any two pairs of legs reacted by making ineffectual efforts to walk, their direction of locomotion being very irregular.

It is thus evident that the reactions of the ants to the vibrations of the underlying solid are not dependent upon the antennæ, head, abdomen, any pair or two pairs of legs. It seems to us probable that stimulation is effected by the transfer of the vibration from the underlying solid to the body of the ant, without reference to any special sense-organ. That the various movements of the ants are true reactions, and not merely motions transferred mechanically from the vibrating base to the body of the ant, as to any small particle capable of vibrating, is seen from the fact that the body of a dead ant does not show these movements, and further that in a live ant these movements cease after the stimulus has been repeated a few times, but begin again after the ant has been allowed a resting period of at least ten minutes.

In none of our experiments was there any evidence of a directive influence exerted by the stimulus on the movements of the ant.

The observations and experiments recorded on the preceding pages lead us to conclude that ants are insensitive to air vibrations, such as are audible to us, and that they are very sensitive to the vibration of the solid material upon which they stand, be this wood, glass, sponge or the earth of their nests. These vibrations apparently affect their whole bodies, reaching them through their legs or any other part in contact with the solid base. It is of course conceivable that if an air vibration were strong enough—*i.e.*, if the sound were loud enough—it might stimulate the body of the ant directly, but apparently this is not usually the case; for, as we have already shown, sounds of ordinary intensity, which call forth no response from the ants when they reach these animals through the air, are very effective as stimuli when they reach the animal from a solid base. It therefore seems probable to us that ants in their nests are stimulated, not by the sound waves in the air of the nest, but by the vibrations of the solid parts of the nest itself. Hence the effectiveness of a heavy footstep in the neighborhood of an anthill as contrasted with the ineffectiveness of the human voice in causing an active emergence of the ants. These animals are, as it were, in the condition of a perfectly deaf person who feels through his feet the vibrations caused by a passing wagon, but cannot hear the sound it produces in the air. This sensitiveness of the ants to the vibrations of the base upon which they rest and their insensitiveness to air vibrations is exactly what would be expected from the requirements of their subterranean life as contrasted with that of aerial insects.

Because of the analogy between the ants and a deaf person we do not wish, however, to be understood to deny hearing to ants; neither do we affirm it.

It has long been recognized by physiologists, if not by the scientific public, that touch and hearing in the vertebrates are very closely related. The apparent separateness of these senses in us is due to the fact that the air waves by which our ears are usually stimulated are too slight to affect our organs of touch. If, however, we transfer our experiments to water, we at once meet with a medium in which, as has long been known, vibrations can be both heard and felt. In dealing with a like question among the lower animals it therefore seems to us misleading to attempt to distinguish touch from hearing, and we shall be more within the bounds of accuracy if we discuss the question from the standpoint of mechanical stimulation rather than attempt to set up questionable distinctions based upon human sensations. We therefore prefer to ignore the question of hearing in ants and to restate our conclusion in the form already given, that these animals are insensitive to the ordinary vibrations of air, but are very sensitive to the vibrations of the solid upon which they stand.

It seems to us probable from our experiments that the material vibrations that stimulate ants reach them in this way rather than through the air. Janet (1893; 1896, p. 19) has described an ingenious method whereby the stridulating of ants can be heard by the human ear, and Wheeler (1903, p. 66) has been able to note a faint sound when a large number of stridulating ants are collected in a bottle. Undoubtedly these stridulations are of ecologic importance to an ant community, but it is our belief, based upon our experiments, that what can be heard by the human ear through the air is probably not the vibration that affects the ants, but rather that the stridulation produces a vibration of the solid constituents of the nest, and that this vibration is the effective one in stimulating the inmates.

Summary.

1. The ants experimented upon did not react to aerial sound waves from a piano, violin, and Galton whistle, which collectively gave a range from 27 to 60,000 vibrations per second.

2. They reacted to most vibrations that reached them through the wood, glass, sponge or nest-earth upon which they stood, though different species seem to have different superior limits in respect to the rate of the vibrations.

3. These reactions are not dependent upon the funicles, the antennæ, the head, the abdomen, any pair or two pairs of legs of the ant, but are usually received through the legs, and probably affect the body of the ant as a whole.

4. The stimulation of ants by the vibration of the solid upon which they stand, and not by the vibration of the surrounding air, accords well with their subterranean life as contrasted with the aerial life of most insects.

5. It is misleading to ascribe or deny hearing to ants; they are very sensitive to the vibration of solids, not to those of air; their reactions could be as appropriately described as resulting from touch as from hearing.

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NEW CHILOPODS.

BY RALPH V. CHAMBERLIN.

Lithobius centurio sp. nov

Dorsum dark brown, the principal scuta darkened along posterior border and along middle; head a little lighter, darkened over middle caudally; antennæ light brown; legs mostly yellowish, the posterior pairs becoming darker, brown; posterior portion of venter darkest, all the scuta excepting the most anterior with a paler central circular area.

Body much narrowed anteriorly.

Posterior angles of the 9th, 11th and 13th dorsal plates produced.

Antennæ of moderate length; articles 19–22, the distal ones, excepting the ultimate, reduced.

Ocelli 22, arranged in 5 series (2, 5, 6, 6, 1+2).

Presternal teeth 2–2.

Coxæ of last two pairs of legs armed dorsally and also dorso-laterally at the furrow, which is more dorsal in position than usual. Anal legs with claw unarmed; spines 1, 3, 2, 1. Claw of penult legs armed with a single spine; spines 1, 3, 3, 1. Spines of first legs 2, 3, 2.

Coxal pores small, round, 3, 3, 3, 3.

In the male the femur of the anal legs is abruptly produced into a lobe at its distal end above, and the tibiæ is produced into a larger lobe at its proximal end above adjacent to the femoral lobe, the lobe being truncate above and somewhat bent distally. The penult legs have the tibia produced into a moderate lobe at its distal end.

Length 14 mm.; width of 10th dorsal plate 2.6 mm.

Locality.—Las Vegas, New Mexico (Prof. T. D. A. Cockerell).

One male.

Lithobius cockerelli sp. nov.

Brown to chestnut, head darkest, some dorsal scuta in one specimen with the posterior margin lined with dark and with a dark stripe along middle; antennæ concolorous with head or but little paler; legs light brown.

Angles of none of the dorsal plates produced.

Antennæ moderately long, articles 28–29, in length long and moderate.

Ocelli 15, arranged in 4 series (5, 1+4, 3, 2).

Presternal teeth 2–2, obtuse, those of each side close together and toward middle.

Three posterior pairs of coxæ armed laterally with a stout spine, unarmed beneath. Anal legs with claw unarmed; spines 1, 3, 3, 1. Penult legs with claw armed with two spines; spines 1, 3, 3, 2–1, 3, 3, 3. Spines of first legs 2, 3, 2.

Coxal pores small, round, 4, 5, 5, 5.

Claw of female gonopods entire, acute, short; basal spines 2–2, the inner shortest.

Length 22 mm.; width of 10th plate 2.6 mm.

Locality.—New Mexico (Prof. T. D. A. Cockerell).

Lithobius fungiferopes sp. nov.

Dark purple-brown, head darkest, almost black; antennæ rufous distally; legs light purple-brown proximally, yellow distally.

Posterior angles of 9th, 11th and 13th dorsal plates produced.

Antennæ short; articles 20, mostly short.

Presternal teeth 2–2.

Posterior coxæ unarmed. Anal legs with claw armed with a spine; spines 1, 1, 0, 0! Penult legs with claw armed with one spine; spines 1, 1, 0, 0. Spines of first legs 0, 0, 0!

Claw of female gonopods wide, short, tripartite; basal spines stout, acute, subequal.

Anal and penult legs of male strongly swollen; none of the joints of anal legs produced into lobes, but the fifth joint of the penult legs bearing at its distal end above a peculiar pilose process which is rounded distally and constricted at base, fungiform.

Length 5–6 mm.

Locality.—Ithaca, New York.

Not uncommon under fallen leaves in woods.

Lithobius euthus sp. nov.

Brown, the first and the last dorsal scuta darker, reddish; head reddish brown; antennæ brown to reddish brown, paler distally.

Angles of 11th and 13th dorsal plates produced in adults or sometimes nearly straight, this character being evidently variable in this form.

Antennæ short (5.4 mm.); articles 25–28, moderate.

Ocelli 8 in 3 series.

Presternal teeth 2–2.

Posterior coxæ unarmed either ventrally or laterally. Anal legs with claw armed with a single spine; spines 1, 3, 2, 0. Penult legs with claw armed with a single spine; spines 1, 3, 3, 2. Spines of first legs 1, 2, 1–1, 1, 1.

Coxal pores small, round, 4(5), 4, 4, 4.

Claw of female gonopods entire, long and acute; basal spines conically acuminate, the inner shorter.

Length 15 mm.; width 2 mm.

Locality.—Austin, Texas (Prof. J. H. Comstock).

Lithobius navigans sp. nov.

Reddish to purplish brown, the middle plates lightest; head yellow; antennæ dark brown basally, becoming yellow distally; presternum and legs yellow; venter yellowish, the first and the last plates darker.

None of the dorsal plates with posterior angles produced.

Antennæ short (2 mm.); articles 28 or 29, short.

Ocelli 12 in 3 series (5, 1 + 5, 1).

Presternal teeth 2–2, small.

Posterior coxæ unarmed beneath or laterally. Anal legs with claw armed with a single spine; spines 1, 3, 3, 1. Spines of penult legs 1, 3, 3, 1. Spines of first legs 0, 1, 1.

Coxal pores 2, 3, 3, 2–3, 4, 4, 4, small, round.

Claw of female gonopods tripartite, lobes acute, the middle longest; basal spines 2–2, short, equal, a little clavately thickened upward and then conically pointed.

Length 7 mm. (♂)–7.5 mm. (♀).

Locality.—Bermudas (Prof. J. H. Comstock).

Several specimens, ♂ and ♀. It is related to the European species *lapidicola* Mein., but is sufficiently distinct to warrant separation. In the same collection were specimens of *Lithobius provocator* Poc., *Mecistocephalus guildingii* Newp., and *Julus moreleti* Lucas, all previously reported from this locality.

Pectiniunguis montereus sp. nov.

Very similar in general appearance and structure to *P. americanus* Boll., but readily separated from this as also from the other two previously described species by the fact that the anal legs are each armed with a large claw. In *plusiodontus* Att. there is a mere vestige of a claw, while in the other species there is no trace of one.

The known species of this genus may be separated by means of the following key:

a.—Prebasal plate exposed.
 a′.—Anal legs armed with a claw, ... *montereus* sp. nov.
 b′.—Anal legs unarmed, ... *americanus* Boll.

b.—Prebasal plate not exposed.

a′.—Ventral pores not existing on segments beyond the 28th; pleural pores absent, ... *europæus* Attems.

b′.—Ventral pores on all plates from the first to the penult; pleural pores present, ... *plusiodontus* Attems.

The specimens of *montereus* examined are, in alcohol, light brown anteriorly and pale yellow posteriorly, the head being brown with the frontal region lighter. The color seems to have faded in the alcohol and in life was probably reddish.

The two individuals have respectively 59 and 61 pairs of legs. They are very gradually though conspicuously attenuated anteriorly, and strongly and rapidly attenuated posteriorly.

The cephalic plate is longer than wide (6.4: 5.8); sides nearly straight and but slightly converging caudad; the posterior angles well rounded; posterior border truncate, not mesally at all incurved.

Antennæ moderate, the ultimate article distinctly shorter than the two preceding together (1.5 : 2).

Ventral pores and last ventral plate nearly as in *americanus*.

Length of larger specimen 48 mm.

Locality.—Pacific Grove, Bay of Monterey, California.

Geophilus regnans sp. nov.

Light brown, paler posteriorly. Body wide anteriorly, attenuated gradually posteriorly.

Head large.

Cephalic plate attenuated in front of middle; anterior border broadly triangular; sides behind straight and subparallel; posterior margin wide, a little incurved mesally. Frontal plate coalesced. Prebasal plate exposed at the middle, the basal plate being a little covered by the cephalic laterally. Basal plate thrice wider than long.

Claws of prehensorial feet when closed not attaining the front margin of head; presternum in front widely angularly emarginate, unarmed; all joints and the claw unarmed.

Antennæ very short, subsparsely pilose; the ultimate article about equalling in length the two preceding together.

Sulci of dorsal scuta not deep.

Anterior spiracles oval, oblique, the first few large, the others gradually decreasing; median and posterior spiracles circular, small.

Last ventral plate very wide, its sides convexly curving, moderately converging posteriorly; posterior margin wide, gently incurved. Last pleuræ moderate in size; pores entirely covered by the ventral plate, few, small.

Anal legs stouter and much longer than the penult, armed with a long, stout claw; like the other legs, almost destitute of hair.

Pairs of legs 79–81.

Locality.—Southern California (Los Angeles, etc.).

I am inclined to think this species the *Strigamia cephalica* of Wood. But it is really a *Geophilus*, and a new name must under any conditions be given to it, as the name *cephalicus* was previously given by Wood to another species in this genus.

Geophilus cayugæ sp. nov.

Body little attenuated anteriorly, strongly attenuated posteriorly.

Cephalic plate with anterior and posterior margins truncate; angles well rounded; sides nearly straight, subparallel; longer than wide (7.4 : 6.7). Frontal plate not distinctly separated. Basal plate two and a half times wider than long.

Claws of prehensorial feet when closed barely reaching the front margin of head; presternum with chitinous lines, front margin widely angularly emarginate, unarmed; femur and claw also unarmed.

First two spiracles large, subcircular, those following circular, gradually decreasing in size caudad, the last very small.

Last ventral plate rather narrow; sides straight, converging posteriorly. Last coxæ enlarged, covered over entire exposed surface, except posteriorly, with large and small pores, of which there are 30 or more on each side.

Anal pores distinct, of moderate size.

First pair of legs much smaller and more slender than those following, the second pair somewhat intermediate in size. Anal legs stouter and much longer than the penult, each armed with a very long and slender claw.

Pairs of legs 65 (♀). Length 55 mm.

Locality.—Ithaca, New York.

Evidently close to *lanius* Bröl. In *cayugæ*, however, the anal pores are conspicuous, not concealed (absent?) as in *lanius*. Also the antennæ are relatively much shorter than in *lanius*, the cephalic plate is of a different shape, the number of pleural pores is much larger and cover the pleuræ above as well as below and laterally, and the pairs of legs number 65 (♀) as against 57 (♀) in *lanius*.

Mecistocephalus anomalus sp. nov.

Body and legs waxy yellow; head pale, somewhat reddish brown; antennæ pale yellowish brown.

Gradually attenuated from the head caudally.

Cephalic plate longer than wide in ratio of 7 : 4.75; strongly narrowed caudally, posterior margin truncate. Basal plate moderately narrowed, wider anteriorly than long in ratio of 3 : 2; pleuræ exposed in usual manner.

Antennæ not attenuated distally, all articles excepting ultimate obconic; ultimate article a little shorter than the two preceding together; length 3.2 mm.

Claws of prehensorial feet when closed reaching but slightly beyond front margin of head; presternal teeth pale, obtuse; median furrow of presternum wide, shallow, not well marked posteriorly; femora with a stout, blunt black tooth, the next two joints with small, black tubercle-like teeth, the claws with an acute tooth.

Anterior præscuta short but all distinctly exposed, the median and posterior ones long. A number of anterior dorsal scuta with a distinct median sulcus between the two lateral sulci.

The anterior ventral scuta with a deep median sulcus which does not attain the margin.

Anterior spiracle large, oval, subvertical, the second and third of similar form but smaller, those following circular, rapidly decreasing in size, those of the middle and posterior region being very small.

Last ventral plate wide, strongly narrowed caudally, the sides straight. Last pleuræ inflated, having along the edge of the ventral plate on each side a row of 4 or 5 very small pores and at a distance on middle part a clearly larger isolated single pore.

Anal pore moderate.

First pair of legs much shorter and more slender than the second. Anal legs stouter and much longer than the penult pair.

Pairs of legs 41(!). Length 22 mm.; width 1 mm.

Locality.—Pacific Grove, California.

One male.

This species cannot well be identified with the *M. limatus* of Wood, which is apparently a much larger form. Aside from other minor differences more or less uncertainly indicated by Wood's description, the number of legs of *limatus* is given as "43–44," indicating that several specimens were examined. The number 44 is, of course, an error; but it is practically certain that the number of pairs of legs, which so far as known is absolutely fixed for each species in this genus, was 43, and not the unusual number 41.

Linotænia rubelliana sp. nov.

Color in life bright red, fading in alcohol to a uniform brown, the antennæ alone remaining somewhat brighter.

Cephalic plate narrowed anteriorly, in front subnarrowly rounded, behind widely truncate. Frontal plate clearly separated. Prebasal plate well exposed. Basal plate twice wider than long, with no indication of a median furrow.

Antennæ short, attenuated distally, the ultimate joint little shorter than the two preceding together; all articles sparsely hirsute with short fine hairs.

Claws of prehensorial feet when closed falling much short of the front of the head; femora unarmed; tooth of claw large, acute; front margin of presternum deeply excavated.

All ventral scuta marked with a distinct median furrow, from the posterior end of which extends outward over each half to the sides a shallow oval impression in front of the posterior margin.

Anterior spiracle moderate, a little elongate subvertically, the second similarly shaped and but little smaller; others circular, very gradually decreasing in size caudally.

Last ventral plate very wide; sides convexly rounded, strongly converging caudally.

Last pleuræ much enlarged; pores serially arranged along and beneath the last ventral plate.

Anterior pair of legs distinctly shorter and more slender, the legs regularly increasing in size from the first to about the sixth pair.

Anal pair of legs scarcely shorter than the penult, a little more slender, armed with a claw.

Pairs of legs 71–75. Length 60–82 mm.; width of largest specimen 2.2 mm. Length of antennæ of largest specimen 4 mm.

Locality.—Pacific Grove and Palo Alto, California.

This large and handsome species cannot be the form described by Wood under the name *epileptica* from an individual captured near Puget's Sound. The latter species is apparently much more like *imperialis* Bröl., the type of which comes from near the same locality. According to the published descriptions and figures, these species agree with each other and differ from *rubelliana,* among other points, in having the prebasal plate covered and in the larger number of legs (81–83 pairs).

STUDIES IN THE ORTHOPTEROUS SUBFAMILIES ACRYDIINÆ (TETTIGINÆ), EUMASTACINÆ AND PROSCOPINÆ.

BY JAMES A. G. REHN.

The material treated in the following pages is contained in the collections of the Academy, the United States National Museum and of Mr. Morgan Hebard, of Chestnut Hill, Philadelphia. The material studied consisted of two hundred and twenty-seven specimens, representing forty-six species and thirty-one genera, of which one genus and twelve species are described as new. The author wishes to thank Dr. W. H. Ashmead, of the U. S. National Museum, and Mr. Hebard for their kindness in permitting the use of material.

Subfamily ACRYDIINÆ (*Tettiginæ* auct.).

Section **Cladonotæ.**

DASYLEUROTETTIX[1] n. gen.

Allied to *Diotarus* and *Trachytettix* Stål, but differing from the former in the presence of tegmina and wings, the rugulose vertex, deplanate and scabrous pronotum, and the truncate character of the cephalic margin of the same. From *Trachytettix* it is separated by the form of the antennæ, the unspined vertex, the longer cephalic femora and the position of the antennæ.

Form depressed, subquadrate in transverse section at the humeral angle; surface scabrous. Facial scutellum with a V-shaped longitudinal excavation, carinæ distinct, subparallel; antennæ placed against the carinæ of the facial scutellum and distant from the eyes, apex of width equal to the remainder of the appendage, vertex broad, about twice the width of one of the eyes. Pronotum truncate cephalad, produced caudad beyond the tips of the caudal femora; humeral angle prominent. Cephalic femora nearly three times as long as wide. Caudal femora heavy and with the paginæ moderately sculptured. Posterior metatarsi distinctly longer than the third tarsal joints.

Dasyleurotettix curriei n. sp.

Types: ♂ and ♀; Mount Coffee, Liberia. April, 1897. (R. P. Currie.) [U. S. Nat. Mus., No. 8111.]

Head short and broad; vertex transverse, the cephalic margin trun-

[1] δασυς rough, λευρος flat, τεττιξ grasshopper.

cate and without a distinct frontal carina; median carina of the vertex low, slightly projecting cephalad; facial scutellum longitudinal, subparallel, the margins arcuate and the costa distinctly sinuate above and below; antennæ inserted on a level with the ventral margin of the eyes, placed against the facial scutellum, when extended caudad reaching to the humeral angle of the pronotum; eyes subpyriform in outline, moderately prominent. Pronotum strongly depressed, arcuate cephalad, closely and uniformly scabrous, obscurely lineato-rugose; cephalic margin truncate; humeral angles broad, extended, depressed; lateral lobes with the elytral sinus moderately deep, inferior sinus deep and acute, caudal angle produced and apically truncate; lateral carina scabro-denticulate, obsolete cephalad of the humeral angles; median carina depressed, arcuate cephalad, caudad of the humeral angles irregularly undulate; caudal process long, subulate, extending caudad of the tips of the caudal femora. Tegmina cylindrical ovate, the surface finely tuberculate. Wings large, extending slightly beyond the apex of the caudal process of the pronotum. Ovipositor valves of the female rather short, thick, serrato-dentate. Cephalic femora moderately undulate dorsad and ventrad. Median femora undulate dorsad, trilobate ventrad. Caudal femora short, inflated, femoral lobe short and thick, dorsal carina with several subobsolete points, ventral carina with several subobsolete lobes, external pagina and dorso-lateral face decorated with strong diagonal scabrous ridges; tibiæ strongly spined, the canthi minutely serrate; metatarsi slightly exceeding the remaining tarsal joints in length, pulvilli subequal in length.

General color bistre, the wings with the cephalic margin and a large rounded spot covering the great part of the wing mummy brown, median limbs barred with cinnamon, caudal limbs more or less regularly blotched with obscure cinnamon.

Measurements.

	♂	♀
Length of body, ...	10.7 mm.	12 mm.
Length of pronotum, ...	12.5 "	13 "
Greatest width of pronotum, ...	4.8 "	5.2 "
Length of posterior femora, ...	6.5 "	7 "

This curious genus and species is represented by a series of five males and nine females, all of which are from Mount Coffee. Little variation is exhibited by the series, a slight difference in the intensity of the scabrous character of the pronotum being all that is noteworthy. I take pleasure in dedicating this species to my friend Mr. Rolla P. Currie, of the U. S. National Museum, who collected the types.

PANTELIA Bolivar.

1887. *Pantelia* Bolivar, Ann. Soc. Entom. Belg., XXXI, pp. 192, 214.

Type.—*P. cristulata* Bolivar (= *Cladonotus horrendus* Walker).[2]

Pantelia armata Bolivar.

1893. *Pantelia armata* Bolivar, Ann. Soc. Ent. France, LXII, p. 176. [Assini, Ivory Coast.]

Mount Coffee, Liberia. April, 1897. (R. P. Currie). [U. S. N. M.] Three females.

These individuals seem to agree very well with Bolivar's description except that they are somewhat larger. Two of the three specimens have the caudal process of the pronotum produced, the remaining individual having the caudal femora hardly exceeded by the pronotum. These two individuals possess well-developed wings, which extend beyond the process of the pronotum.

The genus *Pantelia* includes three species: *P. horrendus* (Walker[3]) (*P. cristulata* Bolivar), from Sierra Leone and the Ivory Coast; *P. armata* Bolivar from Liberia and the Ivory Coast, and *P. uncinata* Bolivar[4] from Caconda, Angola.

Section Scelimenæ.

SCELIMENA Serville.

1839. *Scelimena* Serville, Orthoptères, p. 762.

Included *Tetrix producta*, *harpago* and *uncinata* Serville, of which the first may be selected as the type.

Scelimena abbotti n. sp.

Type: ♀; Khow Sai Dow, Trong, Lower Siam; 1,000 feet. January–February, 1899. (Dr. W. L. Abbott.) [U. S. Nat. Mus., No. 8112.]

Closely allied to *S. producta*,[5] but differing in the smaller size, the narrower vertex, the slightly more compressed form, the uncurved character of the spines on the lateral angles of the pronotum, and in the absence of protuberances on the ventral carinæ of the posterior femora.

Size medium; form elongate; surface minutely scabrous. Head with the vertex very distinctly narrower than one of the eyes, subtruncate, declivent and rounded cephalad, median carina low but distinct; frontal costa forked between the ocelli; rami little divergent,

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[2] *Vide* Karsch, *Entom. Nachr.*, XVI, p. 27.
[3] *Catal. Spec. Derm. Salt. Brit. Mus.*, V, p. 842.
[4] *Jornal Scienc. Math. Phys. Nat. Lisboa*, 2a ser., I, p. 217.
[5] Compared with a pair of *S. producta* presented by Dr. Saussure.

when viewed laterad distinctly arcuate and sinuate dorsad; antennæ slender, about two-thirds the length of the caudal femora, inserted on a level with the ventral margin of the eyes; paired ocelli placed half-way between the vertex and the insertion of the antennæ; eyes sub-globose, quite prominent, somewhat elevated. Pronotum elongate, depressed dorsad, surface undulate with rounded boss-like elevations; cephalic margin truncate, cephalic lateral spines short and blunt; lateral carinæ parallel cephalad; lateral spines strong, depressed, directed laterad without any cephalic curve; inferior sinus rectangulate; humeral angle little extended and represented by the lateral carinæ; median carina low, fading caudad and subobsolete between the sulci; elevations of the pronotum distributed as follows: one large median boss in the interhumeral region, two series of paired protuberances placed caudad; caudal process extending beyond the caudal femora a distance equal to their length. Tegmina elongate, acuminate, apex narrowly rounded, surface coarsely reticulate. Wings reaching to the tip of pronotal process. Cephalic femora with the carinæ undulate. Median femora slenderer than the cephalic and with the carinæ undulate. Caudal femora rather slender, sparsely granulate, carinæ not undulate or dentate, femoral lobe low and subobsolete, external pagina and dorso-lateral face with strong oblique sculpture; tibiæ with the margins expanded, lamellate, unarmed but very finely serrate; metatarsi about half again as long as the remaining tarsal joints.

General color bistre, obscurely marked on the lateral carinæ and the pronotal spines with ferruginous. Cephalic and median limbs with several obscure bands of wood brown. Caudal tarsi, margins and proximal portions of the tibiæ and two obscure bands on the dorsal aspect of the femora wood brown.

Measurements.

Length of body,	15	mm.
Length of pronotum,	21.5	"
Humeral width of pronotum,	4	"
Greatest width of pronotum (including spines),	6.8	"
Length of caudal femora,	8.5	"

A paratypic female, identical with the type in all respects, has also been examined.

I take pleasure in dedicating this striking species to the collector, Dr. W. L. Abbott, who by his tireless energy has placed in the hands of American zoologists an enormous amount of valuable exotic material.

CRIOTETTIX Bolivar.

1887. *Criotettix* Bolivar, Ann. Soc. Entom. Belg., XXXI, pp. 193, 226.

Included *tricarinatus, nexuosus, borrei, nigellus, saginatus, miliaris, baeri, subulatus, vidali, perminutus, rugosus, insidiosus, pulcher, pullus,* and *clavitarsis* Bolivar, *nodulosus* Stål, *brevis* and *emarginatus* Haan and *bispinosus* Dalman. Of these the last is the oldest and probably the best known and may with justice be considered the type.

Criotettix bispinosus (Dalman).

1818. *Acrydium bispinosum* Dalman, Kongl. Vetenskaps Academiens Handlingar, 1818, p. 77. [East India.]

Batu Sangkar, Tanah Datar, Padangsche Bovenland, Sumatra, August–September, 1901. (A. C. Harrison, Jr., and Dr. H. M. Hiller.) [A. N. S. Phila.] One female.

This species has a very extensive range, the territory covered including Burma, Sumatra, Java, Borneo and China. The only previous Sumatran record was from Batang Singalang, mentioned by Haan.

Criotettix bispinosus japonicus (Haan).

1839–44. *A[cridium]* (*Tetrix*) *bispinosum* var. *Japonica* Haan, Bijdragen Kennis Orthoptera in Verhandl. Natuurl. Geschied., p. 169.

Loo Choo Islands, Japan. (Through Y. Hirase.) Nine males, eight females. [A. N. S. Phila., and Hebard Coll.]

These specimens represent a well-marked geographic race of *bispinosus*, characterized by the more apparent linear rugosities on the pronotum and the slightly broader fastigium.

Section **Metrodoræ.**

SYSTOLEDERUS Bolivar.

1887. *Systolederus* Bolivar, Ann. Soc. Entom. Belg., XXXI, pp. 194, 234.

Included *angusticeps* and *uncinatus* Stål, *cephalicus* Haan, and *ophthalmicus, haani* and *languidus* Bolivar; of which *haani* is well figured and may be considered the type.

Systolederus cephalicus (Haan).

1839–44. *A[cridium]* (*Tetrix*) *cephalicum* Haan, Bijdragen Kennis Orthoptera, in Verhandl. Natuurl. Geschied., p. 169. [Batang Singalang, Sumatra.]

Batu Sangkar, Tanah Datar, Padangsche Bovenland, Sumatra. August-September, 1901. (A. C. Harrison, Jr., and Dr. H. M. Hiller.) [A. N. S. Phila.] Three males, four females.

These specimens appear to represent this species which is known only from Haan's brief description. Bolivar, having never seen the species, was unable to add any information to the original description. The possession of a pair of more or less apparent post-humeral spots of velvety black is shared by all the specimens, which are, however, somewhat smaller than Haan's measurements.

MAZARREDIA Bolivar.

1887. *Mazarredia* Bolivar, Ann. Soc. Ent. Belg., XXXI, pp. 194, 236.

Included *sculpta, remissa, semperi, abbreviata, insularis, atypa, lauta, gemella, celebica* and *centrosa* Bolivar, *gallinacea, fuscipes* and *rufipes* Stål. As *gemella* is the only species figured it can be selected as the type.

Mazarredia aptera n. sp.

Type : ♂; Island of Labuan, British North Borneo. [Hebard Collection.]

Differing from all the previously known species of the genus, except *M. minuta* and *truncata* Bolivar, in the absence of tegmina and wings, and from these two species it can readily be distinguished by the greater size and acute caudal process of the pronotum.

Size medium; form depressed; surface scabrous. Head with the occiput not elevated above the level of the pronotum; vertex truncate, about equal to one of the eyes in width, median carina projecting considerably beyond the cephalic margin, lateral carinæ distinct but by no means as apparent as the median, no frontal carina present; frontal costa forked slightly above the ocelli, rami considerably divergent, moderately arcuate when viewed laterad and sinuate dorsad; antennæ inserted on a level with the ventral margin of the eyes; median ocellus placed distinctly ventrad of the antennæ, paired ocelli placed between the middle of the eyes; eyes subovoid, moderately prominent. Pronotum depressed above, subconcave; cephalic margin very broadly and obtusely angulate; humeral angle not prominent; caudal process not exceeding the apex of the abdomen and not reaching the tips of the caudal femora, gradually acuminate to a short distance from the apex where it becomes sharply acuminate with the apex hastate and slightly subulate; posterior angle of the lateral lobes moderately produced and rectangularly extended when viewed dorsad, apically truncate, inferior sinus rectangulate, elytral sinus represented by a very slight emargination; median carina slight, cephalad of the humeral angles very slightly arcuate and elevated, undulate caudad; lateral carinæ obsolete cephalad, arcuate caudad of the humeral angles. No tegmina or wings present. Cephalic and median femora not appreciably undulate. Caudal femora short, strongly inflated, dorsal and ventral margins evenly arcuate, femoral lobe short, blunt, external pagina and dorso-lateral face with distinct but rather low sculpture; tibiæ well supplied with low blunt spines, canthi sparsely and weakly serrulate; metatarsi equal to the third tarsal joint in length, pulvilli low.

General color vandyke brown, obscurely marked along the carinæ of the pronotum with and having annulations on the limbs of pale cinnamon. The pale annulations on the caudal femora are much narrower than the dark bands, and on the caudal tibiæ but one distinct annulus is present, that being preapical; genicular regions of the caudal femora blackish.

Measurements.

Length of body,	11	mm.
Length of pronotum,	9.8	"
Width across humeral angles of the pronotum,	4	"
Greatest width of pronotum,	5.2	"
Length of caudal femora,	7.8	"

The type is the only specimen of this species seen.

CHIRIQUIA Morse.

1900. *Chiriquia* Morse, Biol. Cent.-Amer., Orth., II, pp. 5, 6.

Type.—*C. serrata* Morse.

Chiriquia serrata Morse.

1900. *Chiriquia serrata* Morse, Biol. Cent.-Amer., Orth., II, p. 7, fig. [Castillo, Nicaragua; Volcan de Chiriqui, 2,500 to 4,000 feet, Panama.

Carrillo, Costa Rica. [Hebard Coll.] One immature male.

This individual presents several characters which are more or less at variance with Morse's figure, the head being more compressed and with the carinæ of the vertex developed into distinct erect processes, and the median carina of the pronotum has but two distinct undulations. As the specimen is immature these differences in all probability are due to the stage of the insect.

AMORPHOPUS Serville.

1839. *Amorphopus* Serville, Orthoptères, p. 756.

Type.—*A. notabilis* Serville.

Amorphopus antennatus Bolivar.

1887. *A[morphopus] antennatus* Bolivar, Ann. Soc. Entom. Belg., XXXI, p. 251, figs. 19, 19*a–b*. [Upper Amazon.]

Venezuela. [A. N. S. Phila.] One female.

MITRARIA Bolivar.

1887. *Mitraria* Bolivar, Ann. Soc. Ent. Belg., XXXI, pp. 194, 253.

Included *M. producta* Bolivar and *phyllocera* (Haan), of which the former may be considered the type, as *phyllocera* was apparently unrepresented in the material studied by Bolivar.

Mitraria pontificalis n. sp.

Type: ♀; Mount Coffee, Liberia. February, 1897. (R. P. Currie.) U. S. Nat. Mus., No. 8113.]

Differing from either of the previously known species of the genus in the unarmed margins of the cephalic process, and in the smaller size. The generic diagnosis given by Bolivar will require some modification to include this form, as the antennæ are inserted between the eyes and the metatarsi of the caudal limbs are distinctly longer than the third tarsal joint.

Size rather small; form elongate; surface finely granulose. Head with the cephalic process produced a distance before the eyes equal to the greatest length of one of the latter, depressed dorsad, acute, the apex rounded, margins entire and carinate, median carina distinct; face distinctly declivent; frontal costa forked slightly cephalad of the ocelli; rami slightly divergent; median ocellus inserted on a level with the ventral margin of the eyes, paired ocelli placed directly between the eye; eyes subtrigonal, hardly prominent; antennæ short, very slender, apex acute, inserted directly between the eyes and equidistant from them and the frontal costa. Pronotum slender, very elongate, caudal process extending beyond the tips of the caudal femora a distance about equal to their length, very slightly subulate; cephalic margin very broadly obtuse-angulate; dorsum slightly arched transversely; median and lateral carinæ distinct, the interhumeral region bearing a pair of short accessory carinæ placed on each side of the median carina; lateral lobes with the posterior angle acute, inferior sinus rectangulate, elytral sinus slight. Tegmina cylindrical ovate. Wings extending slightly beyond the apex of the caudal process of the pronotum. Cephalic and median femora with their margins very slightly undulate. Caudal femora slender, margins evenly curved, genicular spine distinct and acute, femoral lobe distinct, external pagina with distinct but irregular diamond-shaped sculpture; tibiæ slightly sinuate, armed apically with distinct spines, canthi minutely serrulate; metatarsi equal to the remaining tarsal joints in length, the two apical pulvilli each slightly longer than the basal one.

General color wood brown, irregular dotted and blotched along the carinæ with vandyke brown; face blackish brown; eyes ecru drab.

Measurements.

Length of body,	10.2 mm.
Length of pronotum,	13 "
Humeral width of pronotum,	2 "
Length of posterior femora,	5.2 "

A paratypic female has been studied in addition to the type.

Section Tettigiæ.

PROTOTETTIX Bolivar.

1887. *Prototettix* Bolivar, Ann. Soc. Ent. Belg., XXXI, pp. 195, 255.

Included *P. fossulatus* Bolivar, and *impressus* and *lobulatus* (Stål); of which Bolivar's species may be considered the type.

Prototettix fossulatus Bolivar.

1887. *P[rototettix] fossulatus* Bolivar, Ann. Soc. Ent. Belg., XXXI, p. 256. [Apiahy, Sao Paulo, Brazil.]

Lota, Chile. January, 1904. (C. S. Reed.) [A. N. S. Phila.] Three males.

These specimens fully agree with Bolivar's description, except that the pagina of the caudal limbs are elevated into plicate ridges as in *lobulatus*. From *lobulatus*, however, they differ in the partially hidden tegmina, the sinuate ventro-caudal margins of the pronotum and the more apparent median carina. As the original description was based on a female these specimens are materially smaller than the measurements given by Bolivar.

ACRYDIUM Geoffroy.

1764. *Acrydium* Geoffroy, Hist. Abrég. Insect, I, p. 390.[6]

Included six non-binomial species, the genus being later restricted by Fabricius[7] to include but two species, *bipunctatum* and *subulatum*, of which two the latter may be considered the type.

Acrydium japonicum (Bolivar).

1887. *T[ettix] japonicus* Bolivar, Ann. Soc. Ent. Belg., XXXI, p. 263. [Japan.]

Kyoto, Japan. (Y. Hirase, No. 41.) [A. N. S. Phila., and Hebard Coll.] Twenty-nine males, eighteen females.

This species is a close relative of *A. türki* (Krauss), and also bears a superficial resemblance to the American genus *Neotettix*. It is, however, a member of the genus *Acrydium* in the restricted sense.

PARATETTIX Bolivar.

1887. *Paratettix* Bolivar, Ann. Soc. Ent. Belg., XXXI, pp. 195, 270.

Included twenty-eight species, of which *peruvianus* and *cayennensis* have been removed to *Allotettix*, *schochii* made the type of *Clypeotettix*, and *fallax* and *aztecus* placed in *Telmatettix*. Of the remaining species the only European one can be considered the type, *meridionalis* Rambur.

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[6] The edition of 1762 is not available for examination, but that of 1764 is said to be identical, except for a few minor details.

[7] *Syst. Ent.*, pp. 278, 1775.

Paratettix frey-gessnerii Bolivar.

1887. *P[aratettix] Frey-Gessnerii* Bolivar, Ann. Soc. Entom. Belg., XXXI, p. 276. [Cuba.]

Portland, Jamaica. (Johnson and Fox.) [A. N. S. Phila.] One male.

The similarity of this species to the Old World *P. meridionalis* is, as noticed by Bolivar, very striking.

Paratettix caudatus (Saussure).

1861. *T[ettix] caudata* Saussure, Revue et Magasin de Zoologie, 2e ser., XIII, p. 399. [Guiana.]

Bartica, British Guiana. April 2 and May 11 and 12, 1901. (R. J. Crew.) [A. N. S. Phila.] Two males, three females.

One of these specimens has the coloration more contrasted than the others, the interhumeral region being bright ochraceous margined posteriorly by a broken line of velvety black.

Paratettix mexicanus (Saussure).

1861. *T[ettix] mexicana* Saussure, Revue et Magasin de Zoologie, 2e ser., XIII, p. 400. [Tropical Mexico.]

Monte Redondo, Costa Rica. January, 1903. (C. F. Underwood.) [A. N. S. Phila.] Two males.

This species has previously been recorded from Volcan de Irazu, Costa Rica.

Paratettix scaber (Thunberg).

1815. *A[crydium] scabru.n* Thunberg, Nova Acta Reg. Soc. Scient. Upsal., VII, p. 159. [Cape of Good Hope.]

Congo. [U. S. Nat. Mus.] Two males, three females.

This species has been recorded from Gaboon, Zanzibar, Caffreria, Lourenco Marquez, and East Indies by Bolivar, and from Adeli, Togoland, by Karsch.

Paratettix histricus (Stål).

1860. *Tetrix histrica* Stål, Kong. Svenska Freg. Eugenies Resa, Ins., p. 347. [Java.]

Loo Choo Islands, Japan. (Through Y. Hirase, No. 71.) [A. N. S. Phila., and Hebard Coll.] Two males, seven females.

This has previously been recorded from localities reaching from Sumatra to the Philippines, including North Australia and New Caledonia.

CLYPEOTETTIX Hancock.

1902. *Clypeotettix* Hancock, The Tettigidæ of North America, pp. 36, 124.

Type.—*Paratettix schocki* (laps. p. *schochii*) Bolivar.

Clypeotettix schochii (Bolivar)?

1887. *P[aratettix] schochii* Bolivar, Ann. Soc. Ent. Belg., XXXI, p. 274 [Guatemala; Mexico.]

Venezuela. [A. N. S. Phila.] One male.

Chinandega, Nicaragua. (C. F. Baker.) [A. N. S. Phila.] One male.

These specimens are questionably assigned to this species, as they are much smaller and more rugose than Mexican individuals which undoubtedly represent *schochii*. It is very probable the two above listed specimens represent a new species, but in view of the known variability of *schochii* I should hesitate to describe them.

HEDOTETTIX Bolivar.

1887. *Hedotettix* Bolivar, Ann. Soc. Ent. Belg., XXXI, pp. 195, 283.

Included ten species, of which the first and oldest—*gracilis* Haan—may be considered the type.

Hedotettix gracilis (Haan).

1839–44. *A[cridium]* (*Tetrix*) *gracile* Haan, Bijdragen Kennis Orthoptera, in Verhandl. Natuurl. Geschied., p. 169. [Krawang, Tondano.]

Trong, Lower Siam. (Dr. W. L. Abbott.) [U. S. Nat. Mus.] One male.

Batu Sangkar, Tanah Datar, Padangsche Bovenland, Sumatra, August–September, 1901. (A. C. Harrison, Jr., and Dr. H. M. Hiller.) [A. N. S. Phila.] One male.

This species has been recorded from Burma by Brunner,[8] and if he is correct in synonymizing *H. festivus* it is also found in Ceylon. As far as the character of the median femora goes, the specimens mentioned above support his contention, as, although true *gracilis*, they have the median femora heavier and with the carinæ more arcuate than in the cephalic pair. The cephalic margin of the pronotum is obtuse-angulate in both specimens.

ALLOTETTIX Hancock.

1899. Allotettix Hancock, Ent. News., X, p. 276.

Type.—*Allotettix prolongatus* Hancock.

Allotettix peruvianus (Bolivar).

1887. *P[aratettix] peruvianus* Bolivar, Ann. Soc. Ent. Belg., XXXI, p. 272. [Pumamarca, Peru.]

Carrillo, Costa Rica. [Hebard Coll.] Seven males, five females.

This species has previously been recorded from Panama and Darien, in addition to the type locality.

Allotettix cayennensis (Bolivar).

1887. *P[aratettix] cayennensis* Bolivar, Ann. Soc. Ent. Belg., XXXI, p. 273. [Cayenne.]

Bartica, British Guiana. April and May, 1901. (R. J. Crew.) [A. N. S. Phila.] Eight males, three females.

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[8] *Ann. Mus. Civ. Stor. Nat. Genova*, XXXIII, p. 111.

Section **Batrachideæ.**

TETTIGIDEA Scudder.

1862. *Tettigidea* Scudder, Boston Journ. Nat. Hist., VII, p. 476.

Type.—*T. lateralis* (Say).

Tettigidea pulchella n. sp.

Type: ♀; Bartica, British Guiana. April 27, 1901. (R. J. Crew.) [A. N. S. Phila.]

Differing from all the other species of the genus in the truncate fastigium.

Size rather small; form moderately elongate; surface scabrous. Head with the vertex about equal to one of the eyes in width, truncate cephalad and projecting but slightly cephalad of the eyes, not excavated, median carina distinct and rather prominent, frontal carina distinct; frontal costa arcuate when viewed laterad, rami very slight and very gradually diverging; antennæ inserted between the ventral portions of the eyes; eyes subtrigonal in outline, slightly prominent. Pronotum subtectate, caudal process reaching the tips of the ovipositors but not of the caudal femora; cephalic margin rectangulate, produced centrally into an acute spine; median carina distinct, moderately arcuate cephalad; lateral carinæ obsolete between the sulci; humeral angles not projecting; posterior process of the lateral lobes rectangulate, inferior sinus long but not very deep, elytral sinus acutely cut. Tegmina cylindrical ovate, apex broad and blunt. Wings slightly exceeding the caudal process of the pronotum. Cephalic femora with the dorsal sulci distinct but shallow. Caudal femora rather short and heavy, the dorsal outline strongly arcuate, the ventral outline nearly straight, femoral lobe sharp and projecting, genicular spine short and blunt, margins finely serrate, external pagina and dorso-lateral face shallowly but distinctly sculptured; tibiæ rather strongly armed, canthi serrate; metatarsi equal to the third joint in length.

General color bistre, inclining toward cinnamon below; antennæ tawny proximad, blackish distad; cephalic and median limbs more or less distinctly annulate with the darker shade on a cinnamon ground.

Measurements.

Length of body,	9.8 mm.
Length of pronotum,	9 "
Humeral width of pronotum,	2.5 "
Length of caudal femora,	6 "

The type is the only specimen which has been examined.

SAUSSURELLA Bolivar.

1897. *Saussurella* Bolivar, Ann. Soc. Ent. Belg., XXXI, pp. 196, 303.

Type.—*S. cornuta* (Haan).

Saussurella sumatrensis Bolivar.

1898. *Saussurella sumatrensis* Bolivar, Ann. Mus. Civ. Stor. Nat. Genova, XXXIX, p. 80. [Pangherang-Pisang, Sumatra.]

Goenong Soegi, Lampong, Sumatra. October–November, 1901. (A. C. Harrison, Jr., and Dr. H. M. Hiller.) [A. N. S. Phila.] Two males.

As the specimens examined by Bolivar were females, the measurements of a male individual may be of interest. Length of body 12.5 mm., length of pronotum 16.5, length of pronotal process 2.7, length of caudal femora 7.

Section **Tripetaloceræ.**

DISCOTETTIX Costa.

1864. *Discotettix* Costa, Annuario Mus. Zool. Univ. Napoli, II, p. 59.

Type. *D. armatus* Costa = *Tetrix belzebuth* Serville.

Discotettix belzebuth (Serville).

1839. *Tetrix Belzebuth* Serville, Orthoptères, p. 759. [Java.]

Kina Balu, British North Borneo. [Hebard Coll.] One male, two females.

Island of Labuan, British North Borneo. [Hebard Coll.] One female.

One of the Kina Balu females has the pronotum not exceeding the tips of the caudal femora.

Subfamily EUMASTACINÆ.

Section **Choroetypi.**

ORCHETYPUS Brunner.

1898. *Orchetypus* Brunner, Abhandl. Senckenb. Naturfor. Gesell., XXIV, heft 2, p. 220.

Included *O. rotundatus* and *subtruncatus* Brunner, of which the latter may be considered the type as it is figured.

Orchetypus ocreatus n. sp.

Type: ♀; Luebo, Congo. (D. W. Snyder.) [U. S. Nat. Mus., No. 8114.]

Closely allied to the Ceylonese *O. ceylonicus* Karsch, but differing in the strongly sinuate caudal portion of the median carina of the pronotum, the larger spines on the caudal tibiæ, the more subequal tegmina and the shorter caudate apex of the wings.

Size large; form compressed; surface rugulose. Head with the occiput and vertex ascending; fastigium produced, elevated, not retrorse, slightly antrorse, acute, apex truncate with a slight median emargination, median carina present dorsad and cephalad; face flattened, slightly concave, much as in *O. ceylonicus;* infra-ocular carinæ very sharp; frontal costa with a flask-shaped expansion between the antennæ; antennæ short, but slightly exceeding the greatest length of the eye; eyes crudely elongate-ovate, distinctly shorter than the infra-ocular portion of the genæ, little prominent. Pronotum strongly compressed; median crest strongly elevated, produced over the head almost to the tip of the fastigium, very slightly arcuate in the cephalic half, bisinuate on caudal half; caudal process acute, slightly recurved at the apex; lateral lobes about as high as long, cephalic and caudal margins straight, inferior margin truncato-sinuate. Tegmina elongate, lanceolate; apex acuminate, narrowly rounded, exceeding the tips of the caudal femora; costal margin strongly dilated proximad. Wings equal to the tegmina in length, tips caudal and extending beyond the major portion of the wing a distance equal to one-fifth the total length of the member. Ovipositor valves with the margins crasso-dentate. Cephalic femora dilated, pyramidical in outline the apex proximal; tibiæ slightly bowed. Median femora with the dorsal carina slightly elevated and arcuate, the cephalo-ventral carina moderately lamellate distad; tibiæ straight. Caudal femora heavy, dorsal carina arcuate and strongly serrato-dentate, ventral carina minutely serrate, external pagina with an irregular rhomboid pattern; tibiæ slightly sinuate distad, proximal section with an acute trigonal lobe on the dorsal surface, spines on the internal margin larger than those on the external; metatarsi slightly shorter than the remaining tarsal joints.

General color tawny-olive, suffused on the dorsal half of the pronotum with raw umber; a broad bar of buff covering the genæ and the lateral lobes of the pronotum, the distal half of the caudal femora, the proximal half of the caudal tibiæ and the cephalic and median femora irregularly blotched and suffused with the same tint.

Measurements.

Length of body,	38.5 mm.
Length of pronotum,	13 "
Greatest depth of pronotum,	11 "
Length of tegmina,	21.5 "
Length of caudal femora,	17 "

The type is unique.

PLAGIOTRIPTUS Karsch.

1889. *Plagiotriptus* Karsch, Entom. Nachr., XV, p. 8.

Type.—*Plagiotriptus hippiscus* (Gerstaecker).

Plagiotriptus hippiscus (Gerstaecker).

1873. *Chorœtypus hippiscus* Gerstaecker, Von der Decken's Reisen in Ost-Afrika, Bd. III, Abth. 2, p. 42, taf. 2, fig. 8. [Mombasa.]

Mombasa, East Africa. [Hebard Coll.] One female.

Section Erianthi.

ERIANTHUS Stål.

1876. *Erianthus* Stål, Ofversigt af K. Vetensk.-Akad. Förhandlingar, 1876, No. 3, p. 55.

Type.—According to Burr[9] *Mastax guttata* Westwood.

Erianthus nipponensis n. sp.

Type: ♀; Nikko, Hondo, Japan. [U. S. Nat. Mus., No. 8115.]

Belong to the group comprising *E. guttatus* Westwood, *flavoinflatus* Brunner and *acutipennis* Saussure. From all of these it differs in having the fastigium unreflexed; from *guttatus* it also differs in the lower and more obtuse fastigium; from *flavoinflatus* in the smaller size, obliquely truncate apical portion of the tegmina, and non-dentate cephalic margin of the pronotum, and from *acutipennis* in the form of the tips of the tegmina and the rotundato-angulate caudal margin of the pronotum. Considerable affinity exists also with *E. obtusus* Burr, but that species has the fastigium obtuse.

Size rather large; form elongate. Head with the occiput and vertex sharply ascending, the fastigium elevated above the eyes a distance equal to half the length of the latter, not reflexed, rectangulate, a median carina present on both the dorsal and cephalic aspects; frontal costa with the interantennal expansion elongate pyriform, the costal carinæ apparent almost to the clypeus; antennæ inserted slightly below the middle of the eyes; eyes elongate ovate, moderately prominent. Pronotum hardly selliform, slightly tectate, median carina distinct, somewhat undulate; cephalic margin sinuato-truncate with a distinct median emargination; caudal margin obtuse-angulate with the angle rounded; dorsal surface strongly rugose, transverse sulci not apparent; lateral lobes slightly longer than the caudal depth, inferior margin obliquely sinuate, cephalo-ventral angle broadly rounded, caudo-ventral angle rectangulate. Tegmina reaching to the apex of the abdomen, enlarged apically and obliquely truncate. Wings ample, as long as the tegmina. Ovipositor valves with the teeth decidedly crassate and

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[9] *Anal. Soc. Españ. Hist. Nat.*, XXVIII, p. 103.

blunt; subgenital plate acute, with a distinct median sulcus. Caudal femora slender, falling slightly short of the apex of the abdomen, the dorsal and dorso-lateral carinæ sparsely serrato-dentate, genicular lobes spinose, genicular spine acute; tibiæ slightly sinuate, the spines of the internal margin longer than those of the external margin; metatarsi about equal to the remaining tarsal joints in length, dorsal carinæ serrato-dentate.

General color raw umber; the head inclining toward cinnamon, eyes vandyke brown; tegmina with a preapical hyaline spot on both the cephalic and caudal margins; caudal femora wood brown with three obscure annuli of darker brown; caudal tibiæ of the general tint with several obscure annuli of wood brown.

Measurements.

Length of body, ...	30	mm.
Length of pronotum.	4.2	"
Length of tegmina, ...	22	"
Length of caudal femora, ...	15	"

The type is unique.

Erianthus malcolmi Bolivar.

1903. *Erianthus Malcolmi* Bolivar, Boletin Soc. Españ. Hist. Nat., III, p. 302. [Malacca, Kwala, Lumpur, Strait Settlements.]

Trong, Lower Siam. (Dr. W. L. Abbott.) [U. S. Nat. Mus.] Three males.

These specimens fully agree with Bolivar's description, except that the face, the lateral lobes of the pronotum and the anal area of the tegmina are suffused with dull greenish, which is probably due to the condition of the specimens.

Section **Erucii.**

ERUCIUS Stål.

1875. *Erucius* Stål, Bihang till K. Svenska Vetens.-Akad. Handl., III, No. 14, p. 36.

Type.—*Mastax agrionoides* Haan.

Erucius vitreus (Westwood).

1845. *Mastax vitrea* Westwood, Arcana Entom., I, p. 100, Pl. 26, fig. 2. [Java.]

Goenong Soegi, Lampong, Sumatra. October–November, 1901. (A. C. Harrison, Jr., and Dr. H. M. Hiller.) [A. N. S. Phila.] Two males, one female.

It is worthy of note that the specimens examined by Brunner[10] and

[10] *Abhandl. Senckenb. Naturf. Gesellsch.*, XXIV, heft 2, p. 227.

considered *vitreus* are not Westwood's species, an examination of the measurements of the two making this fact very apparent. The male of *vitreus* has the subgenital plate acuminate instead of truncate as described by Brunner.

Erucius magnificus n. sp.

?1898. *Erucius vitreus* Brunner, Abhandl. Senckenb. Naturf. Gesellsch., XXIV, heft 2, p. 227.

Type: ♀; Island of Labuan, British North Borneo. [Hebard Collection.]

This species may be separated from *vitreus* Westwood by its larger size and more ample tegmina and wings. As no males have been examined it is possible that it represents the female of *E. pictus* Saussure,[11] based on the male only.

Size large; form as usual in the genus. Head strongly elevated, the occiput and vertex sharply ascending, the interocular region quite narrow, about half as wide again as the frontal costa at its widest part; frontal costa narrow, strongly compressed at the ocelli, subequal below except for a slight widening at the median ocellus, rather deeply sulcate; antennæ very short, the insertion strongly crowded between the eyes and the frontal costa; eyes subelliptical, moderately prominent. Pronotum selliform; cephalic margin sinuato-truncate, caudal margin arcuate; prozona with three distinct transverse ridges, metazona reticulate with a slight median carina; lateral lobes slightly deeper than long, cephalo-ventral angle obtuse, caudo-ventral angle rectangulate, ventral margin oblique, sinuate. Tegmina large, exceeding the apex of the abdomen by more than one-fourth their length, considerably expanded at the tips, costal margin strongly arcuate distad, apex obliquely truncate. Wings equal to the tegmina in length. Ovipositor valves punctate, the margins crasso-dentate; subgenital plate apically acute with a slight median longitudinal depression. Caudal femora slender, falling slightly short of the tips of the ovipositor valves, the distal half slender, dorsal and dorso-lateral carinæ sparsely serrato-dentate; tibiæ slightly sinuate in the proximal half, external spines decidedly smaller than the internal ones; metatarsi slightly shorter than the remaining tarsal joints, superior carinæ serrato-dentate.

General color (specimen discolored) bistre, the face washed with cinnamon; tegmina tawny olive, with two faint oblique apical bars of umber parallel with the apical margin; caudal femora with faint traces of several annuli of a light shade; caudal tibiæ marmorate with umber on a wood brown ground.

[11] *Revue Suisse de Zoologie*, XI, fasc. I, p. 85, fig. 13. [Nanza-Badan, Borneo.]

Measurements.

Length of body, ...	30.5 mm.
Length of pronotum, ...	4.8 "
Length of tegmina, ...	30.5 "
Length of caudal femora, ...	16.5 "

Two females of this species have been studied, the additional specimen being in every way identical with the type.

Erucius dimidiatipes Bolivar.

1898. *Erucius dimidiatipes* Bolivar, Ann. Mus. Civ. Stor. Nat. Genova, XXXIX, p. 81. [Si-Rambé, Sumatra.]

Goenong Soegi, Lampong, Sumatra. October–November, 1901. (A. C. Harrison, Jr., and Dr. H. M. Hiller.) [A. N. S. Phila.] Two males.

The basal portion of the caudal femora of these specimens have retained their original color, which is Chinese orange. By an unfortunate transposition in Burr's key the femora of this species are described as "basi nigra, apice pallida," while Bolivar's original reads: "Femora postica pallida, dimidio apicali nigro."

Section **Eumastaces.**

EUMASTAX Burr.

1899. *Eumastax* Burr, Anal. Soc. Españ. Hist. Nat., XXVIII, p. 257.

Type.—*Mastax tenuis* Perty.

Eumastax dentatus Saussure.

1903. *Eumastax dentatus* Saussure, Revue Suisse de Zoologie, XI, fasc. I, p. 91. [Palmares, Costa Rica.]

Carrillo, Costa Rica. [Hebard Collection.] One male, one female. Costa Rica. (Schild and Bergdorf.) [U. S. Nat. Mus.] One male. The female individual is somewhat smaller than Saussure's measurements, but otherwise is identical.

PARAMASTAX Burr.

1899. *Paramastax* Burr, Anal. Soc. Españ. Hist. Nat., XXVIII, p. 268.

Type.—*Mastax nigra* Scudder.

Paramastax magna (Giglio-Tos).

1898. *M[astax] magna* Giglio-Tos, Bollett. Mus. Zoolog. Anat. Comp., XIII, No. 311, p. 38. [Valley of Santiago, Ecuador.]

Piches and Perene Valleys, Peru, 2,000–3,000 feet. (Soc. Geog. de Lima.) [U. S. Nat. Mus.] One male.

The male of this species is said by Burr to have the face unicolor, but in the individual before me it and the genæ are marked with a broad band of yellowish, as in *læta*, *personata* and other species. The characters of the cerci and the coloration of the limbs, however, place it in *magna*, the absence of the facial decoration in Burr's species possibly being due to the fact that his specimens were from Mexico, and for that reason representing another species. As far as can be made from Giglio-Tos' diagnosis of the female this specimen is his species.

MASYNTES Karsch.

1889. *Masyntes* Karsch, Entom. Nachr., XV, pp. 26, 31.

Type.—*Mastax gundlachii* Scudder.

Masyntes borellii Giglio-Tos.

1897. *Masyntes Borellii* Giglio-Tos, Bollett. Mus. Zool. Anat. Comp. Torino, XII, No. 302, p. 17. [San Pedro, Paraguay.]

Chapada, Matto Grosso, Brazil. April. (H. H. Smith.) [U. S. Nat. Mus.] One male, one female.

The female specimen agrees very well with the original description, except that the size is slightly less. The subgenital plate of the male is more produced and acute than in *tigris*, while the fastigium is more distinctly truncate, with a very slight median emargination which is more apparent in the male than in the female. The orange maculation on the dorsal surface involves two segments in the male instead of one as in the female, and the lateral lobes of the pronotum are subequal in depth, not produced ventrad as seen in *M. tigris*.

Masyntes tigris Burr.

1899. *Masyntes Tigris* Burr, Anal. Soc. Españ. Hist. Nat., XXVIII, p. 276. [Paraguay.]

Corumbá, Matto Grosso, Brazil. March (Highland). (H. H. Smith.) [U. S. Nat. Mus.] Two males.

Chapada, Matto Grosso, Brazil. October (Campo). (H. H. Smith.) [U. S. Nat. Mus.] One male.

The Chapada individual has the tegmina but half the length of those organs in the Corumbá specimens. This species is considerably larger than *borellii*, but very closely related.

Section **Thericleis.**

THERICLES Stål.

1875. *Thericles* Stål, Bihang till K. Svenska Vet.-Akad. Handlingar, III No. 14, p. 35.

Included *T. obtusifrons* and *compressifrons* Stål; the latter since having been removed to *Pseudothericles* leaves as the type *obtusifrons*.

Thericles gnu Karsch.

1896. *Thericles gnu* Karsch, Stettin Entom. Zeit., LVII, p. 248. [Ru Nsororo, 2,000 m., East Central Africa.]

Luebo, Congo. (D. W. Snyder.) [U. S. Nat. Mus.] One male, one female.

As far as can be determined from Karsch's rather meagre description of a female, the above specimens represent his species. Difference is noted in the unicolorous face, the limbs, however, being suffused with blackish, which is limited on the caudal femora to the distal half. The male is gaily colored as in *T. zebra* and is but slightly smaller, but the genæ are solid yellowish from the eye down, the caudal margin of the lateral lobes of the pronotum are more broadly yellowish than the cephalic, the ventral margin is blackish, and the lateral aspect of the proximal abdominal segments are almost solid black. The apex of the male abdomen is strongly clavate, recurved and directed cephalad; the subgenital plate is inflated, subcylindrical, elongate; cerci simple, styliform, hidden under the subgenital plate.

Subfamily PROSCOPINÆ.

CORYNORHYNCHUS Brunner

1890. *Corynorhynchus* Brunner, Verhandl. K. K. Zool.-Bot. Gesell., Wien, XL, p. 101.

Included *C. radula, hispidus* and *spinosus* Klug, and *hispidulus* and *latirostris* Brunner. Of these *radula* may be considered the type.

Corynorhynchus radula (Klug).

"1820. *Proscopia radula* Klug, in Nees ab Esenbeck, Horæ Phys. Berol. p. 20, tab. III, fig. 4. [Rio de Janeiro; Para, Brazil.]"

Rio de Janeiro, Brazil. November. (H. H. Smith.) One male, two females.

One of the female specimens is considerably larger than the other and very materially exceeds Brunner's measurements. No other difference, however, can be detected between it and the other female, which fully agrees with the above-mentioned measurements.

TETANORHYNCHUS Brunner.

1890. *Tetanorhynchus* Brunner, Verhandl. K. K. Zool.-Bot. Gesell., Wien, XL, p. 104.

Included *punctatus* Klug, *sublævis, propinquus, incertus, longirostris* and *angustirostris* Brunner. Of these *punctatus* may be considered the type.

Tetanorhynchus bihastatus n. sp.

Types: ♂ and ♀; Corumbá, Matto Grosso, Brazil. March (Highland). (H. H. Smith.) [U. S. Nat. Mus., No. 8116.]

Closely allied to *T. humilis* Giglio-Tos from Paraguay,[12] but differing

[12] Co-types of this species received from Dr. Borelli have been used for comparison.

in the finer sculpture, the longer subgenital plate of the male and the more acute supraanal plate of the female.

Size medium; form as usual in the genus; surface finely punctate. Head elongate; rostrum in the male but slightly more than half the length of the remainder of the head, in the female subequal to the remainder of the head, acuminate, apex narrowly rounded, carinæ distinct; eyes elongate-ovate, quite prominent in the male; antennæ very slightly longer than the rostrum in the male, slightly shorter in the female, basal joint distinctly shorter than the eye in the male, slightly shorter in the female. Pronotum with the limbs inserted mesad, cephalic margin broadly rounded. Mesonotum and metanotum slightly strigate. Abdomen with the strigæ absent in the male, faintly marked in the female; supraanal plate of the male acuminate, apex rounded; subgenital plate of the male narrowly produced, needle-like; supraanal plate of the female acuminate, apex very narrowly rounded; ovipositor valves stout, the margins unarmed; subgenital plate of the female broadly arcuate. Cephalic and median limbs subequal in size, shorter than the pronotum. Caudal femora elongate, reaching to the middle of the fifth abdominal segment in the male and of the fourth in the female; caudal tibiæ armed on the margins with fifteen to sixteen spines in the male and twenty in the female.

General color olive-green, in the male washed along the sides of the pronotum and the postocular region of the head with yellowish green.

Measurements.

	♂	♀
Length of body, ...	63.5 mm.	91 mm.
Length of head, ...	10.5 "	15 "
Length of rostrum, ...	4 "	7.5 "
Length of pronotum, ...	13.5 "	19 "
Length of cephalic femora, ...	9.7 "	13 "
Length of caudal femora, ...	23 "	27.2 "
Length of caudal tibiæ, ...	24 "	31.5 "
Length of subgenital plate, ...	5 "	

Two specimens of each sex have been examined. The paratypic female has lost both caudal tibiæ, the paratypic male, however, exhibits a spine armament of twenty spines, which is rather different from that of the type. Otherwise the specimens exhibit no striking variation.

Tetanorhynchus smithi n. sp.

Type: ♂; Corumbá, Matto Grosso, Brazil. March (Highland). (H. H. Smith.) [U. S. Nat. Mus., No. 8117.]

Allied to *T. humilis* and *T. bihastatus*, but differing in the more robust build and the heavier cephalic and median femora. The form of the subgenital plate closely resembles that of *bihastatus*.

Size rather large; form more robust than usual in the genus; surface of thorax, head and limbs distinctly punctate, abdomen very obscurely punctate. Head acuminate; rostrum about half as long as the remainder of the head, tapering, apex blunt, carinate distinct but not sharp; eyes elliptical ovate, rather prominent; antennæ about twice as long as the rostrum, basal joint but slightly more than half the length of an eye. Pronotum with a slight median supracoxal dilation; cephalic margin roundate, shallowly emarginate mesad; caudal margin sinuato-truncate. Mesonotum and metanotum moderately inflated, strigæ distinct and serrato-dentate. Supraanal plate acuminate, apex moderately acute, proximal half with a shallow median emargination; subgenital plate produced, needle-like. Cephalic and median limbs similar, the cephalic pair slightly smaller than the median. Caudal femora elongate, reaching to the middle of the fifth abdominal segment; caudal tibiæ with thirteen spines on the external and twelve to fourteen on the internal margins.

General color pale apple-green, suffused dorsad, on the ventral surface of the rostrum and on the entire dorsum of the abdomen with olive.

Measurements.

Length of body,	71.5 mm.
Length of head,	11.5 "
Length of rostrum,	4 "
Length of pronotum,	14 "
Length of cephalic femora,	11.5 "
Length of caudal femora,	25.5 "
Length of caudal tibiæ,	29 "
Length of subgenital plate,	5.2 "

The type is the only specimen of this species seen.

HYBUSA Erickson.

1844. *Hybusa* Erickson, Wiegman's Archiv für Naturgeschichte, X, Bd. II, p. 298.

Type.—*Proscopia occidentalis* Westwood.

Hybusa reedi n. sp.

Type: ♀; Chile. (E. C. Reed.) [U. S. Nat. Mus., No. 8118.]

Differing from *H. occidentalis* in the slenderer head and pronotum, the rather longer limbs and narrower abdomen.

Size medium; form depressed in the thoracic region; surface rugulose. Head conic, the section caudad of the eyes slightly concave, the margin not distinctly serrate and but slightly rugulose; rostrum but slightly longer than the eyes, tapering, apex blunt and broad, depressed with very distinct lateral carinæ; face concave; eyes elliptical ovate; antennæ with the basal joint about one-third the length of the eye. Pronotum with the limbs inserted caudad of the middle; cephalic margin rotundate with a median truncation, caudal margin truncate, lateral margins slightly constricted cephalad of the insertion of the limbs. Mesonotum and metanotum fused, strongly impressed rugulose dorsad, depressed. Abdomen somewhat compressed, carinate, subequal, narrower than the meso-metathorax;[13] supraanal plate sagittate; ovipositor valves heavy, blunt, margins unarmed; subgenital plate very slightly rotundato-truncate. Cephalic and median femora very similar in structure, the cephalic pair slightly the larger. Caudal femora slender, reaching nearly to the distal margin of the sixth abdominal segment; caudal tibiæ bearing twenty to twenty-one spines on the external margins, twenty-two on the internal margins.

General color gallstone-yellow, the eyes dull greenish.

Measurements.

Length of body,	57	mm.
Length of head,	9	"
Length of rostrum,	2.2	"
Length of pronotum,	8.5	"
Length of cephalic femora	8.5	"
Length of caudal femora,	22.5	"
Length of caudal tibiæ,	22	"

An immature specimen from Cautin, Chile (C. S. Reed; January, 1904; A. N. S. Phila.) I also refer to this species. It is a male, but fully agrees with the type in all essential characters.

CEPHALOCŒMA Serville.

1839. *Cephalocœma* Serville, Orthoptères, p. 577.

Type.—*Proscopia sica* Serville.

Cephalocœma sica (Serville).

1839. *Proscopia sica* Serville, Orthoptères, p. 577, Pl. 14, fig. 1. [Southern part of Campos Geraes, Brazil.]

Sao Paulo, Sao Paulo, Brazil. September 1 and 7, 1900. (Adolph Hempel.) [A. N. S. Phila.] Two males.

These specimens have the subgenital plate more produced and elongate than in Serville's figure, but otherwise they fully agree with this species.

[13] This condition may be due to the artificial compressing of the abdomen, but it is very evident that the width is by no means as great as in the female of *occidentalis* figured by Brunner (*Verhandl. K. K. Zool.-Bot. Gesell.*, Wien, XL, taf. V, fig. 10).

Cephalocœma multispinosa Brunner.

1890. *Cephalocœma multispinosa* Brunner, Verhandl. K. K. Zool.-Bot. Gesell., Wien, XL, p. 116. [Porto Alegre, Rio Grande do Sul, Brazil.]

Paraguay. [A. N. S. Phila.] One female.

The measurements of the limbs of this specimen are slightly smaller than those given by Brunner.

Cephalocœma costulata Burmeister.

1880. *Cephalocœma costulata* Burmeister, Abhandl. Naturforsch. Gesell., Halle, XV, heft I, p. 9, taf. I, figs. 5–7. [Argentina.]

Sapucay, Paraguay. [Hebard Collection.] One female.

This specimen is equal to Burmeister's and Brunner's maximum measurements and is considerably larger than two individuals of the same sex from Carcarana, Argentina, in the collection of the Academy. The Sapucay specimen, also, has the rostrum longer than in Burmeister's figure, and in the other specimens examined, but not exceeding the maximum given by Brunner.

Cephalocœma chapadensis n. sp.

Types: ♂ and ♀; Chapada, Matto Grosso, Brazil. July (♂) and August (♀). (H. H. Smith.) [U. S. Nat. Mus., No. 8119.]

Closely allied to *C. costulata* but differing in the longer and subequal rostrum, the more marked longitudinal strigæ and the heavier antennæ.

Size medium; surface of the body with distinct longitudinal strigæ, weaker on the pronotum than elsewhere. Head elongate, tapering; rostrum of the male about equal to the length of the head, of the female slightly longer than the remainder of the head, tapering in the male with a rather blunt apex, subequal in the female, apex rather blunt and subcruciform when viewed cephalad; antennæ equal to the rostrum in the male, about two-thirds the length in the female, basal joint slightly less than half the length of the eye; eyes subelliptical; face very slightly concave. Pronotum elongate, slightly broader caudad than cephalad, limbs inserted very slightly caudad of the middle; cephalic margin rotundato-truncate, caudal margin truncate, lateral margins very slightly expanded dorsad of the coxæ; strigæ distinct, but not high. Mesonotum and metanotum little broader than the pronotum, strongly strigate. Abdomen with the strigæ very distinct; supraanal plate of the male sagittate, apex blunt; subgenital plate of the male compressed, elongate, subequal, the apex obscurely bilobate; supraanal plate narrow, produced, apex bluntly rounded; ovipositor valves strongly compressed, margins unarmed; subgenital plate of the female apically rotundato-truncate. Cephalic and median limbs subequal in size and form. Caudal femora of the male slightly surpassing the apex of the fourth abdominal segment, of the female just reaching the apex of the same segment, slender; caudal tibiæ in the male with sixteen to seventeen spines on the external margins and fourteen to fifteen on the internal, in the female with twelve on the external and nine to ten on the internal margins.

General color wood-brown, the rostrum infuscate ventrad.

Measurements.

	♂	♀
Length of body,	62 mm.	75.5 mm.
Length of head,	11.5 "	15.5 "
Length of rostrum,	5 "	8.5 "
Length of pronotum,	11.5 "	15.5 "
Length of cephalic femora,	7.5 "	10.5 "
Length of caudal femora,	19 "	23 "
Length of subgenital plate,	4 "	

A female from Paraguay, in the collection of the Academy, has also been examined. It differs from the type of that sex only in the smaller size and slightly greater number of tibial spines.

Cephalocœma flavirostris (Blanchard).

1851. *Proscopia flavirostris* Blanchard, in Gay, Hist. Fis. Pol. Chile, Zool., VI, p. 61. [Province of Coquimbo, Chili.]

Zemuco, Chile.[44] January, 1904. (Carlos S. Reed.) [A. N. S. Phila.] One male, one female.

As far as can be made out from the poor original description, these specimens probably represent this species. The pronotum and prosternum have a lateral series of yellowish tubercles which is the only character approaching "prothorace . . . . lateribus flavescenti."

Cephalocœma lineata Brunner.

1890. *Cephalocœma lineata* Brunner, Verhandl. K. K. Zool.-Bot. Gesell., Wien, XL, p. 119, taf. V, fig. 11. [Mendoza, La Plata, Argentina.]

Cordova, Argentine. (F. Schulz.) [U. S. Nat. Mus.] One male, one female.

The female is slightly smaller than the type measured by Brunner. This species is very close to *C. lancea* Burmeister.

ASTROMA Charpentier.

1845. *Astroma* Charpentier, Orthop. Desc. et Depict., tab. IV.

Type.—*Astroma chloropterum* Charpentier.

Astroma chloropterum Charpentier.

1845. *Astroma chloropterum* Charpentier, Orthop. Desc. et Depict., tab. IV. [Chili.]

[44] Possibly an error for Temuco, Cautin, Chile.

Colchagua, Chile. December, 1903. (Carlos S. Reed.) [A. N. S. Phila.] Ten males, ten females.

Lota, Concepcion, Chile. January, 1904. (Carlos S. Reed.) [A. N. S. Phila.] One male.

Zemuco (Temuco?), Chile. January, 1904. (Carlos S. Reed.) [A. N. S. Phila.] One male, one nymph.

Cautin, Chile. January, 1904. (Carlos S. Reed.) [A. N. S. Phila.] One male.

Chile. (E. C. Reed.) [U. S. Nat. Mus.] One male, one female.

The above series is rather constant in size and general characters. One female from Colchagua is abnormal in the brevity of the rostrum, that process having been injured and reduced to a mere stump.

October 4.

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

Eighteen persons present.

The Secretary reported that papers under the following titles had been received on the dates given, and accepted for publication since the last meeting:

"Comparative Age of the Different Floristic Elements of Eastern North America," by John W. Harshberger, Ph.D. (May 28).

"The Fishes of Nantucket," by Dr. Benjamin Sharp and Henry W. Fowler (May 31).

"The Morphology and Metamorphosis of the Alimentary Canal of the Mosquito," by M. T. Thomson (June 6). Transferred to the Entomological Section.

"Notes on Orthoptera from Northern and Central Mexico," by James A. G. Rehn (June 11).

"Notes on Orthoptera from Arizona, New Mexico and Colorado," by James A. G. Rehn (June 29).

"Variability and Autonomy of Phataria," by Sarah P. Monks (July 12).

"Notes on a Collection of California Mammals," by Witmer Stone (July 13).

"On a Collection of Birds and Mammals from Mt. Sanhedrim, California," by Witmer Stone and A. S. Bunnell (July 13).

"On certain Rhachiglossate Gastropoda eliminated from the Aquillidæ," by H. A. Pilsbry and E. G. Vanatta (July 23).

"Studies in the Orthopterous Subfamilies Acrydiinæ (Tettiginæ), Eumastacinæ and Proscopinæ," by James A. G. Rehn (August 17).

"Three Odd Incidents in Ant-Life," by Adele M. Fielde (August 27).

"The Structure and Development of the Compound Eye of the Honey-Bee," by Everett Franklin Phillips (August 30).

"New Chilopods," by Ralph V. Chamberlin (September 2).

"Description of New Land Snails of the Japanese Empire," by H. A. Pilsbry and Y. Hirase (September 6).

"The Development and Structure of the Larva of Paragordius," by Thomas H. Montgomery, Jr. (September 9).

"The Reaction of Ants to Material Vibration," by Adele M. Fielde and George H. Parker (September 20).

The deaths of the following members were announced: Henry Brinton Coxe, William S. Magee and Edward K. Tryon, Jr.

The deaths of R. A. Philippi, and Edward von Martens, correspondents, were also announced.

Dr. H. A. Pilsbry made a communication on the stages of growth and decline in the land mollusca. (No abstract.)

Dr. J. P. Moore spoke of sexual polymorphism in annelids, with special reference to the Polychæta. (No abstract.)

October 18.

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

Thirty-two persons present.

Papers under the following titles were presented for publication:

"The Orthoptera of Thomas County, Georgia, and Leon County, Florida," by James A. G. Rehn and Morgan Hebard (October 11).

"Annotated List of the Types of Invertebrate Cretaceous Fossils in the Collection of the Academy of Natural Sciences of Philadelphia." by Charles W. Johnson (October 14).

Dr. Benjamin Sharp reported his experience during the summer on a trawler from Hull which fished in the North Sea between England and Helgoland, and on the cutter which brought the catch to London. (No abstract.)

A new Centrifuge.—Dr. Henry Emerson Wetherill described a compact centrifuge that will do all the work of the ordinary centrifuge with the advantages of being more compact, less complex, and more easily cleaned.

It does away completely with the heretofore unnecessary gearing required for the revolutions, this being accomplished by a double rotating motion produced by the twisting of rawhides or rope. This to-and-fro motion gives a more level precipitation, and the magnifying bulbous end of the graduated bottle enables a measurement of the smallest amounts of precipitate. The bottles are tightly corked, thus preventing the mixture of the precipitate with the supernatant liquid, and serving as a safeguard in revolving infectious material.

The instrument will fit in the vest pocket like a clinical thermometer, and when one of the little pocket microscopes now to be had is used with it the work at the bedside is facilitated. Not only can urine be sedimented, but by reversing the tube small amounts of cream in milk, of a sufficient quantity, can be tested for. The speed is ample, and reduces the time for testing to one minute.

The following were elected members:

Michael F. McDonough, Charles D. Hart, M.D., and Mrs. Charles Roberts.

Frantisek Vidovsky, of Prague, and A. A. W. Hubrecht, of Utrecht, were elected correspondents.

The following were ordered to be printed:

THE EARLY DEVELOPMENT OF DINOPHILUS: A STUDY IN CELL-LINEAGE.

BY JAMES A. NELSON, PH.D.,
University of Pennsylvania.

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It is a pleasure to me to acknowledge my debt of gratitude to Prof. E. G. Conklin, of the Zoological Laboratory of the University of Pennsylvania, for his kindly advice and constant encouragement in the preparation of this paper. I wish also to thank Prof. T. H. Montgomery and Dr. J. P. Moore for many valuable suggestions offered during the pursuance of the work. To Prof. C. O. Whitman I am indebted for courtesies extended me at Wood's Hole, Massachusetts. In finishing the figures and in preparation of the manuscript for publication, it gives me pleasure to acknowledge my indebtedness to my wife for invaluable assistance.

I.—INTRODUCTORY AND HISTORICAL.

The phylogenetic relationships of *Dinophilus* have presented a perplexing problem to morphologists since the establishment of the genus by Oscar Schmidt in 1848. The various views as to its systematic position may be conveniently classed under three heads: (1) those referring *Dinophilus* to the Turbella ia; (2) those referring it to the

Nemertina, and (3) those referring it to the Annelida, or to some position intermediate between the annelids and the rotifers. The older writers, with the exception of van Beneden, referred the genus to the Turbellaria, on account of its obvious external resemblances to that group. Among these authors may be mentioned Schmidt (1848) (who, however, later changed his opinion), Max Schultze (1849), Diesing (1874), Mereschkowsky (1879), Korschelt, in his first paper on *Dinophilus* (1882), and Weldon (1886).

In 1861 van Beneden described a species from the coast at Ostende, and referred the genus to the nemerteans, principally, it would seem, on account of the character afforded in the possession of a proboscis. Of recent writers who have inclined to this opinion we have only Verrill (1895), who, however, does not enter into a discussion of the relationships of the group, but only provisionally refers it to the nemerteans.

The first to place *Dinophilus* among the annelids was Schmarda (1861), who described a species from the coast of South America, and assigned it to a place in the Oligochæte family of the Naidæ, next to the primitive genus *Ælosoma*. The claims of *Dinophilus* to a place among the annelids have, however, been based chiefly on its remarkable resemblance to certain annelid larvæ, especially those of the polytrochal type. The first to call attention to this fact was Metschnikoff (1866), who in his paper on *Apsilus* wrote concerning the systematic position of *Dinophilus:* "Dass Dinophilus als eine stationäre Anneliden-larva zu betracten ist, und mithin zu der Anneliden ebenso wie Appendicularia zu den Ascidien sich verhält." He also notices some resemblances to certain rotifers. As a curious parallel to this view may be cited Oscar Schmidt's (1882) comparison of the position of *Dinophilus* among the annelids to that of *Axolotl* among the true salamanders.

Graff (1882), in his fine monograph on the Turbellaria, removes *Dinophilus* from the Turbellaria, and considers it as more properly belonging near the Annelida.

Lang (1884) places *Dinophilus* in the line which leads through the Archiannelida to the rotifers. Harmer (1889) also regards *Dinophilus* as nearly related to the Archiannelida; Repiachoff (1886) considers it a true annelid, as does Korschelt (1893); while of the most recent writers Schimkewitsch (1895) considers *Dinophilus* as affording characters which relate it to both the rotifers and annelids.

These various views have been based almost entirely on anatomical evidence, since but three papers deal with the embryology, viz.: Korschelt (1882), Repiachoff (1886) and Schmikewitsch (1895).

Korschelt studied the living egg and described the manner in which the eggs were laid, the early stages of the cleavage, an epibolic gastrulation, and observed that at hatching the young *Dinophilus* closely resembles the adult. Repiachoff's paper is more complete as regards the embryology, giving numerous figures of the cleavage and sections of the gastrula. Two important discoveries are to be attributed to this investigator, viz.: That the mesoderm arises from a pair of mesoblast cells situated posterior to the blastopore, and that a considerable portion of the ectoderm of the adult arises from a pair of large cells situated at the posterior end of the embryo and derived from the largest cell of the 4-cell stage. Schimkewitsch follows along the same lines as Repiachoff, and does little more than confirm the latter's results, though the figures given by Schimkewitsch are much in advance of those given by Repiachoff. These authors, Korschelt, Repiachoff and Schimkewitsch, attempted to compare the cleavage of the *Dinophilus* ovum with that of the rotifers and consequently failed to properly interpret it.

In view of the fact that so little is at present known concerning the early development of this form, the evidence as to its relationships being principally anatomical, it has seemed highly desirable to study the embryology thoroughly, from the earliest cleavage on.

The present paper is concerned almost wholly with the cell-lineage. This has been done for two reasons: first, because such a careful study of the cleavage as is involved in a study of the cell-lineage gives a firm and secure basis for work on the later development; and second, because the study of the cell-lineage of mollusks and annelids has brought to light such striking resemblances that there can scarcely be any doubt that they are of phylogenetic significance.

II.—Material and Methods.

The species of *Dinophilus* with which this paper is concerned has not been determined with certainty. Both sexes correspond closely to the description given by Korschelt (1882) for the species found by him in aquaria at Freiburg, and named by him *Dinophilus apatris*. Repiachoff (1886) has supposed that this species is identical with *D. gyrociliatus* O. Schmidt. The individuals of the species found in the aquaria at the University of Pennsylvania agree with *D. apatris*, and differ from *D. gyrociliatus* in lacking the last or perianal circle of cilia, and also appear to differ from *D. gyrociliatus* in another important respect, *i.e.*, in having no segmental organs. E. Meyer (1887) figured for the females of *D. gyrociliatus* five pairs of nephridia of the type found in annelid larvæ (protonephridia). Careful study of fixed and living material has thus far afforded me no evidence whatever of nephridia of any sort.

The ova which were studied in the preparation of this paper were collected from the sea-water aquaria in the vivarium of the University of Pennsylvania during the months of January to May, 1902.

The ova are laid in gelatinous capsules as described by Korschelt for *D. apatris*, each capsule containing three to seven ova of two sizes, the smaller about one-third the diameter of the larger. The smaller ova give rise to the minute and degenerate males, while the larger ova give rise to the female individuals. The number of the large female ova exceeds that of the male. In fifty capsules 214 ova were counted, of which number 79 were male ova and 135 female. These latter have been the object of my investigation, the small size (ca. 30 micra in diameter) and smaller number of the male ova rendering them much less favorable for study. The capsules were found attached to the various sea-weeds in the aquaria, and particularly to the *Ulva*. A quantity of the sea-weed was taken from the tanks in which the animals were found to be most abundant and squeezed over a large watch crystal. The eggs thus washed out from their capsules, together with much vegetable débris, soon settled to the bottom of the watch crystal, from which they were picked out, under a lens, by means of a fine-pointed pipette and transferred to a small vessel. The vessel found most useful for this purpose was made from the hemispherical bottom of a small test-tube cemented to a slide. The ova collected in this manner proved to be in all stages of development, from the unsegmented ovum to an embryo ready to escape.

The ova were in all cases killed with Kleinenberg's stronger picro-sulphuric fluid, and after washing in 70 per cent. alcohol, were stained with Conklin's (1902) picrohæmatoxylin. This method of fixing and staining has proved satisfactory with so many forms that it was considered advisable, in view of the scarcity of the material, not to experiment further. The ova were then dehydrated, cleared in cedar oil or xylol, and mounted in balsam under covers supported by thin glass feet, thus providing a space in which the eggs may be rolled about by displacing the cover glass.

It has been noted by several observers that *Dinophilus* practically disappears at the approach of warm weather, and this fact was found to be true in this case also. This is interpreted by Korschelt to mean simply that the period of sexual activity has come to an end. However, species of *Dinophilus* have been found at Wood's Hole, Massachusetts, during the summer months by Verrill (1895) and by Miss Moore (1899), so that it would appear that some few individuals lived over the summer.

The animals found in the aquaria were probably imported on seaweed gathered at Wood's Hole, Massachusetts, or at Sea Isle, N. J., and owing to the favorable conditions afforded by the aquaria they multiplied and became abundant During the past three seasons, however, *Dinophilus* has not become abundant until late in the autumn or in the early winter. The largest number of ova were gathered in January and February, the number diminishing from that time, until by May their number was so small that it did not pay to collect them. During the past three years the animals have nearly all disappeared by the middle of June.

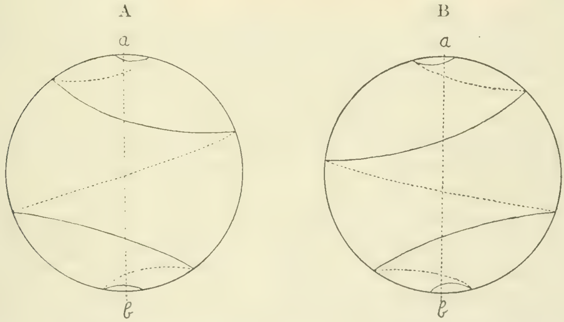


Fig. I. A and B, diagrams of ova with circumscribed loxodromic curves. a–b, egg axis. Copied from Mead (1897).

III.—Nomenclature.

The nomenclature adopted in this paper is that modification of Wilson's system (1892) used by Conklin (1897), with the further modification adopted by Child (1900) in prefixing coefficients to the macromeres, as well as to the micromeres. The macromeres are designated by capitals, the micromeres by small letters.

When the cleavage plane of two cells approximates the direction of the loxodromic curve shown in text fig. I, A, it is dexiotropic; when it approximates the direction of that shown in text fig. I, B, it is leiotropic.

The number of the quartette is indicated by a coefficient. Thus 1a is the member of the first quartette located in the A quadrant. The product of a division which lies toward the animal pole receives the exponent 1, that toward the vegetal pole the exponent 2. Thus $1a^1$ lies nearer the animal pole than $1a^2$. If the cleavage is meridional the right cell, as seen by an imaginary observer located at the animal pole, receives the larger exponent. Thus $1a^{1.1}$ lies to the right of $1a^{1.2}$.

The macromeres receive a coefficient corresponding to the number of the quartette to which they last contributed. Thus 4A last gave rise to 4a.

When cells arise whose origin and fate are similar to those of annelids or mollusks which have already received special names, as, for example, the "trochoblasts" or the "intermediate girdle cells," I have made use of these names. I do not, however, wish to imply that the cells are necessarily homologous with those to which these names were first applied.

The animal pole is that point at which the polar bodies are given off, the point opposite is the vegetal pole.

IV.—History of the Cleavage.

(1) *Unsegmented Ovum.*

My observations on the unsegmented ovum have unfortunately been confined entirely to fixed and stained material. Since in each lot of material all stages were found, from the unsegmented ovum to the larva about to hatch, a considerable amount of time and labor would have been involved and many ova lost in selecting for study the few which were still in an unsegmented condition. The ova are approximately spherical and not elongated in one dimension, as Korschelt describes them in *D. apatris*. Measurements of the diameters of six unsegmented eggs were respectively 108 micra, 100 micra, 90 micra, 96 micra, 92 micra and 100 micra, giving as the average diameter of the egg 97.66 micra. These measurements nearly approach those given by Korschelt for *D. apatris, i.e.,* 111 micra x 92 micra.

Closely surrounding the ovum is a delicate wrinkled vitelline membrane. The protoplasm in the living ovum is nearly opaque, this opacity being due to the presence of minute deutoplasmic spheres uniformly distributed throughout the cytoplasm. These deutoplasmic spheres give to the stained and mounted ova a darkly granular appearance, which in many cases makes both mitotic figures and cell outlines difficult to distinguish. Fig. 1[1] shows the ovum just after the extrusion of the second polar body. The latter is spherical in shape and about half as large as the first polar body, which is somewhat ovoid. In the first polar body a faint nucleus can be made out, but none in the

[1] See Plates XLIII–XLVIII.

second. Neither of them have been seen to divide. The polar bodies in *Dinophilus*, as in all animals, mark the animal pole, but are, however, not a reliable means of orienting the later stages, since through some cause they tend to become displaced and are ultimately taken into the cells over which they happen to lie. In fig. 8, for example, the first polar body is already sinking into the cell 1c, while the second is still free.

In fig. 1, beneath the polar bodies lies the female pronucleus, formed of four nuclear vesicles, each vesicle resembling a small nucleus in appearance, having a distinct bounding membrane and containing small granules of chromatin of varying sizes. Below the vesicles, and containing them as in a cup, is a large hemispherical aster. Somewhat below and to the right of the center of the ovum lies the male pronucleus with its accompanying aster, which lies on the vegetal pole side of the nucleus.

The stage next studied is represented in fig. 2, where the two pronuclei are seen to have come together. The male pronucleus is probably the large bilobed vesicle which lies on the side of the nucleus toward the vegetal pole; the female pronucleus is probably represented by the eight smaller vesicles on the other side. The ovum is in the early prophase of division, a large and deeply staining aster being on each side of the nucleus, though no spindle fibres can yet be distinguished.

(2) *Primary Cleavages.* 1–4 *Cells.*

The spindle for the first cleavage is shown in fig. 3. The cell body has elongated and the spindle is in the anaphase, while the unequal character of this cleavage is clearly indicated by the inequality in the diameter of the two asters as well as by the eccentric position of the spindle. The spindle is inclined at a slight angle to the horizontal plane, the end which is to form the smaller cell being the lower. The explanation of this is not clear; possibly the spindle was oscillating, or perhaps the position of the spindle may have something to do with the beginning of spiral cleavage. Unfortunately this is the only ovum which I have seen in which the spindle is in either metaphase or anaphase, so that it is not absolutely certain that this oblique position is normal. The plane of this division passes through the animal pole, but lies to one side of the pole opposite. The products of this division (fig. 4) are very unequal, the cell C–D greatly exceeding A–B in size.

Immediately after division both cells prepare to divide again, but the two halves of the second cleavage are not simultaneous, C–D dividing much in advance of A–B, as fig. 5 shows. As seen in the figure, the spindle in C–D has reached the late anaphase, the chromosomes lying close to the centrosomes, while a double row of microsomes has appeared on the spindle fibres. On the other hand, in A–B the spindle has only just reached the metaphase. The division of A–B is nearly equal, A being slightly the larger product, while the division of C–D is highly unequal. The spindles for both divisions are inclined in a leiotropic direction, as is especially well shown by the division of A–B in fig. 6, in which the left pole of the spindle is much higher than the right.

The four cells formed by the second cleavage all differ in size (figs. 6 and 7, text fig. II, A and B); while D is relatively colossal, C, B, and A are more nearly alike. Of these C is the largest, A slightly smaller than C, while B is the smallest of all. The enormous size of D can be

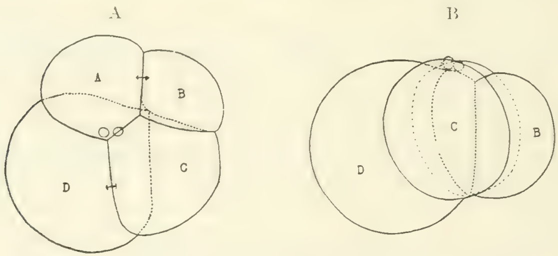


Fig. II. A, 4-cell stage from animal pole; B. same from right side.

appreciated only when the 4-cell stage is viewed from the side, as shown in text fig. II, B.

The size relation of the four cells A, B, C and D appears to be somewhat unusual. In all Annelida and Mollusca investigated which have unequal cleavage the left posterior blastomere D is the largest one of the 4-cell stage, except in the case of *Aplysia* (Blochmann, 1883; Carazzi, 1900) and the *Pteropoda thecosomata* (Fol, 1875). A and B are usually equal, while C is more or less intermediate between B. and D. Among the Lamellibranchia there appear to exist cases parallel to that of *Dinophilus*. An examination of the figures given for *Cyclas* (Stauffacher, 1893), for *Unio* (Lillie, 1895) and for *Dreissensia* (Meisenheimer, 1901) seems to indicate that in these forms B is the smallest of the four cells, while it is fairly evident that C exceeds A in size, although I find no precise statement of these facts in the text of the papers mentioned above. In all these forms D is relatively enormous.

In the 4-cell stage of the *Dinophilus* ovum but one polar furrow is usually present, that at the animal pole, formed by the junction of A and C. This furrow is very long and turns to the right when seen in the second cleavage plane. At the vegetal pole all four cells meet at a point (figs. 6 and 7, text fig. II, A and B). The condition where a polar furrow exists at the animal pole is also found in the Lamellibranchs mentioned alone; in these, however, the furrow is formed by the junction of B and D. The phenomenon of a long polar furrow existing at the animal pole in *Unio* is explained by Lillie (1895) as being due to the fact that "the greater mass of the first blastomeres is ectodermal." This explanation fits the case of *Unio* very well, since the blastomere D which contains the greatest mass of ectoderm takes part in the formation of the polar furrow, but does not explain the situation in *Dinophilus*, where D is entirely excluded from the polar furrow. This condition is probably due to two factors: (1) the extreme obliquity of the second cleavage spindles; and (2) to the relatively small size of B. The inclination of the spindles in A–B and C–D cause A and C to lie above B and D and so meet in a long cross furrow. Were B as large as either A or C it would meet D in a furrow at the vegetal pole, but since its mass is so much less than that of the other cells it just touches D at the vegetal pole.

The somewhat complex relation of the first and second cleavage planes to the embryonic axis will be discussed in a later section; for the purpose of convenience in description, however, the blastomeres A and B will be considered as anterior, C and D as posterior.

(3) *Segregation of Ectoblast.* 4–26 *cells.*

Immediately after the second cleavage of the ovum the nuclei of the blastomeres resume mitotic activity. In fig. 6 asters are seen in all four cells, while between A and C there are still the remains of spindle fibres to be seen. In D the asters have assumed nearly their definitive position, indicating where the ends of the dexiotropic spindle are to lie.

At this time there comes to light a curious and striking feature of the cleavage of the *Dinophilus* egg, mentioned by Lang (1884) as occurring in *Discocœlis*, by Lillie for *Unio* (1895) and by Jennings for *Asplanchna* (1896), also by Child (1900) as occurring occasionally in *Arenicola* at the third cleavage. This peculiarity consists in the fact that the macromeres never divide simultaneously, but always successively and in a regular and invariable order. This order is the same as that of *Unio* and *Arenicola*, *i.e.*, D, C, A, B, while that of *Asplanchna* is D, C, B, A. This order of division is maintained by the macromeres through five successive cleavages, and is more or less perfectly retained by their descendants. This succession is well shown in the ovum represented in fig. 8, where the nuclei of the cells 1D, 1C, 1d and 1c are in the prophase of the next division, while a bundle of spindle fibres still connects the nuclei of 1A and 1a and the micromere 1b is scarcely yet cut off from 1B. This sequence in the division of the macromeres is clearly correlated with the difference in the sizes of A B, C and D, since it has already been pointed out that in relative size the macromeres follow one another in the order D, C, A, B, which is also the order of their division. It is evident that this is only a special instance of a widespread class of phenomena, discussed by Kofoid (1894), who points out that in many ova the larger blastomeres, *i.e.*, those containing a greater amount of yolk, or rather more cytoplasm, tend to divide more rapidly than do the smaller ones. This, as Kofoid shows, is in contradiction to Balfour (1880), who formulated a law which supposes yolk to retard the cleavage. Kofoid ingeniously explains the contradiction by suggesting that "difference in the rapidity of cleavage is apparently correlated with the greater or less absolute amount of protoplasm," and that the amount of protoplasm in turn may be increased through the appropriation of yolk and the ratio of division may be thus indirectly hastened. In *Dinophilus*, however, while it seems tolerably plain that the difference in the time of division of the macromeres is related to their difference in size, yet the latter fact at first sight appears scarcely adequate to explain the great delay in the divisions of B as compared with those of A, since between these two blastomeres the difference in size is comparatively slight. On the other hand, it must be remembered that since the macromeres have different *rates* of division the gap between the time of division of the four blastomeres may be considerably widened as the cleavage progresses; in other words, A may start with but a slight lead over B, yet it is, through its more rapid rate of division, enabled to increase that lead in subsequent divisions. This difference in the rates of division of the four quadrants will become obvious by reference to the table of cell-lineage at the back of the paper.

The spindles for the third cleavage are inclined strongly to the right, and the daughter cells, the first quartette of ectomeres, when first formed lie in the furrow between the macromeres. The diameter of these cells, as figs. 8 and 9 show, is about two-thirds of that of the macromeres from which they arose. They are not, however, all of the same size, the two posterior micromeres 1d and 1c being equal in size and larger than the anterior pair 1a and 1b which also are equal. This size relation between the members of the first quartette occurs in *Nereis* (Wilson, 1892), *Amphitrite* and *Clymenella* (Mead, 1897), in *Arenicola* (Child, 1900), and, as the figures appear to indicate, in *Capitella* (Eisig, 1898), although Eisig states (p. 7) that the micromeres are "unter sich aber annäherend gleich grossen Zellen." Among the Mollusca this size relation seems not to appear at all.

The next cleavage, the fourth, is inaugurated by the second division of 1D. In fig. 8 this macromere is seen to be already in the prophase of division, and while the other cells in the ovum are preparing for division 1D separates by a leiotropic division into the relatively enormous cell 2d and the macromere 2D, which has now been reduced to the size of its fellows (figs. 9 and 10). 2d, the "first somatoblast" of von Wistinghausen (1891), which I shall label X, following Goette and most recent writers on the cell-lineage of annelids, lies in the second cleavage furrow slightly to the left of the mid-line. This cell is a most valuable aid to orientation, owing to its large size and fixed position. In this last division the macromere 2D, the smaller division product, becomes displaced, being crowded downwards so as to be almost directly below 1A (figs. 9 and 10). A similar displacement of 2D occurs also in *Unio* (Lillie, 1895), *Dreissensia* (Meisenheimer, 1901), *Capitella* (Eisig, 1898), and probably whenever the cell 2d greatly exceeds in size its parent macromere. 2D subsequently returns to the level of the other macromeres.

At about the time 2d is produced the first quartette undergoes a rotation in an anti-clockwise direction, so that each micromere comes to lie exactly over the macromere from which it arose (cf. figs. 8 and 10). This rotation is undoubtedly brought about by the division of 1D to form 2d, the latter cell being pushed backward and upward in a leiotropic direction. In *Crepidula* (Conklin, 1897), *Arenicola* (Child, 1900) and in other forms a similar rotation is brought about through the formation of the cells of the second quartette.

The micromeres 1d and 1c next divide, the spindles being inclined in a leiotropic direction. Through these divisions there are budded off from 1d and 1c, on their peripheral sides, small cells of equal size, $1d^2$ and $1c^2$, $1d^2$ being formed first (figs. 9 and 10). These cells, though formed by a truly spiral division, come to lie laterally to their parent cells and overhung by them (figs. 10, 11, and 12). A little later 1a and 1b follow in a similar division, the cells $1a^2$ and $1b^2$ being equal in size and somewhat smaller than $1d^2$ and $1c^2$, and come to lie in the furrow below the micromeres $1a^1$ and $1b^1$ and to the right of them. These last-formed cells are minute and were at first difficult to detect, being overhung by their parent cells. The four cells $1d^2$, $1c^2$, $1a^2$ and $1b^2$ correspond both in origin and subsequent fate to the "trochoblasts" of annelids and to the "turret cells" of mollusks, and will be termed "trochoblasts," since the cleavage resembles that of the annelids rather than that of the mollusks.

While the trochoblasts are forming, 1A and 1C are in division (figs. 11 and 12), giving rise to two other members of the second quartette. The division of the two macromeres is nearly simultaneous, though C is slightly in advance. The two micromeres 2c and 2a are nearly equal in size to the two anterior cells of the first quartette.

Coincident with the division of 1A and 1C is the division of X (2d), the first step in the fourth cleavage (figs. 11, 12 and 13). X buds off a cell of about a third of its own diameter, low down on the right side (x^1, figs. 12 and 13). Closely following the formation of x^1 is the leiotropic division of 1B to form 2b, the last member of the second quartette, and the dexiotropic division of 2D to form the first member of the third quartette, 3d (figs. 13 and 16). Thus the macromere of the D quadrant has now obtained a lead of one division over the macromere of the B quadrant, and this lead is maintained as far as the formation of the fifth quartette. 3b is the smallest member of the second quartette, while 3d will prove to be the largest member of the third. Soon after 3d the other members of the third quartette appear one by one, 3c and 3a equal in size, and last 3b, the smallest of the four, which does not appear until after the formation of the mesoblast cell 4d (figs. 13 to 20).

Meanwhile divisions are occurring in the first and second quartettes. The divisions of the former are dexiotropic and concern the four larger cells only. The left products are nearly alike in size; smaller than the right products in the posterior quadrants, nearly equal to them in the anterior. There is thus formed a flat cap of eight cells (fig. 14), four of which lie radially and four interradially; the former, $1a^{1.2}$, $1b^{1.2}$, $1c^{1.2}$, $1d^{1.2}$, correspond in origin and very probably in fate to the "intermediate girdle cells" of *Nereis* (Wilson, 1892), and they will hereafter be called such. The four remaining cells, following the same terminology, will be called "stem cells." While these last divisions are in progress and the third quartette forming, 2a and 2c each buds off a small cell at its apex (figs. 15 and 16, $2a^1$ and $2c^1$). According to the rule of alternating cleavage this division should be leiotropic; in fact it is nearly equatorial, though the division of 2b, which occurs later, is strongly dexiotropic. The ovum represented in figs. 14, 15 and 16 is the only one seen which shows this division in progress. However, the subsequent position of the cells $2a^1$ and $2c^1$ shows this division to be very nearly an equatorial one, though the next division of the cells $2a^2$ and $2c^2$ is strongly leiotropic (figs. 26 and 27). The cells $2a^1$ and $2c^1$ lie above their parent cells and in contact with the stem and intermediate girdle cells, at the same level with the trochoblasts. In consideration of their origin and subsequent fate they will be given the name "secondary trochoblasts," which is given by Mead (1897) to cells of similar origin and fate in *Amphitrite* and *Clymenella*. During these last divisions X has given rise to a cell on its left side x^2, in size similar to x^1, and nearly opposite that cell but at a somewhat higher level (figs. 16 and 18 and fig. 42). At the same time x^1 is also undergoing division, giving off a cell $x^{1.2}$ at its lower side. This is the so-called anal cell (Mead, 1897).

(4) *Segregation of Mesoblast.*

In the ovum represented in figs. 15, 16, and 17, a large spindle is seen in 3D. In fig. 18 the spindle is in the anaphase and the cell body has elongated, clearly indicating by the unequal size of its lobes the very unequal character of the division products. The latter are shown in fig. 24, the division having been completed. The posterior larger product is 4d, the chief mesoderm cell of mollusks and polychætous annelids. According to the law of alternating cleavage the spindle for this division should be leiotropic; in fact it is dexiotropic. This reversal in direction of the spindle can be accounted for partly by the crowding downward of 4d during the process of its formation. In the ovum represented in fig. 16 the spindle in 3B is nearly horizontal, while in that represented in fig. 18 it is inclined almost 40° to the horizontal plane. This inclination is clearly brought about by the great size of both 4d and X. Abutting as it does against X, 4d is prevented from attaining the level of 4D, and thus the left end of the spindle comes to be the lower. Why the spindle should not be inclined leiotropically at first is not clear.

The position of 4d in front of and below X and slightly to the left of the mid-line is almost precisely that of 4d in *Nereis* (Wilson, 1892), where the conditions concerned in its formation are very similar to those prevailing in *Dinophilus*.

4D is now reduced to about half the size of its fellows. This great reduction in size of the macromere 4D is not known among the annelids, but among mollusks it is a fairly common condition, *e.g.*, *Umbrella* (Heymons, 1893), *Unio* (Lillie, 1895), *Ischnochiton* (Heath, 1899), *Dreissensia* (Meisenheimer, 1901), *Trochus* (Robert, 1903).

With the formation of 4d and 3b the segregation of the germ layers now consists of 29 cells distributed as follows:

Ectoblast	First quartette,	12 cells.
	Second quartette,	8 "
	Third quartette.	4 "
Mesoblast .	Fourth quartette (4d),	1 "
Entoblast .	Entomeres,	4 "
	Total,	29 "

Thus in *Dinophilus* another example is already added to a long list of forms in which the ectoblast arises from the first three quartettes of micromeres, the mesoblast from the left posterior cell of the fourth quartette, and the entoblast from the remaining cells. To this mode of origin of the germ layers apparently the cephalopods alone form an exception. Among the annelids it is at present known to obtain

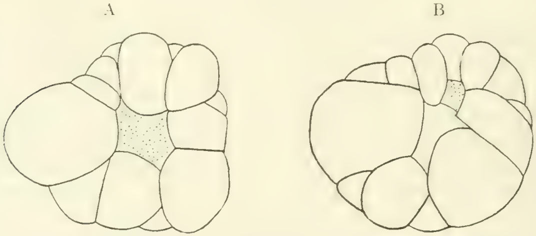


Fig. III, illustrating the reduction of the cleavage cavity. A, optical section of stage of about 54 cells; B, 72 cells. Cleavage cavity stippled.

only in the groups of the Polychæta and Echiuridæ. The fine paper of Eisig (1898) on *Capitella* seems to indicate that this manner of derivation of the germ layers does not extend to the Capitellidæ, since in *Capitella* Eisig derives the permanent mesoblast ("cœlomesoblast") from cells of the third quartette ($3c^1$ and $3d^1$), while 4d gives rise to larval or secondary mesoblast ("pædomesoblast") and ectoderm. However, in view of the probable tendency of the ova of *Capitella* to abnormal development, it is, I think, permissible to doubt these somewhat surprising results until they are verified in the same or some allied form. These results seem all the more surprising in view of the great resemblance which, in other respects, the cleavage bears to that of the Polychæta. Among the Echiuridæ, Torrey (1902, 1903) has found that *Thalassema* in its cleavage and in its mode of origin of the germ layers agrees closely with the Polychæta.

As compared with the Polychæta the origin of the mesoblast cell 4D in *Dinophilus* occurs very early. In fact the segregation of the three germ layers is completed at almost the same instant, since while 3D is dividing to form 4d, 2B is also dividing to form 3b. If, as Mead (1897) urges, the mesoblast belongs to the ideal 64-cell stage, then 4d should typically arise only after the 32-cell stage. As a matter of fact, it

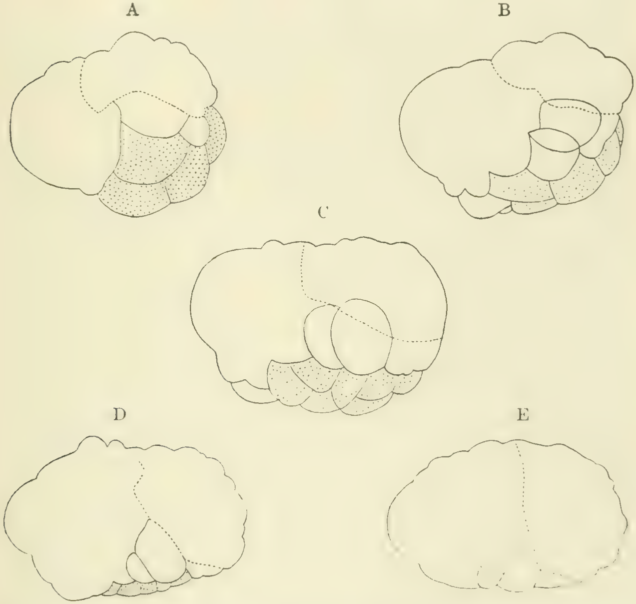


Fig. IV, A, B, C, D, E, diagrams of embryos of *Dinophilus* at different stages, illustrating the migration of the ectoderm during the closure of the blastopore. The ova are drawn as seen from the right side. The approximate limit of the first quartette is shown by a dotted line. The entoderm uncovered by ectoderm is stippled. From camera sketches.

does so arise in all the Polychæta whose early development has been investigated, and also in *Thalassema* (Torrey, 1902, 1903). On the other hand, in *Capitella* 4d belongs to the 29-cell stage, while among the Mollusca are several forms in which 4d is segregated before the 32-cell stage, *e.g.*, *Neritina* (Blochmann, 1882), *Crepidula* (Conklin, 1897), *Physa* (Wierzejski, 1897). At the other end of the series stands *Ischnochiton* (Heath, 1899), in which the formation of 4d is delayed until the 72-cell stage. Yet, in spite of these modifications, which are plainly of a cœnogenetic nature, it is a remarkable fact, as Heath (1898) has pointed out, that the definitive mesoblast preserves its origin from 3D.

V.—Outline of the Further Development.

In order to make the histories of the quartettes more intelligible, it is desirable to give a brief account of the later history of *Dinophilus*, up to the time of hatching. My observations in regard to the main points agree essentially with the account given by Schimkewitsch (1895) for the White Sea form.

After the segregation of the germ layers, *i.e.*, at the 29-cell stage, a cleavage cavity of considerable size has been formed, and this cleavage cavity persists up to a stage of about 54 cells when it has reached its maximum size (text fig. III, A). The ovum is now roughly spherical in outline. Very soon, however, the ectoderm cells which roof the cleavage cavity spread out and flatten down, thus greatly reducing it, and finally causing it to be obliterated completely (text fig. IV, A and B). This flattening of the cap of ectoderm produces a pronounced change in the contour of the embryo, which is now decidedly elongated at right angles to the egg axis, *i.e.*, in an antero-posterior direction, and this elongation becomes more pronounced as development progresses. The ectodermal cap—that is, all of the ectoderm exclusive of the 2d group—now moves over the entoderm in a forward direction. The various stages of this movement are illustrated in text fig. IV, A, B, C and D. In the embryo A, the boundary of the first quartette, marked by a dotted line, lies in a plane nearly parallel to the long axis of the embryo; the apical rosette and the vegetal pole are still nearly opposite one another. In the embryo B the forward movement of the ectodermal cap can plainly be seen to have begun. Embryos C, D and E show the further movements leading to the closure of the blastopore, which brings the first quartette into a position at the anterior end of the embryo, after having rotated through an angle of about 80 degrees. That part of the ectoderm which formerly marked the animal pole, the apical rosette or its derivatives, is now just dorsal to the anterior pole of the embryo, while the boundary of the first quartette lies in a plane almost at right angles to the long axis of the embryo. This forward movement of the ectoderm is brought about by the mitotic activity of the cells of the 2d group dorsal to X—X, *viz.*, x^3, x^4–x^4, x^5–x^5, etc., and probably also of cells derived from the intermediate girdle cell of the D quadrant. Mead (1897), Treadwell (1901) and Torrey (1903) have shown that in the annelids *Amphitrite, Podarke* and *Thalassema* respectively cells from this region wander out through the dorsal gap of the prototroch and contribute to the dorsal ectoderm of the trochophore. The thinness of the dorsal ectoderm of the *Dinophilus* embryo after the closure of the blastopore bears witness to the great mitotic activity in this region (compare figs. 54 and 56 and fig. 58). While this forward movement is taking place the ectoderm is increasing in lateral extent, as comparison of the embryos illustrated in text fig. IV readily shows. At the same time on the ventral side cells of the ventral plate have covered over the mesomeres, so that now the entoblast is completely enclosed with the exception of a small area at the vegetal pole, the blastopore. This soon closes, the ectodermal cells fusing so smoothly as to leave no visible trace of their union. Meanwhile the entodermal cells have undergone a change in that their lower or vegetal pole ends have become progressively smaller as the blastopore closes, while their upper or animal pole ends have become correspondingly larger. During this change in shape of the entomeres their nuclei recede from the surface and move inward (figs. 53–56).

The stomodæum appears as a shallow depression of the ectoderm at the point where the blastopore closed (fig. 58). The ventral plate now begins to grow forward very rapidly, pushing the stomodæum before it until the latter reaches a subterminal position, the position of the definitive mouth (fig. 59, st.). The stomodæal invagination now deepens from a shallow depression to a finger-like inpushing, directed somewhat backward. In fig. 59 the posterior wall of the stomodæum is seen to have thickened; this mass of cells (pro.) is the rudiment of the proboscis. In fig. 60 this organ (pro.) has assumed essentially its definitive structure and relations. From the stomodæal invagination is formed all of the alimentary canal anterior to the stomach, including the Vormagen or proventriculus.

While these changes are taking place the entodermal cells have been slowly dividing and have arranged themselves about a centrally situated cleft, the rudiment of the lumen of the future stomach and intestine (fig. 59, sto.l.). As the development progresses the entodermal cells assume the arrangement and appearance of an epithelium, while at the same time the lumen of the future stomach increases in extent. In fig. 60 the entoderm cells are now seen to form a cuboidal epithelium, while the lumen of the stomach is a long and narrow cleft, extending obliquely downward and forward. From the posterior end of the stomach projects a short diverticulum, the rudiment of the intestine (int. l.).

The proctodæum appears, at the time that the stomodæum has assumed its final position. as a simple thickening of the ectoderm at the posterior end of the body (fig. 59, pr.). At a later stage a small depression appears in this thickening (fig. 60, pr.). The proctodæum probably forms only the terminal portion of the intestine, or anus. Fusion of the proctodæum and stomodæum with the entodermal portion of the alimentary tract does not take place until very shortly before hatching.

The rudiment of the brain appears early. Just after the blastopore has closed, the ectoderm at the anterior end of the embryo is thicker than elsewhere, presenting the appearance shown in optical section in fig. 58. The cells of this region multiply rapidly, and the ectoderm here soon becomes many-layered (fig. 59). At a later period (figs. 60 and 61) a transverse band of nerve fibres (br.com.) is seen below and in contact with the ectoderm at this point, while the nuclei of the deeper layers have become very numerous. The latter undoubtedly constitute the nuclei of the ganglion cells, while the band of nerve fibres constitutes the commissure connecting the lateral lobes of the brain of the adult. The brain is now essentially similar to that of the adult, which remains throughout life in contact with the ectoderm of the head.

The further changes before hatching consist principally in the elongation of the body and the formation of somites. The rapid growth of the ventral plate causes the embryo to bend strongly toward the dorsal side, as is shown in fig. 60, though here the flexure is not nearly so great as it becomes at a still later period. This rapid growth of the ventral ectoderm is apparently not compensated for by a corresponding growth of the dorsal ectoderm until shortly before hatching. The head is separated from the trunk by a constriction at a stage corresponding to that illustrated in fig. 59, that is, as soon as the stomodæum has taken up its final position at the anterior end of the embryo. The trunk segments do not appear until the body begins to elongate, when the constrictions which mark them off appear successively from in front backward. In the embryo shown in horizontal section in fig. 61, one trunk segment, the first, is clearly shown, while two more are indicated posterior to this one.

VI.—History of the First Quartette.

(1) *The Cross and the Intermediate Girdle Cells.*

At the time of the formation of the mesoblast cell 4d, the first quartette consists of twelve cells—four stem cells, four intermediate girdle cells and four trochoblasts (fig. 14). According to the ideal scheme the trochoblasts should by this time have divided once, but their rate of division is very greatly retarded, obviously in correlation with the comparatively late period at which they become functional.

The stem cells are the next to divide. Even before 4d is formed, the posterior stem cells ($1d^{1.1}$ and $1c^{1.1}$) are preparing for a leiotropic cleavage (fig. 14). These divide and $1a^{1.1}$ and $1b^{1.1}$ soon follow; the upper (left) products resulting from the division are four small cells of equal size, forming a quatrefoil at the animal pole, the "rosette" of *Nereis* (Wilson, 1892) and other annelids (fig. 20).

While the rosette is forming, the intermediate girdle cells are also engaged in a leiotropic division which is unequal in all save the D quadrant (fig. 20). In the A, B and C quadrants the right and peripheral product is a small cell, to which, in consideration of its origin and probable fate, has been given the name "accessory trochoblast," a term applied by Heath (1899) to cells of *Ischnochiton* of similar origin and fate.

While the division of the stem cells and intermediate girdle cells is in progress the trochoblasts also divide (figs. 20, 21, 22 and 29). $1c^2$ and $1d^2$ usually divide at nearly the same time, although in fig. 14 $1c^2$ is the only trochoblast showing a spindle; $1a^2$ follows more or less closely on $1d^2$ and $1c^2$, while $1b^2$ is always delayed. The division is meridional in the posterior trochoblasts; in the anterior pair the plane of division, although very nearly meridional, is nevertheless inclined sufficiently to indicate a dexiotropic cleavage (fig. 29).

Returning to the stem cells, the posterior pair of these are found to be again in mitotic activity, their spindles having reached the metaphase before the last division of $1b^{1.1}$ is fully completed (fig. 20). These spindles are not spiral, but truly radial in position. Their central ends lie at a higher level than their peripheral ends.

This division marks the beginning of bilateral cleavages in the first quartette, though these do not appear in the intermediate girdle cells. In fig. 20 the symmetrical position of the spindles in $1c^{1.1}$ and $1d^{1.1}$ is obscured owing to the clockwise rotation of the first quartette, caused by the formation of x^3 in a dexiotropic direction. In fig. 25 may be seen the products of this division: of these the peripheral products are slightly the larger, and are overlapped by the central products, owing to the oblique position of the spindle. Meanwhile the first quartette has rotated in an anti-clockwise direction, being thus restored to its original position. Next $1a^{1.1.2}$ and $1b^{1.1.2}$ divide, the spindles in their cells being also truly radial, with the central ends the higher. The cell pattern produced by these divisions is similar to that first found by Wilson (1892) in *Nereis, Polymnia, Spio* and *Aricia,* and called by him "the cross." The characteristic feature of the cross is the radial divisions of the stem cells. This, as has just been described, is also the case in *Dinophilus*, but the cell pattern is marred by the belated division of $1b^{1.1.2}$, which does not occur until the basal cells of the posterior arms of the cross are again in division (fig. 30). The cross is formed also in *Amphitrite, Clymenella* and *Lepidonotus* (Mead,

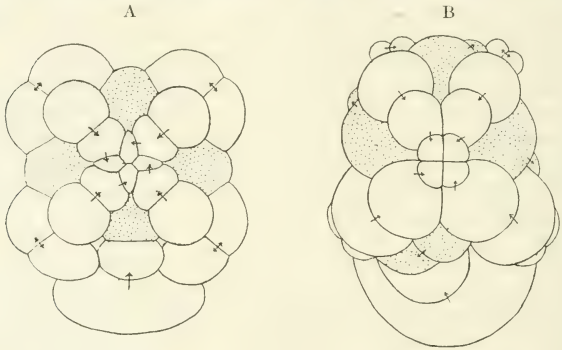


Fig. V, A, the "cross" of *Nereis*, copied from Wilson (1892); B, diagram of the "cross" of *Dinophilus*. The four quadrants are represented as having divided simultaneously.

1897), *Capitella* (Eisig, 1898), *Arenicola* and *Sternaspis* (Child, 1900), and *Podarke* (Treadwell, 1901). In *Podarke* the spindles are slightly dexiotropic, and in *Chætopterus* (Mead, 1897) they are so much so that the cross is not formed at all. In *Dinophilus* the spindles are truly radial, no trace of the spiral type having been observed. The comparison of the *Dinophilus* cross and that of the polychætous annelid *Nereis* will be made clear by reference to text fig. V, A. and B.

The radial spindles forming the cross mark the appearance of bilateral cleavage in the first quartette. Not only is the cross in itself a symmetrical structure, but it is bilaterally symmetrical with respect to the median plane of the embryo, and this is, as Wilson pointed out in *Nereis* (1892), "an adult bilaterality foreshadowed, long before bilateral divisions begin, in the arrangement of the cells." In other words, the adult bilaterality is expressed in the arrangement of the four cells $1a^{1.1.2}$, $1b^{1.1.2}$, $1c^{1.1.2}$ and $1d^{1.1.2}$ brought about through spiral cleavages, and in fact foreshadowed in the 8-cell stage. These facts have all been shown to be true for all the forms in which a cross occurs, and need not be dwelt upon here.

While the anterior stem cells are dividing to form the anterior arms of the cross, new spindles appear in the intermediate girdle cells $1a^{1.2.1}$ and $1c^{1.2.1}$ (figs. 25, 26 and 27). These cells then give rise at their peripheral margins to tiny cells with a deeply staining nucleus (figs. 30, 31 and 32). The direction of these divisions is somewhat uncertain, but judging by the position of the smaller products it is dexiotropic in $1a^{1.2.1}$ and leiotropic in $1c^{1.2.1}$. Later $1b^{1.2.1}$ gives rise to a similar cell (figs. 37 and 41). This division is unmistakably dexiotropic. It is of interest to note that in *Amphitrite* (Mead, 1897) and *Arenicola* (Child, 1900) these same cells should also be small and provided with a densely staining nucleus. In *Thalassema* (Torrey, 1902, 1903) these cells are truly rudimentary, and it seems quite probable that such is the case in *Dinophilus* also, judging from their minuteness and staining reactions.

Closely following the division of $1b^{1.1.2}$ to form the right anterior cross arm, indeed almost simultaneous with this division, is that of the posterior basal cells of the cross. The plane of this division is meridional, as is also the case in the annelid cross, but differs from the latter in that the division is an asymmetrical one, since the left product of the left posterior basal cell is very much smaller than the right product, while the products of the right posterior basal cell are equal (figs. 30 and 37). This curious divergence from the annelid type I am at present unable to explain. Possibly a further study of the cleavage and of the history of the individual cells of the cross might offer a solution of the problem. Closely following the divisions of the posterior basal cells comes the division of the posterior terminal cells. The spindles for this division are meridional, and the upper and central products of this division are minute cells, which lie above their parent cells as shown in figs. 37, 38 and 39. These correspond in origin to the "nephroblasts," which in *Nereis* (Wilson, 1892) form the head kidney (or possibly slime glands), and which in *Amphitrite* (Mead, 1897) give rise to the large mucous glands of the umbrella of the trochophore. In *Podarke* (Treadwell, 1901) these cells are also minute and occupy relatively the same position as in *Dinophilus*. Treadwell describes small cells of the first quartette which sink through the ectoblast and, reaching the cleavage cavity, there degenerate. Torrey (1902, 1903) suggests that among these small cells are those two mentioned above, viz., $1d^{1.1.2.2.1}$ and $1c^{1.1.2.2.1}$. In *Clymenella* the nephroblasts are also small and form part of the dorsal ectoderm of the head, as they do in *Arenicola*. What the fate of these cells is in the case of *Dinophilus* I do not know.

The significance of the annelid and molluscan crosses and of bilateral cleavage in general has been most thoroughly discussed by recent writers on cell-lineage, and on this particular point I have nothing to add. Since, however, it is generally agreed that bilateral cleavages are not directly referable to purely mechanical causes, but are the result of unknown factors, which cause the throwing back of the bilaterality of the adult upon the embryo, it is remarkable that this appearance of the adult bilaterality should have occurred in the same cell generation, in the same direction, and resulting in the same cell pattern as in the Polychæta. This resemblance is still further continued in the direction of division of the posterior cross arms.

The rosette cells at the time of their formation lie in the furrows between the stem cells, but almost immediately afterward they move in a clockwise direction (cf. $1a^{1.1.2}$ and $1a^{1.1.1}$ in fig. 20), so that the cells now lie interradially, instead of radially, as in the annelid cross (text fig. V, B).

At a stage numbering between one hundred and one hundred and fifty cells, the rosette divides dexiotropically and equally. Its cells, which possibly later undergo another division, form a cluster of cells much smaller than those surrounding it, and can be thus distinguished nearly to the time of the closure of the blastopore. As far as my observations on both fixed and living material extend, the rosette never bears cilia. In *Capitella* also an apical tuft of cilia is never present, though the rosette is formed as in other Annelida.

The further history of the first quartette is comparatively simple. The forward movement of the cells of the first quartette has already been described (see text fig. IV, A–E). The limits of the first quartette have been determined by two landmarks, the cells $2a^{2.2.1}$ and $2c^{2.2.1}$ on the right and left sides respectively, and that chain of small cells which I have identified as the prototroch. These latter extend over the sides, passing just anterior to the cells $2a^{2.2.1}$ and $2c^{2.2.1}$, and around the ventral side as a continuous row, but on the dorsal side there is the wide gap so often found in the early stages of the trochophore larva, and due to the same cause, viz., the non-participation of the products of 2d in the formation of the prototroch. Owing to this fact I have not been able to trace with certainty the dorsal posterior limits of the first quartette. On the ventral side the boundary of the first quartette is indicated in fig. 55 by the most anterior row of small cells, and curves forward in a semicircle in front of the blastopore. The position and general outline of the first quartette are sufficiently indicated in text fig. IV, E. It covers like a cap the anterior end of the embryo and corresponds to the umbrella of the trochophore.

At the time of the appearance of the stomodæum the ectoderm at the anterior end of the embryo is seen (fig. 58) to consist of high columnar cells, while the ectoderm cells covering the rest of the embryo—except at the posterior end, where are the still large remnants of the X cells—are cubical or flattened. The centre of this thickened area is not precisely the anterior pole of the larva, but slightly dorsal to that point, at which place the descendants of the rosette were last recognized. This thickening is the rudiment of the brain of the adult. At a later stage the cells of the thickened area have multiplied and become so closely crowded together that their outlines are barely distinguishable. In fig. 59 the brain rudiment has increased both in thickness and extent, and has at the same time moved somewhat dorsad owing to the rapid growth of the ventral plate. In fig. 58 the thickened area represents, as comparison with text fig. IV. E, will show, less than half of the first quartette; in fig. 59 it has increased to nearly twice its former area. Fig. 60 shows the brain in sagittal section at a slightly later stage. On the dorsal side, just behind the brain, is a deep furrow which in the adult separates the head from the trunk. The lateral extent of the brain is shown in fig. 61, a horizontal section of a stage more advanced than that shown in fig. 60. In this embryo the brain already shows signs of its bilobed character. From these figures it can be seen that nearly the whole of the first quartette is involved in the formation of the brain, if we assume that the second preoral ciliated band of the adult arises from the trochoblasts, as is probably the case, since the brain rudiment is limited posteriorly by the constriction which separates the head and trunk; while the second preoral ciliated band of the adult (prototroch) appears on the elevation of the head just anterior to this constriction.

The cell origin of the cerebral ganglia among the mollusks has been very fully described by several recent investigators (Conklin, 1897; Holmes, 1900; Meisenheimer, 1901; Robert, 1903); among the annelids by von Wistinghausen (1891) and by Wilson (1892) for *Nereis*, by Mead (1897) for *Amphitrite*, by Eisig (1898) for *Capitella*. Wilson has shown that von Wistinghausen's account was incomplete and erroneous, and believed that the cerebral ganglia arise from the cross. Later investigators have been unable to either prove or disprove this statement. It is at least certain that the brain is formed from the first quartette of micromeres, and its first rudiment is found in the neighborhood of the rosette. These facts, however, can be gathered from the works of the older investigators (Hatschek, Salensky, *et al*).

In *Dinophilus* the rudiment of the cerebral ganglia involves more than the cells of the cross alone. Its development, however, is typically annelidan, since the ectodermal thickening which represents the earliest rudiment of the brain appears beneath the rosette, which in the trochophore bears the apical tuft of cilia. *This rudiment then is to be regarded as the ontogenetic representative of the "Scheitelplatte" of the annelid trochophore.*

(2) *The Prototroch.*

The head of both the larval and adult individuals of *Dinophilus gyrociliatus* (*apatris*) is encircled by two narrow transverse bands of long cilia, similar to those which are found on the metameres of the trunk, as illustrated in text fig. VI. Both of these bands are preoral; the first being situated just anterior to the eyes, the second surrounds the head near its juncture with the trunk, and passes ventrally just anterior to the mouth. This second preoral band corresponds in position and function to the prototroch of the trochophore. It first appears at a stage nearly corresponding to that figured in fig. 59 as two delicate tufts of cilia on each side of the head.

The history of the cells composing this second preoral ciliated band, which I have already taken the liberty of calling the prototroch, will be considered under the head of the first quartette. I have done this chiefly because of the important place given in the literature of cell-lineage to those components of the annelid prototroch and the molluscan velum derived from the first quartette, the "primary trochoblasts" (Mead, 1897).

At the 29-cell stage the primary trochoblasts are already beginning to divide (figs. 14 and 15). The division is equal in all. The posterior pair divide meridionally, while in the anterior pair the spindle is inclined from the horizontal plane in a dexiotropic direction. While the posterior pair begin to divide as early as the stage shown in fig. 14 (26 cells), $1b^2$ does not complete its division until a stage numbering 54 or more cells is reached. Meanwhile the cells of the second quartette in the A and C quadrants have each given off a small cell above, by a nearly equatorial cleavage (figs. 14, 15, 16, 18 and 19). 2b later also divides, but this cleavage, instead of being equatorial, is strongly dexiotropic, as it should be, following the law of alternating cleavage (fig. 29). While this division is in progress, the lateral cells of the second quartette are again in division (figs. 26 and 27). This division is leiotropic; its result is that a cell similar to but smaller than $2a^1$ and $2c^1$ is placed to the left of these cells. Lastly, $2b^2$ divides similarly, the products being shown in fig. 41. For the six cells thus formed from the second quartette, $2a^1$, $2a^{2.1}$, etc., I have adopted Mead's name of "secondary trochoblasts," though they are not precisely identical in origin with those to which Mead gave this name. At a stage of about 81 cells the secondary trochoblasts $2a^1$ and $2c^1$ divide leiotropically and equally (figs. 34 and 35). No doubt $2b^1$ also follows suit, though I have not seen this division.

The origin of the "accessory trochoblasts" $1a^{1.2.2}$, etc., by the dexiotropic division of the intermediate girdle cells has already been described. There is now an irregular row, formed of 22 small cells, which encircles the embryo at a level just between the first and second quartettes. These cells are arranged as follows, passing from left to right: $1d^{2.2}$–$1d^{2.1}$–$2a^{2.1}$–$2a^{1.2}$–$2a^{1.1}$–$1a^{2.2}$, etc. It is very probable that the accessory and primary trochoblasts soon divide again, since in the embryo from which fig. 50 was drawn $1c^{2.2}$ and $1c^{1.2.2}$ were both undergoing an equal and meridional division. The row of cells thus formed is clearly distinguishable up to the closure of the blastopore, and it was by means of this row as well as by the large size of $2a^{2.2.1}$ and $2c^{2.2.1}$ that I have been able to trace the boundary of the first quartette, as shown in text fig. IV, A. The trochoblasts are very transparent, and become elongated in the direction of the cell row.

At the stage shown in fig. 55 the prototroch is nearly transverse to the long axis of the embryo, as is also shown by the dotted line in text fig. IV, E, but in front of the blastopore it bends sharply forward in a semicircle. In these figures the trochoblasts are represented by the most anterior row of that group of small cells lying just anterior to the blastopore. Beyond the stage represented in fig. 55 I have not been able to trace this group, since all the cells of the ectoderm, through rapid mitosis, soon become nearly uniformly small in size. In fig. 44, where the trochoblasts were last identified, they were on the ventral side, but a short distance anterior to the blastopore, and passed up on each side in a row nearly transverse to the long axis of the embryo (cf. text fig. IV, E). Since the stomodæum appears at the point where the blastopore closed and is then pushed forward through growth of the ventral ectoderm (ventral plate), it follows that the trochoblasts must still remain as a more or less transverse row passing in front of the stomodæum. At the close of the embryonic life, when the transverse ciliated bands characteristic of the embryo are acquired, among these is one which passes around the head just in front of the mouth, and occupying precisely the position that the row of trochoblasts would be expected to assume after the growth changes which have taken place. It must either be supposed that the ciliated ring in question is derived from the trochoblasts or else from other cells occupying a very similar position. Of the two hypotheses the latter appears to me much the more probable, especially in view of the persistence of the prototroch in many annelid larvæ, where it encircles the head, passing ventrally just anterior to the mouth, its position thus essentially coinciding with that of the second preoral ciliated band of *Dinophilus.*

The cell origin of the annelid prototroch has been determined in *Nereis* (Wilson, 1892), *Amphitrite* and *Clymenella* (Mead, 1897), *Arenicola* (Child, 1900) and *Podarke* (Treadwell, 1901). Among the mollusks the precise cell origin of the velum has been determined in but two forms, *Ischnochiton* (Heath, 1899) and *Trochus* (Robert, 1903), although in two other forms, *Crepidula* (Conklin, 1897) and *Planorbis* (Holmes, 1900), the origin of the velum has been determined with considerable, if not absolute, certainty. Below is given, for the sake of convenience in comparison, a table of the components of the prototroch and velum in the A quadrant of those forms in which it has been most carefully worked out. The components of the prototroch of *Dinophilus* are added for comparison.

	Primary Trochoblasts.	Secondary Trochoblasts.	Accessory Trochoblasts.
Nereis	$1a^2$	None	None
Amphitrite *Clymenella* *Lepidonotus* *Arenicola*	$1a^2$	$2a^{1.1.1}$ $2a^{1.1.2}$ $2a^{1.2.1}$	None
Podarke	$1a^2$	$2a^{1.1.2}$ $2a^{1.2.1}$	$1a^{1.2.2.2}$
Thalassema	$1a^2$	$2a^{1.1.1}$ $2a^{1.1.2}$ $2a^{1.2.1}$	$1a^{1.2.2.2}$
Ischnochiton	$1a^2$	$2a^{1.1.1}$ $2a^{1.1.2}$	$1a^{1.2.2.2}$
Trochus	$1a^2$	$2a^{1.1.1}$ $2a^{1.1.2}$ $2a^{1.2.1.1.1}$	None
Dinophilus	$1a^2$	$2a^{1.1+}$ $2a^{1.2+}$ $2a^{2.1+}$	$1a^{1.2.2+}$

All the forms mentioned have the primary trochoblasts in common; in all, except *Nereis*, the gaps between the four groups of primary trochoblasts are closed partly or entirely by cells derived from $2a^1$, $2c^1$ and $2b^1$; *Ischnochiton*, *Podarke* and *Dinophilus* agree in that the cells $1a^{1.2.2}$, $1b^{1.2.2}$ and $1c^{1.2.2}$ participate in the prototroch. In common with the annelids, there is also a dorsal gap in the prototroch, owing to the fact that none of the cells of the D quadrant, except the primary trochoblasts, take part in its formation.

Dinophilus differs from all the other forms in (1) the small size of the primary trochoblasts, (2) that at least the posterior pair of the primary trochoblasts probably divide twice meridionally, and (3) in that $2a^{2.1}$, $2b^{2.1}$ and $2c^{2.1}$ also take part in closing the gaps between the groups of primary trochoblasts in the quadrants A, B and C. These differences, however, are of slight importance compared with the great and striking similarity to the annelids manifested in the origin of the cells which almost certainly form the second preoral ciliated band of the adult *Dinophilus*. In the light of this similarity the conclusion is almost unavoidable *that the second preoral ciliated band of Dinophilus is truly the homologue of the annelid prototroch.*

The peculiarities in the formation of the *Dinophilus* prototroch become readily comprehensible if the character of the end result, *i.e.*, the second ciliated band, be considered, and also the time at which this organ comes into functional activity. The cleavages involved in the formation of the prototroch are thus clearly seen to be of prospective significance, or morphogenetic.

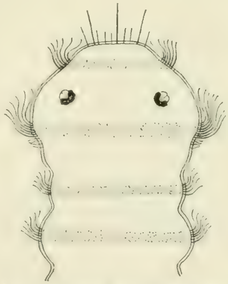


Fig. VI.—head and first two trunk somites of *Dinophilus* larva, soon after hatching. Drawn from a living individual.

The ciliated bands of the larval or adult *Dinophilus* are, as compared with the prototroch or velum of such forms as *Amphitrite, Arenicola, Podarke, Ischnochiton* or *Trochus*, relatively narrow tracts (text fig. VI), consisting of but a few rows of long cilia, as shown in the figures of Korschelt (1882) or Meyer (1887). Moreover, these tracts probably do not become functional until late in embryonic life. Conklin (1897) has shown that the size of the protoblast of an organ is related not only to the size of that organ, but also to the time at which it becomes functional. In the light of this fact the small size of all the trochoblasts is easily explained.

The two meridional cleavages of the primary trochoblasts and the participation of $2a^{2.1}$, $2b^{2.1}$ and $2c^{2.1}$ in the prototroch tend toward the same end, *i.e.*, the production of a narrow band of small cells. 2a, 2b and 2c, instead of each giving off one large cell to the prototroch which subdivides into four cells, covering a broad area, each lays down side by side two small cells, which may then divide meridionally (or nearly so) without violation of the law of alternating cleavages, and thus increase the length of the prototroch, but not its breadth.

VII.—History of the Second and Third Quartettes.

(1) *2d* (=*X*).

The origin of 2d (=X) has already been described. The size of this cell is enormous as compared with that of the other cells of the embryo. This relatively enormous size recalls the conditions found among the lamellibranchs, *Cyclas* (Stauffacher, 1893), *Unio* (Lillie, 1895) and *Dreissensia* (Meisenheimer, 1901), and among annelids in *Arenicola* (Child, 1900), and also in *Clepsine* (Whitman, 1878). The first two divisions of this cell have already been described; the products of these divisions and the first product of the third division, x^3, are shown in fig. 42. In this figure it is seen that x^1 and x^2 are not precisely symmetrical with respect to X, either in size or position, since x^2 is somewhat larger than x^3 and placed at a higher level on X. $x^{1.2}$ lies precisely in the ventral mid-line. x^3 lies dorsally to the left, as viewed from behind, and has been formed by a dexiotropic division of X. The approaching division of $x^{1.1}$ and $x^{1.2}$ as shown in the figure is of interest, since $x^{1.1}$ is the first cell in the embryo to violate the law of alternating cleavages, inasmuch as the spindle for this division has the same direction as that which formed $x^{1.2}$. This reversal of the spindle in $x^{1.1}$ was first pointed out by Mead (1897) for *Amphitrite,* and was also found by Child (1900) in *Arenicola.* The products of this division and the corresponding one of x^2 are shown in fig. 43. In this figure are also shown the spindles for the fourth cleavage of the X group. Two points are to be noted in this cleavage: (1) the division of x^2 has evidently pushed x^3 toward the left (right in the figure), bringing it almost into the mid-line; and (2) X is dividing into bilaterally placed halves. This bilateral division of X is a striking and constant feature of the unequal type of cleavage among the polychætous annelids. A similar division occurs in the lamellibranchs, but appears at the fifth cleavage, instead of at the fourth. All the products of the fourth cleavage of X are shown in fig. 44. $x^{1.1.2}$ has budded off a small cell below; $x^{2.2}$ has divided into nearly equal parts by a meridional cleavage; while x^3 has split into unequal parts, the left product being the greater, and occupying a median position in the cleft between X and X. The cell $x^{2.2.1}$ is now nearly equal to $x^{1.1.2.1}$, and their next two divisions (figs. 47 and 49) are bilaterally symmetrical. The same may be said of the small cells $x^{1.1.1}$ and $x^{2.1}$ (figs. 41 to 48). While I have not followed the history of these latter cells further, it is extremely probable that their divisions are also bilaterally symmetrical. There is here then an instance of a symmetrical arrangement of cells derived by asymmetrical divisions, examples of which are found in the annelid and molluscan crosses, and in the X group of *Amphitrite* (Mead, 1897) and *Arenicola* (Child, 1900), and probably also in many other forms. While $x^{1.1.2.1}$ and $x^{2.2.1}$ are almost equal, $x^{2.2.1}$ is really somewhat the smaller of the two; and in this connection it is of interest to remember that on this side, the left, next to $x^{2.2.1}$, lies the largest member of the third quartette, viz., 3d. Returning to figs. 44 and 45, the cells $x^{1.1.1}$ and $x^{2.1}$ are seen to have each given off a minute cell toward the vegetal pole. These cells are also shown in figs. 38 and 39.

The products of the bilateral division of X, called by Wilson (1892) the "posterior proteleblasts," and by Child (1900) the "posterior stem cells," undergo a series of bilateral divisions. The first is shown in figs. 45–47, x^4 and x^4. These cells have pushed forward $x^{1.1.1.1}$ and $x^{2.1.1}$. The cells formed by the next division of the posterior stem cells come to lie together near the median plane, and are also budded off toward the animal pole. Meanwhile $x^{3.2}$ has been divided into equal parts by a meridional plane, and these three cells assume a symmetrical arrangement (fig. 48). I regret that I have not followed the division of the members of the X group beyond this point. Figs. 53 and 55 show what is probably the next division of the posterior stem cells, by means of which two large cells, x^6–x^6, are separated off ventrally and laterally. After the closure of the blastopore the posterior stem cells each undergo a further subdivision into two cells by a meridional cleavage. The four cells thus formed resemble in appearance the "posterior teloblasts" of *Nereis* (Wilson, 1892).

The lineage of those cells which lie on the vegetal pole side of the posterior stem cells was followed as far as is indicated in the figures, but a consideration of their cleavages is of little value, inasmuch as there is no sign of a paratroch at the time when the blastopore closes, and the cells on the ventral side of the embryo have by this time become so small and thin as to be very difficult to distinguish satisfactorily.

There are two points in connection with the cleavage of X which require special mention. The first of these concerns the first four cleavages of X. These cleavages are essentially the same as those of X in *Amphitrite* and *Clymenella* (Mead, 1897) and *Arenicola* (Child, 1900). This similarity extends not only to the direction of the cleavages, but also to their products, which bear to one another a very similar size relation. This striking resemblance cannot be ascribed to the effect of alternating cleavages, since at the third cleavage this law is violated in $x^{1.1}$, at the fourth in X. The divisions of X in *Dinophilus* and *Nereis* (Wilson, 1892) differ no more than do the corresponding divisions in *Nereis* and other annelids (*Amphitrite*, etc.). These differences are, that in *Nereis* x^3 is formed exactly in the dorsal mid-line, and that the division of x^1 is delayed, and is nearly equal when it occurs. In all the Polychæta whose cytogeny is known (except *Podarke*) bilaterality appears in X at the fourth cleavage. It may then be said of *Dinophilus that bilaterality appears in the cell X in the same cell generation as in all polychætous annelids investigated having the unequal type of cleavage, and appears in x^1 at the same cleavage as in at least three polychætous annelids.*

The second point concerns the arrangement of the cells of the X group. In *Nereis* the main body of the descendants of X are so distributed that they come to lie on the vegetal pole side of the stem cells, the latter remaining near the prototroch. In the other Polychæta, up to the time of the closure of the blastopore, the descendants of X are uniformly distributed about the posterior stem cells, so that up to a late stage the latter occupy a central position with regard to their products. In *Dinophilus*, on the other hand, the greater part of the descendants of X, up to the time when the blastopore is closed, are distributed dorsal and lateral to the posterior stem cells. This peculiarity is related to the peculiar shifting of areas, which has already been briefly described in the chapter on the later development. This distribution is not due entirely to a difference in the direction of the division of X—though in *Nereis* two cells, x^4 and x^4, are budded off toward the vegetal pole—but to a shifting of the cells among themselves. For example, in *Amphitrite* the cells x^1 and x^2 shift to the vegetal pole side of X, while in *Dinophilus* the same cells always retain a lateral position.

The further history of this group, as far as I have been able to trace it, is as follows. At a time near the closure of the blastopore, as shown in fig. 55 and text fig. IV, E, the first quartette has been shifted forward through nearly 90 degrees, being pushed forward through the formation of x^4–x^4, x^5–x^5, etc., until the descendants of these cells cover the dorsal surface of the embryo up to the limits of the first quartette and also cover a large portion of the lateral surface. Behind the blastopore the descendants of X form a small group of cells, which in fig. 53 have not yet covered in the primary mesoblasts. Mitotic activity in this region has been very slight, as may be gathered from examination of the optical section shown in fig. 54. The effect of active mitosis in the posterior dorsal region is perceived in the thinness of the ectoderm in this region. The X cells posterior to the blastopore appear to advance and fuse with the other ectoderm cells surrounding the blastopore. Whether they actually form part of the blastopore I cannot at present say, but judging from their position in fig. 55 it seems probable that they do. The stomodæum is formed, as has already been stated, at precisely the point where the blastopore closed. It then moves rapidly forward to occupy the position shown in fig. 59. This movement is caused by the growth of the cells posterior to the blastopore, which up to this time have been slow in dividing, as well as by new additions from the posterior stem cells. This ventral plate of cells derived from X corresponds in origin and position to that group known among the annelids as the "ventral plate." Examination of the ventral side of an embryo at this stage shows numerous mitotic figures, and the rapid growth of this region is testified to by the thinning of the ventral ectoderm and by the dorsal flexure shown in figs. 59 and 60.

From this time on, it is evident that the further growth of trunk ectoderm is due entirely to growth of the cells of the X group, for, since the appearance of the segments from in front backward indicates terminal growth, it is evident that the descendants of X can alone be concerned. 2d or X, then, contributes at least the larger part of the trunk ectoderm, as is the case in all the polychætous annelids whose cell lineage has been studied. A larva of four segments is shown in horizontal section in fig. 61. By comparison of this figure, which is drawn to the same scale as the other figures, an adequate idea can be obtained of the relatively enormous extent of the trunk ectoderm. When it is recollected that this latter is formed principally, if not exclusively, from 2d, without any addition of food material from the exterior, the colossal size of 2d is very readily comprehended. A very similar case is found in the development of *Arenicola.* In this form, as already remarked, the first somatoblast is also unusually large, and furnishes material for the first three segments of the adult worm. In *Dinophilus* direct development has wholly supplanted the larval type, since the material stored up in 2d forms six body segments, the total number found in the adult.

(2) *2a, 2b and 2c and the Third Quartette.*

The divisions of the cells 2a, 2b and 2c up to an advanced stage have been described in dealing with the history of the prototroch. There is left but one division to record, which I have observed only in $2a^{2.2}$ and $2c^{2.2}$. This division is shown in figs. 34 and 35. The plane of the division is nearly equatorial, but inclined slightly in a leiotropic direction in the C quadrant, in a dexiotropic direction in the A quadrant. Of the two products the lower is somewhat the smaller. I have never witnessed a corresponding division in $2b^{2.2}$, but it very probably occurs. The position and small size of this cell make it difficult to study in the later stages. The two products of $2a^{2.2}$ and $2c^{2.2}$ respectively are quite conspicuous up to an advanced stage, although they probably divide into smaller cells just before the blastopore closes.

The origin of the third quartette has been dealt with in the description of the cleavages. 3d is the largest cell in this quartette, 3b the smallest, while 3a and 3c are intermediate in size. At the 40-cell stage 3d divides equally and leiotropically. The products of this division are shown in fig. 22. A little later 3c divides, but in quite a different manner, budding off a small cell toward the animal pole. The plane of the division is equatorial (fig. 26). Next 3a also buds off a cell toward the animal pole, the spindle being nearly vertical, though the position of the products indicates a leiotropic division. 3b divides some time after 3a, and here the spindle is decidedly leiotropic (fig. 34). It is interesting to note that both 3b and 2b, in their respective quartettes, are the most conservative in retaining the primitive direction of their divisions. While 3a is in division, spindles are seen in $3d^1$ and $3d^2$ (fig. 27). These cells bud off tiny cells toward the animal pole (fig. 32). Of these latter that derived from $3d^1$ is the smaller. The spindles for this division are nearly vertical, but sufficiently inclined to make the division leiotropic, in direct violation to the law of alternating cleavages. Even before 3b has completed its first division 3c has budded off another cell toward the animal pole, the spindle being inclined dexiotropically, as it should be according to the law of alternating cleavages (fig. 34). With this division, or rather the one which follows it, *i.e.*, that of 3b, I have ceased to follow the cell-lineage of the entire egg.

In fig. 53 the position of the cells $2a^{2.2.1}$, $2a^{2.2.2}$, $2c^{2.2.1}$, and $2c^{2.2.2}$ is clearly seen. Each pair of cells form a portion of the lateral margin of the blastopore; $2a^{2.2.1}$ and $2c^{2.2.1}$, which formerly were above, that is, to the animal pole side of $2a^{2.2.2}$ and $2c^{2.2.2}$, now lie anterior to them. They still, however, maintain their relative position in the ectoderm, and their changed relation to the entoderm and the X group is the result of the shifting of the ectoderm already described. A clear idea of the change of position of the cells in question may be obtained from a glance at text fig. IV, A–D. The corresponding cells in the B quadrant have not been seen. Doubtless $2b^{2.2}$ divides, as do $2a^{2.2}$ and $2c^{2.2}$, though at a much later period, but the products of such a division are not to be recognized in fig. 53. In the embryo represented in the figure the trochoblasts can plainly be discerned dorsal to $2a^{2.2.1}$ and $2c^{2.2.1}$; on the ventral side of the embryo they form an irregular cell row. Below this there is a group of small cells which presents to the eye no definite arrangement. These represent the descendants of $2b^{2.2}$; 3a and 3b. Posterior to the blastopore are those cells which in annelids form the ventral plate. These cells barely cover the posterior face of the primary mesoblasts. Just posterior to $2a^{2.2.2}$ and $2c^{2.2.2}$ are one or two small cells on each side whose lineage has not been determined, but which are probably descendants of 3d and 3c. Turning to fig. 55, the relations of the cells surrounding the blastopore are much less clear. On each side of the anterior portion of the blastopore are two cells slightly larger than those surrounding them. These are probably the descendants of $2a^{2.2.1}$, $2a^{2.2.2}$, $2c^{2.2.1}$ and $2c^{2.2.2}$. The blastopore has meanwhile narrowed to an irregular cleft, the cells anterior to it forming a seam, while the cells of the ventral plate have only advanced sufficiently to cover in one of the mesoblasts and part of the other. All of the cells which constitute the rim of the blastopore are small and extremely thin and transparent, making their outlines very difficult to discern, and the exact lineage of any of these impossible to determine. From a comparison of figs. 53 and 55 it is seen that the cells of the ectoderm have crowded toward the vegetal pole from all directions, but especially from the sides. It is also evident that the anterior portion of the margin of the blastopore, between $2a^{2.2.1}$ and $2c^{2.2.1}$, is composed of the descendants of $2b^{2.2}$, 3b and 3c; that the lateral margin is at least partly composed of the descendants of 2a and 2c, unless the small cells which form the blastopore rim in fig. 55 have all slipped in around $2a^{2.2.1}$, $2a^{2.2.2}$, $2c^{2.2.1}$ and $2c^{2.2.2}$. It seems probable that this is not the case, but that the small cells comprising the lateral margin of the blastopore are derived from the second quartette. It is, however, fairly certain that some small cells have pushed in between the descendants of 2a and 2c and the cells of the X group. These must be the descendants of 3c on one side and 3d on the other.

In *Nereis*, Wilson (1892) described these cells $2a^2$, $2c^2$ and $2b^2$ as "stomatoblasts," since they converge to form an arc of cells as the blastopore closes, and are concerned in the formation of the stomodæum. Mead (1897) states that in *Amphitrite* $2a^2$, $2b^2$ and $2c^2$ come to occupy positions similar to the "stomatoblasts" of *Nereis*, but is in doubt as to their precise fate. In *Capitella*, Eisig (1898) finds that the margin of the blastopore is composed entirely of the products of the second quartette ("œsophagoblasts"). In *Podarke* (Treadwell, 1901) at least one cell from the second quartette forms a portion of the stomodæal wall, as do also products of 3a, 3b and 3c. In *Arenicola* (Child, 1900) eight products from the third quartette function as stomatoblasts and form an arc of cells similar to that formed by the stomatoblasts of *Nereis*.

Various conditions are found among the Mollusca. In *Ischnochiton* (Heath, 1899) products of both the second and the third quartettes take part in the formation of the blastopore lips; this appears to be also the case in *Planorbis* (Holmes, 1901), while in *Trochus* (Robert, 1903) the lips are formed at first by cells derived from both the second and third quartettes, but later the products of the second quartette are excluded from the rim of the blastopore.

In conclusion, it may be said that in *Dinophilus* no one set of cells can be denominated stomatoblasts, but that products from both the second and third quartettes take part in the formation of the blastopore rim. The products of $2b^{2.2}$, 3a and 3b, since they lie immediately in front of the blastopore, probably contribute to the formation of the stomodæum. The fate of the cells $2a^{2.2.1}$, $2a^{2.2.2}$, $2c^{2.2.1}$ and $2c^{2.2.2}$ is problematical. It is possible that they, too, contribute to the formation of the stomodæal wall. On the other hand, it seems pretty certain that but a small part of 3c and 3d contribute to the formation of the stomodæum. Their position, just anterior to the cells of the X group, which is not materially altered during the shifting of the ectoderm, together with their large size, makes it possible that they contribute largely to the lateral ectoderm of the head.

Mesoblast of ectodermal origin (larval mesoblast, Lillie; pædomesoblast, Eisig) has been described for a number of Mollusca, and the annelids *Podarke* (Treadwell, 1901), *Capitella* (Eisig, 1898), *Aricia* (Wilson, 1898) and *Thalassema* (Torrey, 1903). Schimkewitsch (1895) describes cells from the ectoderm in the anterior part of the *Dinophilus* embryo as migrating into the body cavity and there contributing to the mesenchyme. Certain cells, of whose exact lineage I am ignorant, belonging to the first quartette, do invaginate (figs. 57 and 58), and it is quite possible that one or more of them may give rise to the mesenchyme of the head and the mouth segment region; but it is my belief that ectomesoblast, if such exists, is very small in amount, and that the greater part, if not all, of the mesenchyme of the adult as well as the ovaries are formed from 4d.

VIII.—History of the Fourth and Fifth Quartettes.

(1) *The Entomeres.*

The entoderm, at the time 4d is formed (fig. 17), consists of 2A, 2B, 1C and 3D. The origin of the third quartette and the primary mesoblast cell 4d have already been described. The other three members of the fourth quartette arise by an equal and leiotropic cleavage. Figs. 23 and 24 show the origin of 4c, fig. 29 that of 4a, while figs. 33 and 41 show 4b already formed. At the 72-cell stage 4D has divided dexiotropically into 5D and 5d (fig. 33), the latter product being the smaller. The inequality of this division compensates, so to speak, for the inequality of the division preceding, since at the completion of the seventh cleavage the original macromeres 5A, 5B, 5C and 5D are alike in size. After the division of 4D, 4C, 4A and 4B divide equally and dexiotropically to form the fifth quartette (figs. 51 and 52). The original macromeres now form a cross, the arms of which lie radially. Since up to the last division the macromeres lay interradially, it is evident that a rotation of the macromeres through an arc of 45 degrees has been brought about. This rotation has taken place in an anticlockwise direction, viewing the ovum from the animal pole, as can be seen by a comparison of figs. 50 and 52. This movement is due to the reduction in size of the macromeres and their superficial position at the seventh cleavage. During this cleavage the members of the fifth quartette are, on the other hand, held in place by their greater surface contact with the surrounding cells of the egg, so that the macromeres 5A, etc., are rotated, as were the members of the first quartette at the time of their origin. A similar rotation apparently occurs also in *Amphitrite, Clymenella* (Mead, 1897) and *Arenicola* (Child, 1900).

After the division of the fourth quartette the entomeres cease dividing and enter a resting stage which continues until after the closure of the blastopore. They now form a thick, roughly ovoid mass of cells, fourteen in number. At the centre of this mass on the ventral side (fig. 52) lie the four macromeres, 5D posterior, 5B anterior, while 5C and 5A lie laterally. Alternating with the macromeres are the four members of the fifth quartette, while at the outer ends of the cross formed by the macromeres lie the three pairs of entomeres belonging to the fourth quartette. This relation is very similar to that described by Wilson (1892) for *Aricia*. In both cases this arrangement is probably brought about by the mechanical processes involved in spiral cleavage. Each cell approximates in shape a four-sided prism, the nuclei lying in the lower ends of the cells, near their ventral surface. As the blastopore narrows, however, these nuclei begin to move inward (figs. 54 and 56). This movement is associated with a change in shape of the entomeres, which in turn is part of the process of gastrulation. As the blastopore lips draw together (figs. 53 and 55) the lower or vegetal pole ends of the entomeres grow smaller, while the upper or animal pole ends become larger (figs. 54 and 56). These cells thus change from a prismatic to a pyramidal shape. Viewed in a sagittal optical section their outlines radiate fanwise from the blastopore (fig. 56). This condition is figured by Repiachoff (1886) and also by Schimkewitsch (1895). This peculiar phenomenon may be a reminiscence of a time when the type of gastrulation was embolic and not epibolic, and the latter condition may have been brought about by acquisition of food yolk during the phylogeny. Such acquisition of yolk is a secondary character commonly associated with a change from larval to direct development, and it is perfectly possible that a change from emboly to epiboly may have been brought about in this manner. The nuclei have meanwhile undergone changes in structure as well as in position. The chromatin, which before was distributed in the nuclear vesicles in the form of small granules, is now concentrated in each vesicle in one deep staining chromatin nucleolus (fig. 56). This condition is not an uncommon one in resting cells, and is also seen in the entomeres of *Crepidula* (Conklin, 1897, figs. 52, 53 and 54).

The further history of the entoderm I have not been able to follow in detail. At a period when the stomodæum has assumed the position of the definitive mouth, the entoderm cells are seen to have multiplied somewhat and to have assumed an arrangement quite different from that found in earlier stages. In fig. 57, which is a horizontal, optical section of a stage when the stomodæum is just making its appearance, the entoderm cells have still the radial arrangement which they assumed at the time of the closure of the blastopore. In fig. 59, a sagittal section of a much later stage, the arrangement is totally different; the entoderm cells have multiplied and are now arranged in a more or less definite layer about a small central lumen.

(2) *The Mesomeres.*

At the 29-cell stage 4d is but just formed and lies on the lower side of the cleaving ovum, below and in front of X and to the left of the mid-line. Very soon after its formation 4d divides again. This division parts it, by a bilateral cleavage, into two equal cells, the primary mesomeres M and M. This division is illustrated in figs. 28 and 44. The primary mesomeres remain undivided up to the 72-cell stage, when they undergo a division of great interest. This division is shown in figs. 33 and 36. By it two small cells are budded off anteriorly toward the vegetal pole, and close to the line of juncture of the two mesomeres. This division is, however, not bilaterally symmetrical, *but is, on the other hand, plainly dexiotropic, and follows the law of alternating cleavages.* The product of the left mesomere thus lies in the furrow formed by the juncture of the two mesomeres and the entomeres 5D and 5d. The product of the right mesomeres, on the other hand, lies between its parent cell and 5D. The next division of the mesomeres (fig. 50) is also not symmetrical. By this division the left mesomere buds off a small cell on its left anterior surface, that is, leiotropically; on the other hand, the right mesomere violates the law of spiral cleavage by dividing in the same direction as before and placing a small cell to the left of its first product (fig. 50). The next division marks the beginning of true teloblastic cleavages. Each mesomere in this division buds off dorsally and laterally a small cell. Just how many of these divisions occur before the closure of the blastopore I cannot say, but probably not more than two. After the closure of the blastopore the mesomeres begin to shift apart, moving laterally, forward and somewhat dorsally. In the horizontal optical section shown in fig. 57 they have reached a position which, I think, is their final one. In this movement they not only have changed their position with regard to one another, but also with regard to the median plane of the embryo. Up to the time of the closure of the blastopore the mesomeres are situated at the left of the ventral mid-line, but, as shown in fig. 57, at the close of this movement the mesomeres are bilaterally situated with respect to the median plane of the embryo.

The cause of this shifting apart is not clear, but I think it is to be explained by the peculiar shape of the entomeres. These are, at the time the blastopore closes, pyramidal in form, with their apices at the blastopore. This point, as will be seen by reference to figs. 53 and 55, is just anterior to the junction of the mesomeres. After the ectoderm of the ventral plate has enclosed the mesomeres, they are subjected to a pressure from the ectoderm which tends to force them inward against the narrow ends of the entomeres. These latter press in between the mesomeres and wedge them apart. They are, however, prevented from passing backwards, and in fact compelled to move forward, by contact with the cells of the X group. In *Thalassema* there occurs a similar shifting apart of the mesomeres, which Torrey (1903) also explains as being caused by pressure of the entomeres.

The position occupied by the mesomeres is at first sight somewhat different from that occupied by similar cells among the mollusks and annelids. In the majority of these forms the mesomeres, soon after their formation, are invaginated into the cleavage cavity. In *Dinophilus* they remain on the exterior until covered by ectoderm, when they move laterally to the entoderm. There was, however, at an early stage a cleavage cavity between the ectoderm and the entoderm, and had the mesomeres moved into it, then their behavior would have been that of the corresponding cells in most mollusks and annelids. As it is, their migration into the cleavage cavity is postponed until a later period of the history of the embryo, but their final position is not essentially different from that of other forms.

In fig. 57 a band of mesoblast cells is seen on each side of the entoderm, running forward from the mesomeres, which are in division. The mesoblast is also shown in fig. 59 ventral to the entoderm.

The later history of the mesoblast has not been followed out in detail. It is my hope to be able at a later period to determine precisely to what organs and tissues the mesomeres contribute, but it seems fairly certain that they give rise to the mesenchyme and sex organs (ovaries) of the adult.

Of especial interest would be the fate of the first two products of each mesomere, in the light of the discovery made by Conklin (1897) that part of 4d is in *Crepidula* entodermal.

Following Conklin's discovery, Wilson (1897) in *Nereis*, Treadwell (1901) in *Podarke* and Torrey (1903) in *Thalassema* found that part of the mesomeres in these forms was entodermal. I have not been able to follow out the fate of the first two products of each mesomere, since their small size and position causes them to become inextricably blended with the ectodermal cells surrounding the posterior lip of the blastopore. The position of three of these cells in the mid-line suggests, however, that their fate may be different from that of the other products of the mesomeres.

IX.—Axial Relations.

The discussion of the axial relations of the *Dinophilus* embryo falls naturally under two heads, viz.: (1) The relation of the first and second cleavage planes to the future median plane of the adult, and (2) the shifting of areas which occurs in relation to the closure of the blastopore. Both of these questions have received much attention from embryologists, and have been so thoroughly discussed by the writers on cell-lineage that it would be superfluous for me to attempt here to treat the subject at length, and so I shall confine myself to stating what these relations are in the *Dinophilus* embryo and to comparing them with a few other forms.

As already mentioned, the cell 2d is of very great value as a landmark. From its origin up to the time when the last traces of it are seen, it marks the posterior end of the embryo. Of course it may be said that since the first three cleavages are of the spiral type, and not of the bilateral type, and since x^1 and x^2 are not exactly equal in size, that the centre of 2d before these cleavages could not well be situated at the same point as that of 2d after them. This, however, is not a point of practical importance. To all intents and purposes the centre of the cell 2d lies in the future median plane of the embryo. The animal and vegetal poles lie in this plane, so that its relation to the cleaving egg can now be determined.

2d, after its formation, lies in the furrow between 1c and 1D. A glance at the figures from fig. 10 to fig. 33 shows that the second cleavage plane between the macromeres, up to the 72-cell stage (fig. 33), very nearly coincides with the median plane of the embryo, since both 2d and the vegetal pole lie in this furrow. At the 72-cell stage, however, these relations are beginning to undergo a change. As described under the history of the entomeres, the macromeres undergo a rotation through 45 degrees, bringing 5D and 5B into the former plane of the second cleavage. This point will be made clear by reference to figs. 50 and 52. The median plane of the embryo and adult then passes through 5B and 5D, and forms an angle of 45 degrees with the plane of the second cleavage between the original macromeres. In conclusion, it follows, since 2d marks the posterior region of the embryo, and since during the early cleavage stages it lies in the furrow between the posterior macromeres, that the second cleavage plane does coincide in a general way with the future sagittal plane of the embryo, although it is evident that at the 4-cell stage the cleavage plane between C and D must pass to the right of the sagittal plane of the embryo. This result is at variance with the results obtained among the Annelida by most writers, though Wilson (1892) found that the second cleavage coincides with the sagittal plane of the future embryo. Much importance, however, cannot be attached to these relations of the entomeres with the embryo, since they are the result of shiftings between the macromeres and micromeres, which may occur at an early period. In

Dinophilus, for example, the members of the first quartette when first formed lie in the furrows between the macromeres; at the next cleavage they are shifted in a sinistral direction, so that they lie precisely over their parent macromeres (cf. figs. 8 and 10), and this relative position is retained up to the formation of the fifth quartette. In *Amphitrite* (Mead, 1897) and *Arenicola* (Child, 1900) this sinistral rotation does not bring the micromeres so precisely over the corresponding macromeres.

In considering the relation of the cleavage plane with the embryonic axis, the micromeres are of far more importance than the macromeres. An examination of the figures of the later cleavages will show that the planes of the first and second cleavages as traced over the entire embryo do not coincide with its transverse and sagittal planes, but that here the rule laid down by Lillie (1895) holds good, viz.: "The members of the odd generations of ectomeres, as well as the entomeres, are distributed two each, right and left of the middle line; those of the even generations are placed anterior, posterior, right and left."

The shifting of the axis, which is largely concerned in bringing about the closure of the blastopore, has been already described in chapter V. It was there spoken of as a forward movement of the first quartette, or rather of the ectoderm of the anterior half of the embryo. This shifting, I think, might better be looked upon as a shifting backward of the ectoderm of the posterior half of the embryo, considering the animal pole as the fixed point. In the first case the blastopore would be closed from in front backward; in the latter from behind forward, which brings it into line with what we know of other forms. In either case the egg axis is bent through an angle of nearly 90 degrees, but not quite, since the animal pole is, as Wilson (1892) showed to be the case in *Nereis*, probably slightly dorsal to the anterior pole of the embryo. This shifting of areas during the process of gastrulation is almost precisely similar to that which occurs in *Crepidula*, as described by Conklin (1897). There is in that form a bending of the egg axis through 90 degrees, and also caused by rapid growth of the cells of the D quadrant, which pushes forward the ectoderm of the aboral surface over the entoderm, the vegetative pole being apparently the fixed point. This condition is attributed by Conklin to the accumulation of yolk in the entoderm cells, and doubtless this is the cause of the similar relations existing between entoderm and ectoderm in *Dinophilus*, the solid yolk-laden mass of entoderm cells altering their form and relative positions but little, while the ectoderm is shifted over them.

X.—The Phylogenetic Relationships of Dinophilus in the Light of Its Early Development.

In this chapter I wish to briefly compare the early development of *Dinophilus* with that of other groups, and to consider what light a study of its cell-lineage sheds on its systematic position. That the study of cell-lineage is of value in determining relationship has been abundantly shown by the results accomplished in this particular branch of zoological research. These have in a most striking degree corroborated the results attained by the study of comparative anatomy, and have further shown that in a large number of forms, representative of large and important groups, the characters of the various forms as manifested in the cleavage are as constant as the anatomical characters, and must therefore be as truly inherited. Furthermore, since cœnogenetic changes may be supposed to affect the later stage of development first, we may expect to find the earlier stages retaining longer their primitive characters, although even the earliest stages have been affected by precocious segregation and are no longer highly primitive. The study of the early development cannot be regarded as a sure or certain guide in determining relationship in every case, yet it may, I think, be very properly called to aid in the determination of the relationships of doubtful forms. In the case of *Dinophilus*, the cleavage has presented such startling and accurate resemblances to the chætopod annelids that it seems impossible that they do not indicate relationship, for so many and minute correspondences could hardly have arisen independently. I have already stated these resemblances separately, but wish here to bring them together, in order that their force may be more apparent.

In the first place the manner of origin of the germ layers—ectoderm arising from the first three quartettes, mesoderm from the left posterior member of the fourth quartette, and entoderm from the remaining cells—brings *Dinophilus* into a list of forms already large and still increasing, containing members of the Lamellibranchia, Gasteropoda, Polychæta and Echiuridæ. In common with many Annelida and Mollusca the larger part (or all) of the ectoderm of the trunk is derived from one cell, the posterior member of the second quartette. A little later the resemblances to the annelids become more marked. In the development of the second preoral ciliated band of *Dinophilus* is recognized the prototroch of the trochophore, and the earliest rudiment of the brain appears at the same point as the annelid "Scheitelplatte." There are, however, in the cleavages themselves resemblances to the cleavage of the polychæte annelids which are most striking, viz., in the origin of the bilateral cleavages. In the cross and in the products of 2d the transition from the spiral type of cleavage to the more specialized bilateral type occurs in precisely the same cells and in precisely the same directions as in the Polychæta. Moreover, the second bilateral divisions of the cells of the posterior arms of the cross continue this resemblance. All these characters, if such they may be called, when viewed as a whole, point in no uncertain way to a descent from the annelid stem, and at a point not far from that at which the Polychæta arose.

If we consider, as I think at present we must, that the trochophore is a larval form common at least to the Annelida, we cannot regard the development of *Dinophilus* as primitive. This view is upheld by many features of the cleavage, especially by the many departures from the spiral type exemplified in the divisions of the primary trochoblasts and many other cells, and also in the discrepancy between the size of 2b and 3b as compared with their sister cells. Further evidence of secondary change is found in the enormous size of 2d and 4d, which have acquired a very large amount of cytoplasm in order to supply material to build up the trunk region, which in the trochophore is ordinarily acquired from the exterior through active feeding. Besides these there is the retarded development of the adult organs, which do not become functional until the animal is nearly ready to hatch, but which must have been primitively functional at a much earlier period. Such organs are the intestine and prototroch. The latter, together with the rosette, and possibly the perianal band of cilia, which may represent the paratroch, are the sole relics of organs peculiar to the trochophore. It is to be regarded as doubtful if even these would now be recognizable, were it not for the fact that these are also concerned in the formation of adult organs. How quickly such a larval organ as the prototroch may disappear is illustrated in the development of *Sternaspis* (Child, 1900), where the prototroch has entirely disappeared, though this larval organ is highly developed in related forms. Thus in the light of the cleavage, as well as in that afforded by the more recent work on the anatomy of *Dinophilus*, Metschnikoff's conjecture appears almost prophetic. *Dinophilus* probably is to be regarded as a "stationäre Annelidenlarva," but one in which the larval stage has become an end stage toward which the development tends and which has become correspondingly modified.

Postscript.

Since the above paper was presented for publication there have come to hand two papers by Prof. John H. Gerould: "The Development of Phascolosoma" (*Arch. Zool. exp. et gen. II, 2, 1904*) and "Studies on the Embryology of the Sipunculidæ: I. The Embryonal Envelope and Its Homologies" (*Mark Anniversary Volume, Art. XXII*). In the former of these two papers Prof Gerould shows that in *Phascolosoma* the ectoderm arises from the first three quartettes of micromeres, the mesoderm from 4d, and the entoderm from the remaining cells, thus adding a representative of the Sipunculidæ to the list of forms mentioned in section IV (4) of the present paper. The author further points out the presence of a typical annelid "cross" and "rosette" in *Phascolosoma*, that the prototroch of the larva is formed from the sixteen "primary trochoblasts," and that the "somatic plate" arises from 2d. The second paper mentioned, among other interesting facts concerning the relation of the larva of *Sipunculus* and *Phascolosoma*, establishes the homology of the "serosa" of *Phascolosoma* with the prototroch of *Sipunculus*.

TABLE OF CELL-LINEAGE. QUADRANT A.

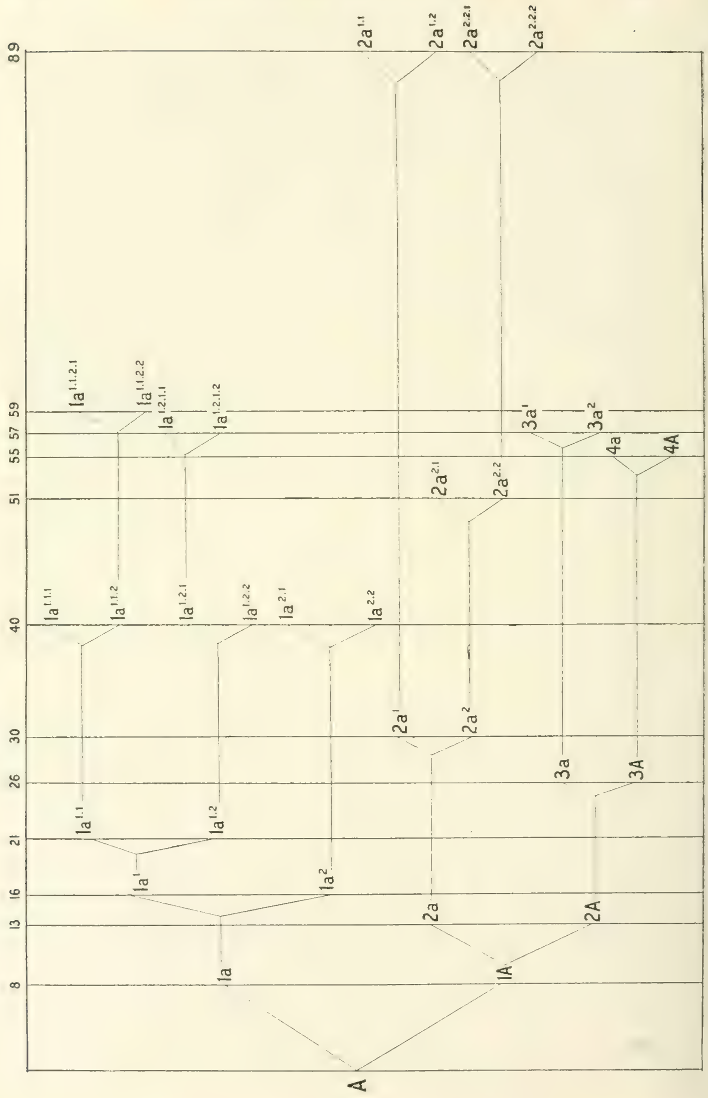


Table of Cell-Lineage. Quadrant B.

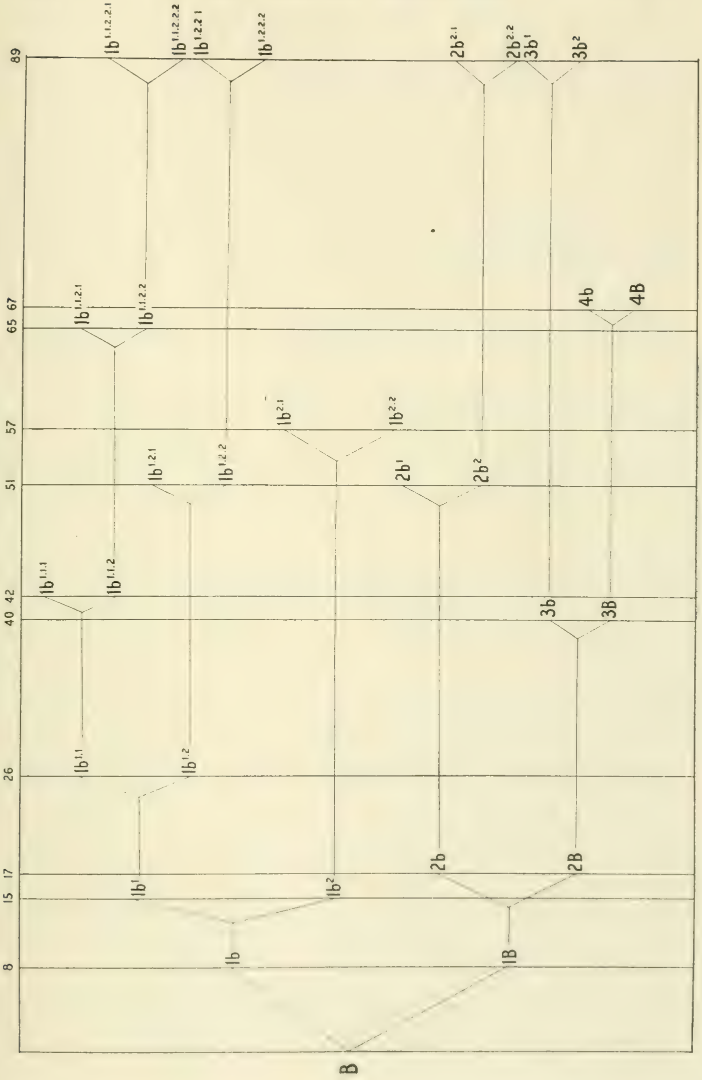


TABLE OF CELL-LINEAGE. QUADRANT C.

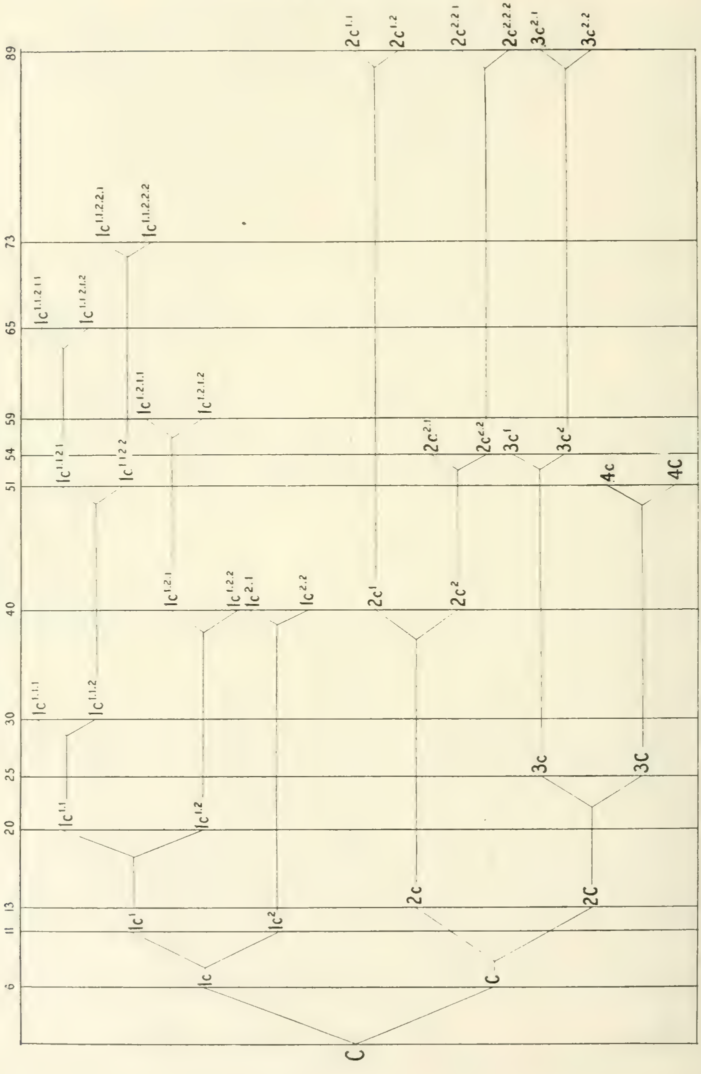
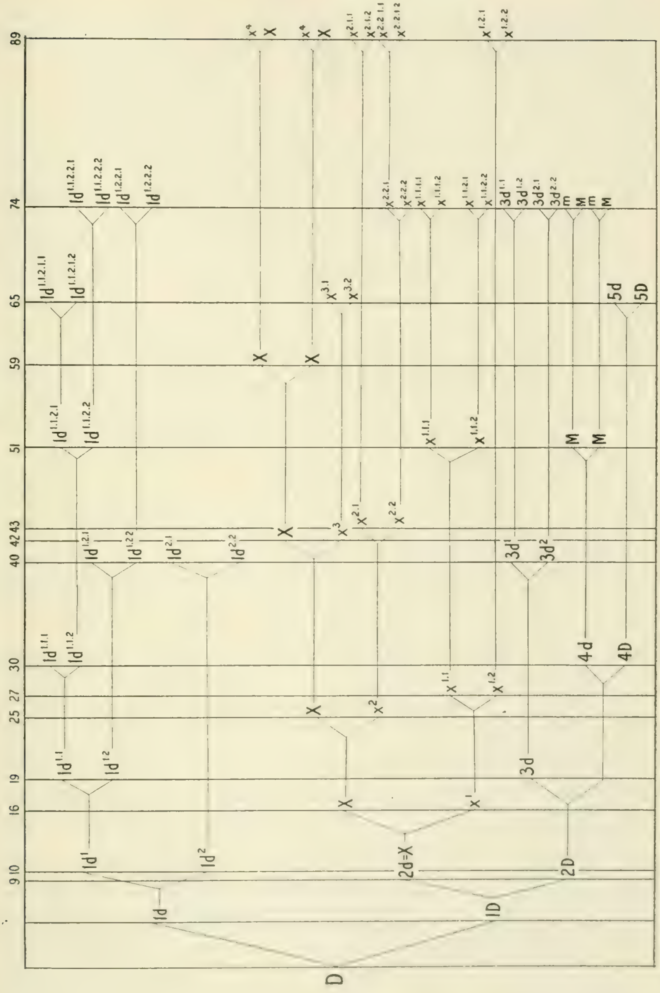


TABLE OF CELL-LINEAGE. QUADRANT D.



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EXPLANATION OF PLATES XLIII–XLVIII.

The figures have, with few exceptions, been drawn with the camera lucida at the table level under Zeiss homo. imm. $\frac{1}{12}$, oc. 2. With whatever lenses used, however, all the figures were drawn to the same scale of magnification.

REFERENCE LETTERS.

bl., Blastopore.
br., Brain.
br. com., Commissure of brain.
gl., Gland
int.l., Lumen of intestine.
m., Mouth.
mes., Mesoderm.
pr., Proctodæum.
pro., Proboscis.
st., Stomodæum.
sto.l., Lumen of stomach.
v.p., Ectoderm of ventral plate.

PLATE XLIII, Fig. 1.—Unsegmented ovum, after the expulsion of the second polar body. The female pronucleus lies at the animal pole of the egg, surrounded on its lower side by a large aster. The sperm nucleus, with its accompanying aster, is seen to the right of and below the centre of the ovum.

Fig. 2.—Unsegmented ovum after union of the two pronuclei.

Fig. 3.—Early anaphase of first cleavage spindle. The cell-body is beginning to elongate.

Fig. 4.—Two cells. Prophases of spindles for second cleavage.

Fig. 5.—Two cells. A–B in metaphase, C–D in anaphase of division.

Figs. 6 and 7.—Four cells. Spindle fibres still connecting A and B. Animal pole.

Fig. 8.—Seven to eight cells. Animal pole. 1c and 1d formed and in pro-

phase of next division. 1a just formed and 1b in process of formation. 1c is taking in one of the polar bodies.

Fig. 9.—Nine cells, left side. 2d just formed; 1d preparing to give off $1d^2$.

Fig. 10.—Twelve cells, animal pole. $1a^2$ just formed.

Fig. 11.—Thirteen to fourteen cells, animal pole. 1b about to divide.

Fig. 12.—Thirteen to fourteen cells, right side. 2c just formed; 2d = X dividing to form x^1.

Plate XLIV, Fig. 13.—Thirteen to fourteen cells, left side. 2a in process of formation.

Fig. 14.—Twenty-six cells, animal pole. $1b^{1.2}$ just formed; $1c^{1.1}$ and $1d^{1.1}$ preparing to form rosette.

Fig. 15.—Twenty-six cells from right side. Spindle fibres connecting 3C and 3c; $1c^2$ preparing to divide.

Fig. 16.—Twenty-six cells, left side. 2a and 3D preparing to divide; spindle fibres connecting X and x^2, and 3A and 3a.

Fig. 17.—Twenty-six cells, vegetal pole. $x^{1.2}$ forming; 3D in metaphase of division.

Fig. 18.—Twenty-eight cells, left side. $2a^1$ formed; cell body of 3D elongated.

Fig. 19.—Twenty-eight cells, right side. 2B in division.

Fig. 20.—Forty cells, animal pole. $1c^{1.1.2}$ and $1d^{1.1.2}$ preparing for their first bilateral division.

Fig. 21.—Forty cells, right side.

Plate XLV, Fig. 22.—Forty cells, left side.

Fig. 23.—Forty-two cells, right side. 4c just formed.

Fig. 24.—Forty-two cells, vegetal pole. 4d preparing for bilateral division.

Fig. 25.—Fifty-four cells, animal pole. Bilateral division of the posterior stem cells of the first quartette completed.

Fig. 26.—Fifty-four cells, right side. $2c^{2.1}$ formed.

Fig. 27.—Fifty-four cells, left side.

Fig. 28.—Fifty-four cells, vegetal pole. Bilateral division of 4d completed; X preparing for bilateral division.

Fig. 29.—Fifty-three cells, anterior end. Divisions of 3A, 2b, 3b, 1b and $2c^2$ shown.

Fig. 30.—Seventy-two cells. Division of cells of posterior arms of cross; arm of cross in the B quadrant just formed.

Plate XLVI, Fig. 31.—Seventy-two cells, right side.

Fig. 32.—Seventy-two cells, left side.

Fig. 33.—Seventy-two cells, vegetal pole. $x^{2.2}$ divided; 5d just formed.

Fig. 34.—Eighty-one cells, right side. $2c^{2.2.}$ and $2c^{1.}$ divided.

Fig. 35.—Eighty-one cells, left side. $2a^{2.2}$ and $2a^1$ in process of division.

Fig. 36.—Eighty-one cells, vegetal pole. Dexiotropic division of M. and M.

Fig. 37.—Eighty-nine cells, animal pole. Division of $1b^{1.2.1}$.

Figs. 38 and 39.—Eighty-nine cells, right and left sides respectively.

Plate XLVII, Fig. 40.—Eighty-nine cells, vegetal pole.

Figs. 42–49.—Products of 2d = X viewed from the posterior end. Fig. 42 was drawn from the same ovum as represented in Fig. 20; Fig. 44 likewise corresponds to Fig. 30; Fig. 45 to Figs. 34–36; and Fig. 47 to Fig. 37.

Fig. 50.—Vegetal pole. Formation of 5a and second division of M and M.

Fig. 51.—Vegetal pole. 4c divided; 4a and 4b dividing.

Fig. 52.—Division of entomeres completed.

Plate XLVIII, Figs. 53 and 55.—Two stages during the closure of the blastopore. They show also the division of X and X to form x^6 and x^6.

Figs. 54 and 56.—Optical sagittal sections of same, showing change in form of the entoderm cells and the inward migration of their nuclei.

Fig. 57.—Horizontal optical section of embryo at the time of the appearance of the stomodæum. The mesomeres, which are seen in division, have moved apart. In front of each mesomere is seen the band of mesoblast to which it has given rise.

Fig. 58.—Optical sagittal section of same stage, showing formation of

stomodæum. At the anterior end is also seen the ectodermal thickening which gives rise to the brain.

Fig. 59.—Sagittal section of a much later stage than the last. The stomodæum has assumed the position of the definitive mouth, while the entoderm cells have multiplied and arranged themselves about the rudiment of the intestinal lumen. Below the entoderm cells is seen the mesoderm.

Fig. 60.—Sagittal section of a late stage. The entoderm cells now form an epithelial layer about a well-defined lumen. The rudiment of the intestine is making its appearance.

Fig. 61.—Horizontal section of an embryo with four segments.

Fig. 62.—Transverse section of a stage similar to that illustrated in Fig. 60, showing the relations of the three germ layers.

THE DEVELOPMENT AND STRUCTURE OF THE LARVA OF PARAGORDIUS.

BY THOMAS H. MONTGOMERY, JR.,

Professor of Zoology in the University of Texas.

The embryology of the *Gordiacea* is a subject full of mystery and interest, notwithstanding the attempts at its solution. It is one fraught with technical difficulties, and one where the obtaining of material is usually a matter of chance. With a peculiar delight then, after many vain attempts to collect the eggs, I found in March and April of the present year numerous adults of both sexes, with egg-strings in abundance, of *Paragordius varius* (Leidy) in a small stream that passes through the town of Austin, Texas.

Ovipositing females were brought to the laboratory, and the egg-strings kept for weeks in small jars of water aerated by plants. The full-formed larval stage is reached in from ten to twelve days, and these larvæ live for more than a week longer before they leave the egg-membranes. After leaving the latter they live for only a few days unless they reach their proper host.

In Texas, as in Pennsylvania, the last host is the large cricket (*Acheta abbreviata*); in this host are found individuals from about one-third the ultimate size to the adult stage. As is well known for all the species of *Gordiacea*, the adults leave their terminal hosts and come into the water, where the eggs are fertilized and laid. Whether the cricket is the only host of *Paragordius varius*, or whether there is a preceding one into which the larva first enters, I have not yet been able to determine. Attempts were made to infect crickets with larvæ, by crushing the egg-strings containing the latter so as to liberate the larvæ, and placing drops of water filled with the larvæ upon grass fed to the crickets. None of the adult crickets lived longer than a month in confinement; and each one out of about 75 kept under observation was examined in vain at the time of its death for *Paragordius* larvæ. Crushed egg-strings were placed in water containing Amphipods (Gammarids); at the end of two weeks the Amphipods showed numerous larvæ encysted in the intestine and musculature, but these larvæ underwent no further development. Terrestrial Isopods (*Oniscus*) found in damp places were placed in contact with water containing larvæ, and such water was dropped upon their mouths; two weeks later a single one of them showed a single larva in the intestine, encysted but dead. Pieces of egg-strings were placed in aquaria with brook minnows; the fish some three weeks later showed larvæ encysted in the intestine, and a few in the muscles, but here again no further development of the larvæ was obtained. Finally infection attempts were made with tadpoles of *Bufo*. The first lot of tadpoles were small (but operculum present), and crushed egg-strings were placed in their water on April 12; most of the tadpoles died between the 16th and the 18th of April, the last on the 19th; the autopsy showed large numbers of larvæ (not encysted) in the intestine, but most if not all of the larvæ were dead. About the same results were reached with two other lots. Larvæ placed in water containing mosquito larvæ (*Culex*) encysted themselves in the mosquitoes and soon caused their death.

These results are, of course, quite indecisive, except in showing that mosquito larvæ and toad tadpoles cannot be normal hosts of the parasites. So I have not been able to secure the early post-larval development of *Paragordius*, and in the present contribution shall deal with that literature only which concerns the development up to the larval stage.

Since the ultimate host is a land insect, while the parasites are at first aquatic, it is of value to determine how long the mature worms can withstand desiccation. One adult female within a few hours after emerging from a cricket was placed in a dry dish; four hours afterward she was alive, but with dry cuticle; eighteen hours afterward she was shriveled up and did not resuscitate on being placed in water. Several adult females, a few hours after escaping from crickets, were placed in an open dish on moist filter paper; twenty-four hours afterward they were still alive though the body surface was dry, and on placing them in water they lived for several days. Egg-strings when dried shrivel up and the eggs die quickly.

Portions of egg-strings at timed periods were preserved in three fixatives: Zenker's fluid, made up of 5 per cent. of corrosive sublimate and 5 per cent. of glacial acetic acid in Müller's solution (bichromate of potash 2 parts, sulphate of soda 1 part, water 100 parts); a mixture of 95 per cent. alcohol, 3 per cent. nitric acid, and aqueous solution of corrosive sublimate in equal parts; and a mixture of glacial acetic acid 10 parts, and 95 per cent. alcohol 90 parts. The fixation with Zenker's fluid is by far the best of these, producing no distortion and preserving admirably delicate cellular details. To my surprise I found, contrary to the results of other workers, that the ova, despite their membranes, are readily penetrated, and that all alcoholic and strong acid solutions are to be avoided. Flemming's fluid (osmic acid, acetic acid and chromic acid) penetrates easily, but blackens the tissues too quickly. A fixation of three to twenty hours in Zenker's fluid is followed by rinsing in distilled water for fully the same length of time; then the egg-strings are brought through successive alcohol grades up to 83 per cent. They remain in the latter for several days, then are brought down gradually to distilled water. With each egg-string in a narrow, round-bottomed vial, I take a glass rod and thoroughly crush the egg-string in water after it has been well hardened in alcohol; thus the eggs are easily freed from each other and none are lost. An aqueous stain is then poured upon them; and for material fixed in Zenker's fluid I found Delafield's hæmatoxyline, diluted with an equal volume of water, for two to three hours, the best. The ova, still within the same vial, are brought up through successive grades of alcohol to absolute alcohol, half an hour in each grade; then into a mixture of equal parts of absolute alcohol and xylol; then into pure xylol. They are then mounted in Canada balsam. These methods have been given in detail, because only after numerous failures have I been able to secure fine preparations. In the structure of the larva much can be determined by study of it in life. And one can best investigate the armature of the proboscis by causing it to be permanently evaginated through treatment with a rather strong aqueous solution of caustic potash; this swells up the whole body. Sections were made of numerous egg-strings, but the paraffine imbedding causes great distortion of the cells, and it is necessary to imbed for several hours. The whole mounts of the ova and larvæ were the most instructive.

1. The Early Development.

The structure of the adult reproductive organs has been previously described by me (1903) in detail, and it is necessary here to recall only a few points to make the development clear. The ovaries are a pair of long tubes extending nearly the entire length of the body, each consisting of a longitudinal tube, the "uterus" of the authors, and of very numerous lateral diverticula or pouches, "ovaries" in the narrow sense, each of which communicates by an aperture with the uterus. The posterior ends of the two uteri are ciliated, and are termed the oviducts, and these open into the atrium, into the anterior end of which opens also the large receptaculum seminis. The end of the intestine communicates with the atrium, and from that point to the posterior end of the body extends the tubular cloaca, with the cloacal aperture between the three tail lobes. The atrium is lined with a glandular epithelium, as is also the proximal end of the cloaca; the remainder of the cloaca bears a cuticular lining.

The egg-cells contained in the lateral diverticula of the ovaries of adult females (individuals whose external cuticula is of a dark color) are all ovocytes of the first order at the end of the growth period (fig. 1, Pl. XLIX). The nucleus is more or less central in position, contains one large deeply staining nucleolus, and a nuclear sap which shows no trace of chromatin and only in a few cases exceedingly delicate linin fibres; even strong iron hæmatoxyline stains fail to demonstrate chromatin particles. The cell-body evinces a zone of yolk globules (shaded in figs. 1 and 15), placed near the periphery; while the cytoplasm is coarsely alveolar, and the meshes of very regular size in the perinuclear area.

While these ovocytes are passing from the "ovaries" to the "uteri," but before they have entered the latter, their nuclei are in prophases of the first maturation mitosis; such stages are shown in figs. 2–5. The nucleolus becomes smaller and stains less intensely, while there appear, usually close to it, chromosomes in the form of long loops (figs. 2, 3); these do not first appear simultaneously, but successively. These chromosomes shorten into the form of minute dumbbell-shaped bodies, seven in number (fig. 4), and for the first time is seen in the nucleus an achromatic network (fig. 5). These are bivalent chromosomes, as shown by their shape and by the fact that there are fourteen single chromosomes in the cells of the embryo. Two points are remarkable in regard to them: first, that no trace of them is to be seen in the preceding rest stage; and second, that they appear in succession close to the nucleolus, and later are frequently found in a compact group—a condition infrequent in a prophase. The evidence is that these chromosomes come out of the nucleolus, and that during the rest stage they are contained within it. Such a condition has recently been demonstrated for the egg of *Asterias* by Hartmann (1902); but that it is by no means a usual condition in Metazoa, on the contrary is decidedly unusual, was previously shown by me (1898). As the ovocyte enters the uterus the seven double chromosomes are arranged in the equator of the first polar spindle (fig. 6; fig. 7, a pole view of the spindle); this has the form of the corresponding spindle of *Ascaris*, and no centrosomes are demonstrable. As the ovocytes, closely compacted together, are propelled rapidly backward along the uteri and so through the oviducts into the atrium, the spindle moves gradually nearer the periphery of the egg.

The females are impregnated with sperm, and the receptaculum seminis filled with a great mass of it, before the ovocytes enter the uteri, so before the first polar spindle is formed. This I have proved by examination of numerous adult females. There is an intimate coition, the male placing his cloacal aperture against that of the female; and the sperm has to traverse the length of the cloaca before reaching the receptaculum. Ova will apparently not develop unless fertilized, for there was no development at all in the egg-string of a female whose receptaculum was without spermatozoa. In the testes of the adult male only mature spermatozoa are present, and in this species there appears to be no spermatophores.

When the ovocytes reach the atrium they become surrounded by the minute flagellate spermatozoa issuing from the receptaculum, and in the posterior part of the atrium and the proximal end of the cloaca the sperm enters the egg (fig. 6). The pole spindle is now excentric; the spermatozoon enters usually at a point of the periphery furthest removed from the spindle, but sometimes quite near it (fig. 6). On strongly destained hæmatoxyline preparations the spermatozoon head is sharply distinguishable. The ovocytes are propelled backward within the cloaca compacted into an egg-string. While the ovarian egg has a limiting membrane of very delicate nature, the egg in the proximal part of the cloaca has a thicker membrane that stains with hæmatoxyline (fig. 6); this increases in thickness as the egg progresses backward and becomes the outermost envelope of the egg (figs. 8, 10). At the posterior end of the cloaca each egg shows a spermatozoon within the cell membrane, and the first polar spindle at the periphery of the cell (fig. 8). At this stage the egg has two membranes: the outer, thinner one staining with chromatin stains, already mentioned, and a thicker inner one that stains faintly with cytoplasmic stains (fig. 8); both are closely adherent to the cytoplasm. But where the polar spindle touches the periphery these membranes are not present. It is probable that both these membranes are products of the cytoplasm, and not of any gland cells of the genital passages (as I had previously opined), else one could not explain their absence in the region of the polar spindle. The outer membrane has at its inception probably a glutinous nature, serving to hold the eggs together in a string.

The eggs pass out of the cloaca in a cylindrical continuous string, usually much convoluted, and in the first few days snowy white; the worm may occupy as much as twenty-four hours in the discharge of its egg-string, and then, with its body flaccid and flattened, it expires.

The first pole-body is cut off by the egg shortly after the expulsion from the body, and when it is cut off the two cell-membranes separate it from the surface of the egg (fig. 9). Shortly afterward these two membranes swell, probably by osmotic action of the surrounding water, and together compose a double membrane removed from the surface of the egg (fig. 10), while the cytoplasm has formed a third delicate membrane which remains adherent to it. By this means the first polar body becomes removed from the surface of the egg. The ovocyte of the second order (fig. 10) shows the second polar spindle, like the first in form, and without an intervening rest stage, and this also contains seven chromosomes (fig. 11). The chromosomes are too minute to allow a determination of which of these is the reduction division; the second polar body is then cut off (fig. 12), but remains adherent to the egg, and the stage of the ovotid is reached.

During the process of formation of the second polar body the spermatozoon is changing into the sperm nucleus (figs. 10, 12), in that its head becomes a rounded chromatin mass lying within a clear vacuole. Quite frequently there is polyspermy, but I have no evidence that such cases develop into embryos. When the second polar body is cut off we find the sperm nucleus in the form of a large spherical nucleus, with a nucleolus and a linin network; and the egg nucleus in a less advanced stage (fig. 13). Finally the two nuclei are seen, both in the rest stage (fig. 14). It is remarkable, and to my knowledge unique in the known cases of fertilization, that the two pronuclei are unequal in volume in the rest stage (fig. 14), as also in the prophases of the first cleavage (fig. 15); not a single case was found in which they were of equal volume. The smaller one appears to be the egg nucleus, because in most cases it is the one nearest the second polar body. Its smaller size is probably due to the fact that it is formed in less time than the sperm nucleus, and that the period is very short between its rest stage and the formation of the first cleavage spindle.

Fig. 15 shows the two pronuclei in the prophase of the first cleavage, the sperm nucleus being the one at the left hand; the nuclear membrane of each has disappeared at the point where there is an accumulation of finely structured cytoplasm, resembling the "archoplasm" of the similar stage in *Ascaris*. Each pronucleus contains a linin network and seven minute chromosomes; these are shown in the drawing much less distinctly than in the preparation, where the chromosomes are stained intensely blue and the linin very faintly. The first cleavage spindle (fig. 16) contains 14 chromosomes (only 12 seen in this figure), and the spindle, unlike the polar spindles, is pointed at each end; but neither at this stage nor at any of the later ones have I been able to determine the presence of centrosomes.

The double egg-membrane, which we saw had become separated from the surface of the egg, is still present and continues to include the embryo until the larval stage is a week old or more. It is a complete protection for the egg against any bacterial organisms.

In the matter of the cleavage I have spent much time in the endeavor to work out the cell-lineage, but have been unable to do so. The egg is spherical; the second polar body varies in its position with regard to the axis of the first cleavage spindle; the yolk appears to be rather uniformly distributed near the periphery. So there is no means of orientation of the uncleaved egg. The cleavage is total and adequal (figs. 17–21). The two blastomeres of the 2-cell stage are almost equal in volume, but one is always slightly larger than the other (fig. 17). In the 4-cell stage (fig. 18) there are two larger blastomeres and two smaller ones, but the difference is very slight. The axes of the spindles in the 2-cell stage may be parallel or not, and the cells may divide simultaneously or successively. In the 4-cell stage it is most frequent that a line connecting the two smaller blastomeres is perpendicular to one joining the two larger, in such a way that all four blastomeres do not lie in one plane; they apparently never arrange themselves in the T-shape so characteristic of *Ascaris*. Then the blastomeres are not spherical, but so moulded by mutual contact that it is exceedingly difficult to determine their relative volumes. Again, the blastomeres of the 4-cell stage may divide simultaneously or not. For these reasons I have found it impossible to work out the cell-lineage, without, however, wishing to imply that it may not be perfectly determinate.

A cœloblastula (fig. 20) is formed at an early cleavage, sometimes as early as six blastomeres, almost always at the 8-cell stage (fig. 19). At the 16-cell stage (fig. 21) the cleavage-cavity is large. On optical sections one pole of the blastula shows cells somewhat larger than those of the opposite pole.

While there are but a relatively small number of blastomeres, an invagination of the larger-celled wall of the blastula commences and leads to the establishment of a typical invagination gastrula (figs. 22–27). All the lining (mesentoderm) of the gastrocœl is not formed by an inpushing of the wall of the blastula, but it appears rather that only a small number of cells are invaginated, and that by the cell division of these the mesentoderm increases in amount. The orifice of the invagination, the blastopore is very narrow, and in a position that corresponds with the ventro-posterior end of the larva; and the end toward which the mesentoderm turns (figs. 23, 24, 26) is anterior; so we can now distinguish anterior and posterior, dorsal and ventral, right and left. The invaginated layer of cells is a mesentoderm, because from it comes both the mesenchym and the entoderm, as shown in figs. 25–27, where the mesenchym cells are shaded. From that area where the mesentoderm joins the ectoderm (the outer cell-layer) takes place a proliferation of cells of the mesentoderm, leading to the formation of loose cells and masses of cells, the mesenchym, lying within the cleavage-cavity. Fig. 23 shows just at the blastopore two particularly large blastomeres, which I first took to be mesenchym pole cells; but I found them in only one case, and do not believe there is a proliferation from a pair of pole cells, though the proliferation comes from the region near the blastopore. In no case was there any evidence of formation of the mesenchym from the side of the ectoderm; in these stages the mitotic spindles of the ectoderm cells lie always parallel to their free surface, never perpendicular to it, as would be necessary for the formation of mesenchym. Particularly decisive in this matter are cases like that shown in fig. 25—mesentoderm cells dividing at right angles to the surface of the mesentoderm. This embryonic tissue is properly *mesenchym* and not *mesoderm,* since the cells do not arise as an epithelium or in compact masses, but separately; and cases like that of fig. 27, where they appear for a time to compose solid masses, are delusive and due to the difficulty of distinguishing the cells. At no stage up through the larva do these cellular elements become epithelia.

The remainder of the early development may be traced rapidly, and simply in order to clarify the organization of the larva. The blastopore closes early (*Bl.*, figs. 24–29), or remains as a very narrow opening. The entoderm grows forward and is largest at its apex (fig. 26); this portion of the entodermal canal will become the gland of the larva (figs. 28–30, *Gl.*). By cell division the few first-produced mesenchym cells form more numerous smaller elements within the cleavage-cavity, shown as the shaded cells in figs. 26–32. The next notable change is that at a point nearly opposite the blastopore (*Bl.*) the ectoderm thickens (fig. 28), becoming two to three cell-layers deep, whereas elsewhere it has become much thinner; at this stage also the anterior end of the entodermal canal is becoming constricted off from the remainder. In the next stage the thickened ectoderm mass commences to invaginate (fig. 29), this being the commencement of the proboscis; at the inner surface (that surface bordering on the cleavage-cavity) this invaginated ectoderm shows an annular proliferation (*Di.*, fig. 29), which is the perceptible beginning of the diaphragm of the larva. Now also the anterior portion of the entodermal canal is nearly cut off from the posterior, it is the immature condition of the larval gland (*Gl.*); sometimes, as in fig. 29, its anterior end is pointed and in contact with the ectoderm of the proboscis, and probably this pointed end represents the beginning of the tube duct of the gland; at least I have no further evidence as to the mode of development of the duct. Fig. 30 shows the ectodermal invagination further progressed, and the gland (*Gl.*) completely cut off from the intestine (*In.*); the mesoderm cells are numerous. In the stage of fig. 31 the embryo is bent upon itself, comma-shaped, since the growth is not of volume but of length, and the double egg-membrane prevents growth in a straight line. The embryo is bent in the region of the diaphragm (*Di.*). The diaphragm and the whole proboscis anterior to it is ectodermal, except for a few mesenchym cells (shaded) that have now become young muscle cells. Behind the diaphragm, all that region which may be termed the "trunk," we find entoderm composing the embryonic intestine (*In.*) and gland (*Gl.*), mesenchym (shaded), and a thin layer of ectoderm which, on the ventral surface near the diaphragm, is thickened (embryonic nervous epithelium). Fig. 32 is an immature larva with the armature of the proboscis developed.

During these stages the ectoderm of the surface of the body becomes very thin, and its component cells fewer in number (compare figs. 27 and 31); this is evidently due to a participation of the whole ectodermic layer in the proboscidial invagination. In the intestine also the nuclei move to the two ends (compare figs. 29 and 32), so that elsewhere the intestinal wall becomes very thin. The blastopore is completely closed, but its position still marked by the angle of junction of the ectoderm (hypodermis) and entoderm (intestine). The gland loses its central lumen.

2. The Larva (Plate L).

The larva is still included within the double egg-membrane, and is not noticeably larger in volume than the egg-cell, so that during all this time it can have taken no nourishment from without.

A transverse diaphragm (fig. 36, *Di.*), the margins of which are fused with the hypodermis (*Hy.*), separates the body into two regions an anterior proboscis and a posterior head-trunk. The diaphragm is with difficulty demonstrable, somewhat thicker than the hypodermis, and staining slightly with hæmatoxyline; on its anterior surface are a few nuclei, of which four central ones are notably conspicuous. It is traversed only by the duct (*Gl.d.*) of the gland (*Gl.*). It is owing to the presence of this diaphragm that movements of the proboscis cause no movements whatever of the fluid within the cavity (archicœl) of the head-trunk.

The proboscis is seen in evaginated condition in fig. 36, in contracted in fig. 37. The evagination is due to the contraction of longitudinal muscles (*Mus.*) lying beneath the body wall and reflected over the axial stalk of the proboscis. A contraction of these muscles evaginates the armature, partly perhaps by a direct pull, partly perhaps by producing a pressure upon the fluid contained within the cavity of the proboscis. A comparison of figs. 36 and 37 furnishes the best representation of the mechanics of this process. When the armature is evaginated the wall of the proboscis shows its annular folds very close together (fig. 36); when retracted, further apart and less numerous. What causes the retraction of the armature is difficult to decide, but it is perhaps due to the tension of certain long cells (*Fib.*) lying at the base of the axis.

The hypodermis of the outer wall of the proboscis is exceedingly thin from the diaphragm to the base of the third row of spicules (*Sp. 3*) of the armature, and contains not more than one or two nuclei. On its outer surface is a thicker homogeneous cuticula which does not extend over the armature region. Cuticula and hypodermis together compose a very thin outer wall which is thrown into folds, so that the larva appears to be superficially annulated. As well as I could determine these folds are temporary, and their number changes with movements of the proboscis, though the annulations are always present. There are no circular muscles to produce them. The hypodermis is thickened below the spicules and stilets which compose the armature, and shows one nucleus at the base of each stilet and each spicule; at the base of the stilets (*St.*, figs. 36, 37) the hypodermis becomes continuous with the axial ectodermic cell mass.

The armature, best studied in life or on individuals treated with caustic potash, shows three rows of spicules and three stilets (figs. 33–37). The first row of spicules (*Sp. 1*) is composed of a circle of six spicules, namely, a pair of dorso-lateral and a pair of dorso-ventral spicules, and a pair of lateral ones considerably larger than the others. The second row (*Sp. 2*) is made up of a circle of four spicules, a dorso-lateral and a ventro-lateral pair lying beneath the corresponding pairs of the first row; these are the smallest of all the spicules. The spicules of both of these rows are flattened, pointed cuticular plates, with slightly thickened margins. The third row of spicules (*Sp. 3*) is composed of a circle of needle-like spines, seven in number: one dorsal, one pair of dorso-lateral, one pair of dorso-ventral, and one pair of closely approximated ventral spicules. All these spicules project backward when the armature is evaginated. The three stilets point forward; one of them is ventral (*St.v.*, figs. 33–35), and the others dorso-lateral (*St.d.*). Each is a slender rod, with the proximal end widened, but with a depression on each side of the expansion (there shaped like a human red blood corpuscle); and with the distal end also expanded and bearing on its median surface a series of fine parallel ridges. The stilets surround a delicate canal, at the base of which opens the duct of the gland (*Gl.d.*). The whole armature is an exquisite device for the penetration of the tissues of the host, and for moving through them—the stilets penetrating, the spicules by their gripping pulling the larva forward. One does not know which to admire more, the perfection of the larva for occasioning torture or the beneficence of the Providence allowing such torment.

The axis of the proboscis is separated from the outer wall by a space, archicœl, and is composed of a cord of cells extending from the base of the stilets to the diaphragm (figs. 36, 37). That part of this cord nearest the stilets passes over continuously into the hypodermis, and is composed of a mass of cells without perceptible boundaries, containing a number of large nuclei. So far as I can determine these are simply undifferentiated ectodermic cells. The other end of the cord is made up of a number of long spindle-shaped cells (*Fib.*), attached at one end to the diaphragm; these may serve as elastic retractors of the evaginated armature.

The musculature of the proboscis is composed exclusively of longitudinal fibres (*Mus.* of figs. 36 and 37), the only faintly shaded structures in these drawings of the proboscis. These muscle cells are too minute for any determination of their finer structure; one can simply determine their long spindle shapes, the presence of nuclei in them, and the fact that they do not form a continuous layer, but are separated from one another though parallel. Their arrangement is shown in figs. 36 and 37.

All this region anterior to the diaphragm has been called by me the proboscis, because evidently the whole is simply an organ for penetration and locomotion in the host, even though it composes about one-half of the body. There is no entoderm in its constitution (except the duct of the gland body situated behind the diaphragm), and mesenchym only in the form of the musculature; all the remainder is ectodermic. It has no intestine, and no nervous system, unless, indeed, the large cells of the axis may be considered embryonic nerve cells, or some of the cells on the anterior surface of the diaphragm. It is not comparable with a head, nor is it to be regarded as a segment of equal morphological value with the head-trunk. The proof is yet wanting, but it will probably be found that this proboscis is the essential larval organ, disappearing more or less completely before the adult condition, and that the head-trunk is the persisting region.

The posterior head-trunk (fig. 36) is bent upon the proboscis, as the larva lies within the egg-membranes, but by the action of the longitudinal muscles the whole body may be straightened. Its hypodermis and cuticula is of the same structure as that of the posterior portion of the proboscis, except for the presence of two pairs of cuticular hooks (*H.*), placed right and left on each side of the posterior end, and for the presence of a thickening of the hypodermis. This thickening (*Nv.*) lies ventral just behind the diaphragm, and shows a double row of large nuclei, one row to the right and the other to the left of the median line, and each row with four to five nuclei. This thickening is to be regarded as the nervous system of the larva. It is an ectodermal thickening of definite form in every larva; and its ventral position corresponds with the position of the nerve cord of the adult. There are no other parts of the larva which can be considered nervous, unless the large hypodermal cells composing the axis of the proboscis have that function—against which assumption a number of objections might be urged. This thickening is then a double row of neuroblasts, recognizable only on carefully stained preparations; nerve fibres cannot be determined.

The longitudinal muscle-cells (*Mus.*) lie just beneath the hypodermis, and terminate anteriorly against the diaphragm. They have the same appearance as those of the proboscis, but are more difficult to perceive, particularly those of the dorsal side. Here also there is no trace of circular muscles.

In the archicœl, at the anterior end of the head-trunk, is placed a large gland (*Gl.*), which, as we have seen, arose as an abstriction from the entodermal canal. By a long duct (fig. 36, *Gl.d.*) it is connected with the exterior at the base of the stilets (*St.*) of the proboscis. This gland lies free within the archicœl, and contains about eight large nuclei; cell boundaries are barely distinguishable, and the cytoplasm is dense and stains uniformly. The long, convoluted duct can usually be found only in life, when it appears as a perfectly clear, convoluted line. On a few preparations, however, its portion within the gland body was deeply stained by hæmatoxyline. It arises near the posterior end of the gland body, extends through the length of the latter, then piercing the diaphragm extends forward through the archicœl of the proboscis, *i.e.*, on the surface of the axial stalk. Whether this extremely delicate canal is intercellular or intracellular in the gland body, I could not ascertain; if it were intercellular it would represent a portion of the gastrocœlic cavity. As to the function of this gland, the position of its external aperture at the base of the stilets would point to its being a poison gland. There is no good reason for judging it to be an excretory organ; and indeed we shall see that what are probably excretory masses become stored up within the cavity of the intestine.

The intestine (*In.*, fig. 36) of the larva is a closed tube, terminating blindly at its anterior end, and at its posterior connecting with the cuticula of the body wall without external opening; this latter point corresponds with the blastopore (*Bl.*). This posterior end of the intestine appears as a narrow, solid stalk, with two or four nuclei apposed to its surface. The wall of the remainder of the intestine is very thin, except at the opposite ends where it is thickened and embraces several large nuclei. Within the intestinal lumen are always present usually two, sometimes more, large globules (*Glo.*) of a pale brownish color and viscid consistency. These appear first when the larva is not quite mature as a thinner fluid, but subsequently accumulate as homogeneous, rounded globules. These cannot represent food substance, for the blastopore is closed and the intestine has no connection with the exterior. It is then probable they represent products of metabolic waste, in which case the intestine of the larva would serve as an excretory reservoir.

Within the archicœl, just at the posterior end of the head-trunk, is a mass of a few small cells (*Mus.*), evidently mesenchym cells that have not become specialized; they are embryonic, and may be germ cells.

Finally, the body-cavity of the larva is an archicœl, without floating cells and apparently without connective tissue. There are no mesodermal epithelia (mesothelia); and the only transverse septum of the body, the diaphragm, is ectodermic.

3. Previous Work.

I have not seen the papers of Grube (1849) and Meissner (1856), nor yet the last paper on the early development, one in Russian by Tretiakow (1901).

Leidy (1850, 1870) gives a very superficial account, with no figures, of the formation of the larva; he noted the proboscis invagination, and the spicules ("filaments") of the armature.

Villot (1874) was the first to give an extended account of the development of the larva. He described the formation of the egg-string ("nidamentum"), and the appearance of the egg-envelopes; and describes the polar bodies as being very variable in number, form and volume. He found the segmentation to be total and equal and leads to a "germe" formed of two concentric spheres (the process of which was not determined), ectoderm and entoderm respectively. He noted the ectodermal invagination at the anterior end of the embryo and interpreted it to be the beginning of the "head" (equivalent to my term "proboscis"). His fig. 49 is the most detailed sketch yet given of the structure of the larva. The whole armature of the proboscis is described very accurately. But he describes an anterior mouth communicating by an œsophagus with a posterior intestine, and the latter by an open anus with the exterior—failing to see the diaphragm, and mistaking for an œsophagus the solid axial cord of the proboscis. He saw correctly the gland and its duct, but interpreted it as an excretory organ. The musculature is noted, and the body-cavity described as filled with cells. His second paper (1891) is mainly a criticism of the work of Camerano.

Camerano (1889) studied the development not quite to the point of the larval stage, figures the chromosomes and certain details in the formation of the polar bodies, which he finds to be two in number. The earliest penetration of the spermatozoon he did not see, but describes a succession of stages of the two pronuclei, and figures them as of unequal size. The early cleavage he finds to be quite variable in different eggs, though holoblastic. In regard to the process of gastrulation his results are entirely different from mine. He finds the embryo at the end of the cleavage to be a flattened plate, not a sphere, a disk composed of two layers of cells—a sterroblastula. This plate becomes quadrangular instead of circular in outline; then an invagination takes place at one end of the plate, which he interprets as a prostoma, and concludes the sterroblastula to have become a cœlogastrula. I can only interpret Camerano's results as follows: First, that the strong fixatives employed produced flattening of the embryos, which I have frequently observed after fixation with acetic acid or strong alcohol; second, that he did not see the gastrula invagination at all (which would take place at the stage of his figs. 43 to 45), and mistook the ectodermal proboscidial invagination for the gastrula cavity.

Villot was in error in describing the true larva as the "état embryonnaire" or "première forme larvaire," and the immature worm found as a parasite in insects the "état larvaire proprement dit" or "deuxième forme larvaire." Camerano and Vejdovský (1894) are quite right in insisting, in opposition to Villot and von Linstow, that the organism as it leaves the egg-membranes is the larva, and that there is no second larval stage. That stage is the larva which is equipped with a temporary larval organ, the proboscis; all later stages, as far as they are known, are but progressions toward the adult condition.

4. Conclusions.

The opinion I had previously expressed (1903) from a study of the adult anatomy of *Paragordius* was as follows: "With the Nematoda the Gordiacea have in common only one important structure, the tubular genitalia and their opening into the cloaca. With the Annelida they agree in the structure and innervation of the musculature, and in having dorso-ventral mesenteries which divide body-cavities bounded by cell-layers. But there is good reason for doubting the homologies of these mesenteries and body-cavities in these two groups of animals. They differ from the Annelida in showing no trace at all of true metamerism (either in the nervous system, the body-cavities, the genitalia or the body wall); in the absence of a cerebral ganglion, of a vascular system, of setal sacks or extremities; and very markedly in the structure of the genitalia. In view of these facts the Gordiacea cannot be regarded as even highly degenerate Annelida, as Vejdovský has done, nor yet as modified Nematoda, the view of most of the writers, but must rather be considered a group of isolated position, as Grenacher, von Siebold and Villot have regarded them."

The present study of the early development confirms this view, but shows that there is considerable correspondence of the cleavage and gastrulation processes with those of the Nematoda. The middle germ-layer is not a connected mesoderm, but a mesenchym of disconnected cells, arising from the mesentoderm close to the blastopore.

The larva has two marked peculiarities. First, by a transverse septum, the diaphragm, the body is partitioned into an anterior proboscis and a posterior head-trunk. This proboscis is entirely ectodermal except for mesenchymatous muscles, and lacks any nervous system, excretory system, and any portion of an intestine. Though it composes half the body, it is probably a purely larval organ that takes no part in the adult structure; the diaphragm marks the future boundary of the adult head, and the proboscis is precephalic. A support for this view, apart from good anatomical considerations, is to be found in the work of Vejdovský (1894), particularly his fig. 17; this represents an outline of the head of an immature individual, showing at the tip of the definitive head the still persisting proboscis with a transverse septum. The future head and trunk proper then lie behind the proboscis of the larva, and this head-trunk becomes the complete body of the adult; this we can say certainly, even though the early post-larval development is entirely unknown.

This head-trunk has a wall like the proboscis, a hypodermis with cuticula, and longitudinal mesenchymatous muscle fibres. There is no cœlom, no peritoneum or mesenteries. The nervous system is simply a ventral thickening of the hypodermis. In the head-trunk is found the second striking peculiarity of the *Paragordius* larva—a gland connecting by a long duct with the anterior end of the proboscis. This gland is entodermal, arising as an abstriction from the anterior end of the entodermal tube. In point of origin it resembles an enterocœl, a mesoderm sack, and its early lumen is a portion of the gastrocœl. But there the resemblance ceases, for it becomes a gland, evidently secretory and not excretory, which later develops a duct to the exterior. Its origin is unpaired. The only forms which show a similar unpaired enterocœl arising from the anterior end of the entoderm tube are the Holothurians, and there an outgrowth of a portion (hydrocœl) of the hydro-enterocœl connects it, in the form of the stone canal, with the exterior. But it would be a rash comparison, in no way justified, between a Gordiacean and a Holothurian. This gland probably continues to a late stage of the development under the form of the "braune Drüse" of *Gordius*, described by Vejdovský, but is not homologous with the problematical "supraintestinal organ" that I found in the adult of *Paragordius*.

When we consider this ectodermal proboscis, the ectodermic diaphragm and the enterocœlic gland; the absence of any cœlomic cavities, ciliary wreaths and excretory organs; the lack of a mouth and the mesenchymatous musculature, we must conclude this union of characters to make the Gordiacean larva unique, not closely comparable with any other larva.

If my interpretation of the larva is correct, then the early post-larval development, which has yet to be studied, should show the mouth arising in the plane of the diaphragm, probably as an ectodermic stomodæum; the dorsal commissure of the brain developing in the same region; and the reproductive organs arising from the small mass of mesenchym cells at the posterior end. But the point of most importance that remains to be investigated is the first origin of that tissue so peculiar to the Gordiacea, the "parenchym," and its arrangement into layers. Not until that is done can the structure of the adult be adequately interpreted.

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Explanation of Plates XLIX and L.

The following abbreviations have been employed in the figures:

Bl., blastopore.
Cut., cuticula.
Di., diaphragm.
Fib., fibre cells.
Gl., gland.
Gl.d., gland duct.
Glo., globules within intestine.
H., cuticular hooks.
Hy., hypodermis.
In., intestine.
Mes., mesenchym cells.
Mus., musculature.
Nv., nervous thickening of hypodermis.
Sp. 1–Sp. 3, spicules of rows 1–3.
St.d., dorsal stilets.
St.v., ventral stilet.

All the figures, except 33–35, are camera lucida drawings at a magnification of 1312 diameters.

Plate XLIX, Fig. 1.—Ovocyte from lateral diverticulum of ovary, at end of the growth period; the yolk globules shaded.

Figs. 2–5.—Nuclei in successive prophases preceding the formation of the first polar body.

Fig. 6.—Portion of an egg near the proximal end of the cloaca, showing the first polar spindle and the entering spermatozoon.

Fig. 7.—Pole view of the first polar spindle.

Fig. 8.—Outline of the whole egg, from a posterior end of the cloaca, showing the two egg-membranes, first polar spindle and spermatozoon.

Fig. 9.—Portion of the periphery of an egg, showing first polar body formed.

Fig. 10.—Outline of egg, showing second polar spindle, sperm nucleus and, separated from the surface of the egg, the two membranes.

Fig. 11.—Pole view of second polar spindle.
Fig. 12.—Outline of egg, sperm nucleus and expulsion of second polar body.
Figs. 13, 14.—Outline of eggs, second polar body on surface, egg nucleus at right, sperm nucleus at left in both figures.
Fig. 15.—Prophase of first cleavage, seven chromosomes in each nucleus; sperm nucleus at left, egg nucleus at right; yolk globules shaded.
Fig. 16.—First cleavage spindle and second polar body.
Figs. 17–19.—2-cell, 4-cell and 8-cell stages.
Fig. 20.—Optical section of a blastula.
Fig. 21.—16-cell stage.
Figs. 22–24.—Successive gastrula stages, optical median sections.
Figs. 25–27.—Optical median sections of later gastrulæ, showing the early formation of mesenchym cells (shaded).
Fig. 28.—Optical median section at stage of ectodermal thickening; mesenchym shaded.
Fig. 29.—Optical median section at stage of beginning ectodermal invagination; mesenchym shaded.
Figs. 30–32.—Similar views of successive later stages.
Figs. 33–35.—Freehand drawings to show the armature of the proboscis in extended position. 33, slightly oblique ventral view; 34, view from the right side; 35, slightly oblique dorsal view.

Plate L, Fig. 36.—Freehand drawing, on a much larger scale than on the preceding plate, of a larva from the right side, with the proboscis fully extended.
Fig. 37.—Similar drawing of the proboscis in invaginated condition.

NOVEMBER 1.

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

Twenty-four persons present.

The deaths of Samuel W. Woodhouse, M.D., October 23, Ralph F. Cullinan, October 30, and A. F. Mueller, M.D., October 20, members, were announced.

MR. WITMER STONE made a communication on the birds of the Galapagos Islands. (No abstract.)

NOVEMBER 15.

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

Twenty-seven persons present.

MR. STEWARDSON BROWN spoke of the between-tide plants of the Delaware river. (No abstract.)

Nominations of Officers, Councillors and members of the Committee on Accounts were made, to be balloted for at the annual meeting.

The following was accepted for publication:

NEW, RARE OR LITTLE KNOWN SCOMBROIDS. No. 1.

BY HENRY W. FOWLER.

The present paper is one of a series now in preparation, which will be intended to give accounts of the more interesting *Scombroids* contained in the collection of the The Academy of Natural Sciences of Philadelphia. While a few of the species appear to be new, others are rare, and some are of value in establishing identifications of older naturalists. I have framed complete descriptions of some species which have at all times needed elucidation, while a number of others are supplemented with notes. Changes in nomenclature which appear necessary are given. In such cases some are due entirely to a rigid adherence to the original orthography. In the introduction of several new subgenera it may be remembered that where transitional forms occur, like those in the older conception of *Caranx*, the better defined groups, possibly of different lines of descent, had at least best be indicated even if only provisionally.

SCOMBRIDÆ.

SCOMBRINÆ.

Subgenus SCOMBER Linnæus.

Scomber scombrus Linnæus.

Syst. Nat., Ed. X, 1758, p. 297. In Oceano Atlantico.——Bonaparte, Cat. Met. Pesc. Europ., Napoli, 1846, p. 73.

Five examples from Italy. Bonaparte Coll. (No. 386.). Dr. T. B. Wilson.

Subgenus PNEUMATOPHORUS Jordan and Gilbert.

Scomber kanagurta Rüppell.

Atl. Reis. Nördl. Af., Fisch., 1828, p. 93. Gomfuda. [Red Sea.]——Fowler, Journ. Acad. Nat. Sci. Phila., XII (2), 1904, p. 506, Pl. 12, upper figure.

Head $3\frac{7}{10}$; depth 4; D. VIII–I, 11, 5; A. I, 11, 5; P. I, 20; V. I, 5; scales about 148 in lateral series to base of caudal; about 13 scales in a transverse series between origin of second dorsal and lateral line; about 24? scales between lateral line and origin of anal; width of head 2 in its length; depth of head $1\frac{1}{4}$; snout $3\frac{1}{2}$; eye $3\frac{1}{2}$; maxillary $2\frac{1}{2}$; mandible $1\frac{3}{4}$; interorbital space $3\frac{3}{5}$; depressed dorsal $1\frac{3}{4}$; base of second dorsal $2\frac{1}{10}$; base of anal $2\frac{1}{10}$; pectoral 2 (damaged); ventral $2\frac{1}{3}$; least depth of caudal peduncle $8\frac{1}{4}$.

Body elongate, rather deep, compressed, and greatest depth near middle of its length. Caudal peduncle small, its width $\frac{2}{3}$ its depth.

Head triangular, deep, and compressed, and profiles evenly though slightly convex above and below. Snout long, conic, sides becoming compressed, and top of head flattened anteriorly. Eye high, nearly touching upper profile, and a little anterior. Mouth moderate, its gape reaching about half way in space between tip of snout and front rim of pupil. Preorbital long, of about even width, and groove extending about opposite middle of eye. Maxillary when exposed reaching front rim of orbit, but when mouth is closed reaching front rim of pupil, and entirely concealed posteriorly by preorbital. Teeth small, conic, rather few, and uniserial in jaws. Tongue small, anterior, elongate, tip rounded and free. No teeth on roof of mouth. Nostrils lateral, and space between each moderate. Anterior circular, about midway between tip of snout and front of eye. Posterior a short vertical slit. Interorbital space broad, flattened, or only slightly concave in middle. Top of head, posterior to eyes, convex.

Gill-opening large, its posterior margin forming a vertical undulation leaving a large flap at lower corner, and extending forward till nearly opposite posterior nostril. Shoulder girdle furnished with two broad fleshy processes with a rather broad space between. Isthmus long and thin, but without a sharp edge. Rakers 13+23, long, though a little shorter than longest filaments, or about equal to space between tip of snout and posterior nostril. Rakers compressed, rather attenuate, and furnished with a series of fine pointed and rather flexible bristles on each inner edge. Filaments longest on middle of ceratobranchial. Pseudobranchiæ about equal to space between tip of snout and anterior nostril. Air-bladder rather large.

Scales small, all narrowly imbricated, those about pectoral and just behind gill-opening enlarged. Scales below second dorsal small. Cheeks and top of head scaly, rest of head naked. Lateral line concurrent with back till after first dorsal, then inclined straight to base of caudal. A short keel at base of each caudal lobe laterally. Pectoral without flap, but with a ridge along scales above to its tip. Soft dorsal and anal covered with minute scales, other fins except pectoral, naked. Adipose eyelid large, leaving only middle third of eye exposed.

Dorsal spines slender, pungent, first two close together, third longest, and others graduated to last which is short. Depressable in a groove which extends well beyond its tip when fin is depressed, and origin falling a little nearer base of soft dorsal than tip of snout, or about over first $\frac{3}{7}$ of pectoral. Second dorsal small, inserted nearer origin of pectoral than base of caudal, and anterior rays elevated. Spine weak. Finlets of both dorsal and anal similar, at equal distances, and last longest. Anal similar to soft dorsal, inserted about midway between origin of pectoral and base of caudal, or a little behind origin of soft dorsal. Pectoral high, small, and reaching beyond middle of base of spinous dorsal. Ventral low, inserted a trifle behind(?) origin of pectoral. Caudal small, deeply emarginate.

Color when fresh in arrack, blue-black above, with many round deep or darker spots than body-color, and area above well separated from lower surface of body by a sharp line of demarcation which reaches lateral line below first finlets. Sides of head, trunk, and caudal peduncle, together with all of lower surface of body, silvery-white. Dorsal, caudal and pectoral grayish, latter especially on its outer and inside basally blackish. Ventral and anal whitish. Inside of gill-opening grayish. Peritoneum silvery.

Length $8\frac{1}{4}$ inches.

Thirty-one examples, but all of the others young. Padang, Sumatra. Coll. A. C. Harrison, Jr., and Dr. H. M. Hiller. Acad. Nat. Sci. Phila. and Stanford University. In the example described above I found a small *Leiognathus* $1\frac{3}{16}$ inches in length. It was taken from the gullet.

I provisionally adopt the name *Scomber kanagurta*, though derived from Russell's Indian fish[1] and based on that of the Red Sea by Rüppell, who subsequently described *S. chrysozonus*[2] and *S. microlepidotus*[3] from the same place. Kner recorded the latter from the Nicobars and Hong Kong,[4] and Bleeker from Pinang.[5] Dr. Steindachner considers both identical with *S. loo*,[6] and Day[7] united all three with *S. kanagurta*, *S. moluccensis*,[8] and *S. reani*,[9] though Dr. Klunzinger separated *S. microlepidotus*, retaining *S. kanagurta* and *S. chrysozonus* as distinct.

Dr. Meek records *microlepidotus* from Aden.[10] One of his examples now in the Museum of Stanford University I have examined. It has exceedingly long gill-rakers, the longest almost equal to snout and one-

[1] *Kanagurta* Russell, *Fishes of Coromandel*, II, 1803, p. 28, Pl. 136.
[2] *Neue Wirbelthiere, Fisch.*, 1835, p. 37, Pl. 11, fig. 1. Massaua. [Red Sea.]
[3] *L. c.*, p. 38, Pl. 11, fig. 2. Massaua.
[4] *Reis. Freg. Novara, Zool.*, I, 1865, p. 143.
[5] *Versl. Kon. Ak. Wet.*, XII, 1861, p. 74. [Record.]
[6] *Sitz. Ak. Wiss. Wien*, LVII, 1868, p 987. Rothen Meere.
[7] *Fishes of India*, II, 1876, p. 250.——*L. c.* in *Supplement*, 1888, p. 790.
[8] Bleeker, *Act. Soc. Sci. Ind. Neerl.* (Besch. Visch. Amboina), I, 1856, p. 40. Amboina, in mari. (M. Dnijmaer Van Twist.)
[9] Day, *Proc. Zool. Soc. London*, 1870, p 441.
[10] *Field Mus. Pub.*, 22, Zool., Ser. I, No. 8, Nov., 1897, p. 172. [Record.]

third of orbit. In number about 30 on lower part of first arch. Shoulder girdle inside gill-opening nearly smooth and with obsolete processes. Later Dr. Meek kindly examined the other examples, which are at present in the Field Columbian Museum, and informs me that the gill-rakers are long, and numerous, longest reaching from tip of snout to middle of pupil, $2\frac{1}{2}$ to $2\frac{2}{3}$ in head.

SARDINÆ.

Auxis bisus (Rafinesque).

Scomber bisus Rafinesque,[11] Carat. Alcun. Nuov. Gen. Spec. Animal. Piant. Sicilia, 1810, p. 45, Pl. 2, fig. 1. Palermo.
Auxis bisus Bonaparte, Cat. Met. Pesc. Europ., Napoli, 1846, p. 74.

Head (measured from tip of upper jaw[12]) 4; depth about $4\frac{4}{7}$; D. XI–IV, 7, 8; A. IV, 9, 7; P. I, 20; V. I, 5; width of head $1\frac{4}{7}$ in its length; depth of head at posterior margin of preopercle $1\frac{2}{5}$; snout $4\frac{1}{3}$; orbit $5\frac{1}{2}$; interorbital space 4; base of rayed dorsal, without finlets, $3\frac{9}{10}$; base of anal, without finlets, 5; mandible $2\frac{2}{3}$; least depth of caudal peduncle 3 in snout. This example agrees with Goode's figure, except that the origin of the spinous dorsal would fall nearer the tip of the depressed pectoral than its base. Length 19 inches. Italy. Bonaparte Coll. ($\frac{76}{T}$). Dr. T. B. Wilson.

On comparison with a single example from Newport (Rhode Island) collected by Samuel Powel, and agreeing with Goode's figure,[13] this difference is still carried out. However, the Newport example is only about $12\frac{1}{2}$ inches long, and thus it may be accounted for by age. Goode's figure does not show the keel above the base of the pectoral fin and parallel with the upper margin of the same fin. It is more distinct and extends further posteriorly in my Italian example.

I retain Rafinesque's name provisionally until more material is compared, as it is possible that the East Indian form[14] may be different.

PELAMYS Walbaum.

Klein, in Walbaum, Pet. Arted. Gen. Pisc., III, 1792, p. 584. (Type here affixed is *Scomber pelamis* Linnæus.)
Gymnosarda Gill, Proc. Acad. Nat. Sci. Phila., 1862, p. 125 (*unicolor*).

Pelamys alleterata (Rafinesque).

Scomber alleteratus Rafinesque, Carat. Alcun. Nuov. Gen. Spec. Animal. Piant. Sicilia, 1810, p. 40. Palermo.
Scomber aletteratus Rafinesque, *l. c.*, Pl. 2, fig. 3.

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[11] I do not know whether this name is later than *Scomber rochei* Risso, or not. Rafinesque's preface is dated April 1, 1810

[12] Also measured in same manner for the other comparisons.

[13] *Fishery Indust. U. S.* (Nat. Hist. Aquat. Animal, I), 1884, Pl. 92, upper figure.

[14] *Scomber thazard* Lacépède, *Hist. Nat. Poiss.*, II, 1800, p. 599.——*L. c.*, III, 1800, p. 9. Vers le septième degré de latitude australe, auprès des rivages de la Nouvelle-Guinée.

Two examples from the island of St. Thomas, West Indies. They agree, and both differ from the following example in the smaller head, which is at least $3\frac{3}{5}$ in its own length and that of the trunk.

Pelamys affine (Cantor).

Thynnus affinis Cantor, Journ. Ass. Soc. Bengal (Cat. Malay. Fish.), XVIII, 1850, p. 106. Sea of Pinang.——Günther, Cat. Fish. Brit. Mus., II, 1860, p. 363. (Type.)

I provisionally retain this as a distinct form from that of the Atlantic. Cantor's fish may be identical, though East Indian and Micronesian examples need comparison. The single example from Honolulu, now before me, has a larger head than the West Indian examples, being contained less than $3\frac{1}{2}$ or about $3\frac{1}{3}$ in the length of head and trunk. Dr. Günther's figure[15] of an example from the Seychelles shows the pectoral high in position, its origin level with the upper margin of the eye, a character which I have not observed as yet in any examples of *Pelamys*.

Germo germon (Lacépède).

Scomber germon Lacépède, Hist. Nat. Poiss., II, 1800, p. 598. No locality.
Scomber germo Lacépède, *l. c.*, IV, 1803, p. 1. Le grand Océan austral, improprement appelé mer Pacifique, vers le vingt-septième degré de latitude méridionale et le cent troisième de longitude. [Eastern Indian Ocean.]
Germo germon Fowler, Journ. Acad. Nat. Sci. Phila., XII (2), 1904, p. 506, Pl. 8, lower figure.

Head $3\frac{1}{2}$; depth 4; D. XIII–III, 11, 9; A. III, 11, 8; P. I, 31; V. I, 5; about 158 scales in a lateral series to base of keel on caudal peduncle; width of head $1\frac{1}{2}$ in its length; depth of head $1\frac{1}{3}$; snout $3\frac{1}{4}$; eye $5\frac{3}{4}$; maxillary $2\frac{1}{2}$; mandible $2\frac{1}{4}$; interorbital space $3\frac{1}{5}$; first dorsal spine $2\frac{1}{4}$; height of soft dorsal, measured from middle of its base, $2\frac{5}{6}$; height of anal $2\frac{5}{6}$; least depth of caudal peduncle about $10\frac{2}{5}$; width of caudal peduncle, measured across keels at their widest part, $4\frac{1}{2}$; ventral $2\frac{1}{2}$; pectoral $3\frac{4}{7}$ in body; space between tip of caudal lobes when expanded, $3\frac{1}{3}$.

Body elongate, broad, fusiform, thick, and greatest depth about middle of its length. Caudal peduncle broad, depressed, and with a broad cutaneous keel on each side.

Head deep, conic, and sides compressed. Snout conic, sides hardly compressed. Eye anterior, high, with narrow adipose eyelids, and its posterior margin midway in length of head. Mouth oblique, tip of mandible even with snout, and maxillary reaching posteriorly till opposite first third of eye. Maxillary with its upper portion slipping under preorbital, its distal expanded extremity $\frac{2}{5}$ of orbit, and with a

[15] *Journ. Mus. Godef.* (Fische der Südsee), V, 1876, Pl. 95.

short oblique groove from its lower angle. Teeth small, conic, sharp and uniserial in jaws. Vomer with a patch of minute teeth. Palatines with similar elongate and narrow patches. Tongue free, elongate, thick, and broadly rounded in front. Anterior nostril nearer front rim of pupil than tip of snout. Posterior a vertical slit a little less than half of orbit and placed in last third of space between its front rim and anterior nostril. Interorbital space and entire top of head convex.

Gill-opening deep, broad, and extending forward till opposite space between nostrils. Rakers $5+16$, compressed, pointed, and longest $\frac{2}{3}$ of orbit. Filaments numerous, long, and longest a trifle longer than eye. Pseudobranchiæ about $\frac{3}{5}$ of eye. Isthmus long, slender, and with rounded edge.

Scales minute, and cycloid, those forming small corselet greatly enlarged anteriorly. Soft dorsal and anal, together with base and middle of caudal, covered with minute elongate scales. Lateral line superior and convex at first, then extending down on middle of side of caudal peduncle to keel. Base of caudal with a low keel above and below. A narrow scaly keel above upper pectoral ray running back for about $\frac{2}{3}$ length of fin. Scales on outside basal portions of ventrals enlarged. Head naked, and cheek with long narrow horizontal bundles of muscular fibres.

Spinous dorsal depressable in a groove, anterior spine longest, enlarged, close to second, and others from third all shorter and further apart. Insertion of spinous dorsal nearly midway between front margin of eye and origin of soft dorsal, which falls well in front of that of anal, or midway between front rim of orbit and base of caudal. Finlets similar, evenly distributed, and with a long point behind. Caudal broad, lunate, strong, and lobes narrow. Pectoral long, and reaching origin of anal. Ventral small, strong, inserted a little behind origin of pectoral and fitting in a depression on belly.

Color when fresh in arrack faded probably. Back and upper surface apparently faded steel-gray. Side grayish with round whitish spots on side of abdomen. Lower surface silvery-white. Dorsal and caudal dusky-brown. Upper finlets grayish, lower whitish with a gray blotch. Anal grayish. Pectoral blackish-gray. Ventrals white with gray membranes. Keel on caudal peduncle blackish. Peritoneum pale.

Length $17\frac{1}{2}$ inches.

One example from Padang, Sumatra. Coll. A. C. Harrison, Jr., and Dr. H. M. Hiller.

This form has never been compared with the Atlantic fish, in view of which it would seem best to retain Lacépède's name for the Indian form. Bennet records a fish from Polynesia, which may probably be identical.[16]

Sarda sarda (Bloch).

Scomber sarda Bloch, Naturg. Ausl. Fisch., VII (X), 1793, p. 44, Pl. 334. Im mittländischen, als auch im atlandischen Meere.
Pelamys sarda Bonaparte, Cat. Met. Pesc. Europ., Napoli, 1846, p. 74.

Head about 4; snout $3\frac{1}{8}$ in head; eye 7; maxillary 2; interorbital space $4\frac{1}{10}$. Length about $18\frac{3}{4}$ inches. Italy. Bonaparte Coll. (4). Dr. T. B. Wilson.

This single dried example is in poor condition. It agrees with Goode's figure[17] so far as one is able to judge from its preservation.

Germo alatunga (Gmelin).

Scomber alatunga Gmelin, Syst. Nat. Linn., I, 1788, p. 1,330. Periodice gregarius in mari mediterraneo, migrans, edulis.
Thynnus alalonga Bonaparte, Cat. Met. Pesc. Europ., Napoli, 1846, p. 74.

Head[18] $3\frac{1}{3}$; depth about $4\frac{3}{4}$; D. XV–III, 11, 9; A. III, 11?, 7; P. II, 32; V. I, 5; width of head $1\frac{3}{5}$ in its length[18]; depth of head, at posterior margin of eye-socket, about 2; snout $3\frac{2}{5}$; eye-socket $4\frac{1}{3}$; maxillary $2\frac{2}{3}$; interorbital space, about middle of eye-socket, 4; mandible $2\frac{1}{8}$; greatest width of caudal peduncle $7\frac{1}{8}$; pectoral $3\frac{1}{2}$ in space between tip of snout and base of caudal. Origin of spinous dorsal inserted posterior to origin of pectoral a distance about equal to $\frac{1}{2}$ length of snout. Origin of the anal would fall about opposite base of last dorsal ray. First two dorsal finlets small, especially the first which is like that of *Germo germon*.[19] Ridge along upper edge of pectoral distinct nearly to tip of fin. Color obsolete though pale blotches on side of abdomen seem to be separated by oblique lines. Length 27 inches. Italy. Bonaparte Coll. ($\frac{27}{1}$). Dr. T. B. Wilson.

Goode's figure[20] is rather poor. It shows the origin of the spinous dorsal opposite that of the pectoral, and the pectoral fin reaching opposite the first dorsal finlet, which is also not especially smaller than the

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[16] Other references are probably:
Thynnus pacificus Cuvier, *Hist. Nat. Poiss.*, VIII, 1831, p. 96. (Based on Commerson.)
Thynnus argentivittatus Cuvier, *l. c.*, p. 97. La mer des Indies. (M. Dussumier.) (Part.)
Scomber germo Bennett, *Nar. Whaling Voyage*, II, 1840, p. 278. Coasts of the Polynesian Islands.

[17] *Fishery Indust. U. S.* (Nat. Hist. Aquat. Animal, I), 1884, Pl. 92, lower figure.

[18] The head is here measured, for all comparisons of this species, from tip of snout.

[19] *Journ. Acad. Nat. Sci. Phila.*, XII (2), 1904, Pl. 8, lower figure.

[20] *Fishery Indust. U. S.* (Nat. Hist. Aquat. Animal, I), 1884, Pl. 95A.

others. The scales above the base of the pectoral are much larger, and those directly above in the corselet are on the contrary indicated as smaller.

I adopt Gmelin's original spelling as there is no evidence that it is an unintentional error, though of course incorrect.

Subgenus SCOMBEROMORUS Lacépède.

Gill-rakers 8 to 12 on first arch below angle. Dorsal spines XVII or XVIII. Teeth 30 to 40 in each jaw. Lateral line somewhat wavy and descending obliquely.

Scomberomorus argyreus sp. nov. Plate LI, lower figure.

Head 4; depth $4\frac{2}{5}$; D. XVII–III, 13, 8; A. V, 13, 8; P. I, 20; V. I, 5; width of head $2\frac{2}{3}$ in its length; depth of head $1\frac{2}{5}$; snout 3; orbit $4\frac{1}{2}$; maxillary $1\frac{2}{3}$; mandible $1\frac{2}{3}$; interorbital space $3\frac{2}{3}$; fourth dorsal spine $2\frac{4}{7}$; third simple dorsal ray $2\frac{1}{6}$; height of anal fin (damaged) $2\frac{1}{2}$; least depth of caudal peduncle $4\frac{3}{4}$.

Body apparently compressed, rather deep, profiles similar, and greatest depth between origins of soft dorsal and anal. From this point back tail well compressed, especially small caudal peduncle. Latter with depth about $\frac{3}{5}$ of its length, measured to end of last vertebra.

Head a little small, compressed apparently, and triangular anteriorly in profile. Snout sharply conic, equal to about $1\frac{1}{2}$ eye-diameters. In front this is formed by broad maxillaries which project well forward to form pointed tip of snout. Eye circular, a little high, and a little anterior. Mouth large and mandible even with tip of snout in front. Maxillary extending posteriorly till opposite posterior rim of orbit, slipping below orbital rim for good portion of its length, and width of distal extremity $\frac{3}{4}$ of diameter of pupil. Teeth compressed, $\frac{20-19}{20-19}$ in jaws. Tongue rather broad, obtuse, thick, small, and a little free in front. Patches of very minute teeth on vomer, palatines, and pterygoids. Tongue almost perfectly smooth, but surfaces of branchial bones in pharynx finely asperous. Nostrils distinct, well separated. Anterior circular, and a little less than diameter of pupil from front of eye. Posterior a vertical slit close in front of eye, also a little less in length than half of pupil. Interorbital space broad, and elevated convexly a little. Margin of opercle rounded posteriorly, hardly forming a blunt angle.

Gill-opening extending far forward till opposite anterior nostril. Rakers small, I, 3 + 12, longest $\frac{2}{5}$ length of longest filament, rather far apart and not sharp. Longest filaments about $\frac{4}{7}$ of orbit. Pseudobranchiæ well developed, though a little smaller. Isthmus long, sharp, and trenchant.

Scales not evident except in lateral line where they are very small. Tubes small. A few small scales above base of pectoral behind gill-opening, and along base of spinous dorsal. Lateral line a little high at first then sloping down gradually behind soft dorsal, wavy to base of caudal, though median, and not forming a keel. Pectoral with distinct axillary cavity. Inner ventral ray well adnate to abdomen by means of membrane. Eye without adipose eyelid, but skin on postocular region just behind eye adipose-like.

Spinous dorsal inserted well forward, about midway between tip of snout and origin of soft dorsal, a little behind that of pectoral, anterior spines longer than others, first two close together and fourth longest. Base of fin depressable in scaly sheath. Soft dorsal inserted a little in advance of that of soft anal, nearly midway between front margin of orbit and base of caudal, anterior rays highest, graduated down from first developed ones. Anal similar, also finlets. Caudal broad, deeply forked, lobes slender, their outer edges straight, and tips pointed. Pectoral broad, high, and upper rays longest, first simple and enlarged. Ventral small, inserted well behind origin of pectoral or about under its posterior base, and rays stout.

Color in alcohol, back and uppermost surface rather light brown, without traces of spots or markings. Lower surface including greater portion of sides bright silvery-white. Greater part of head with silvery. Fins pale or dilute warm olive-brown, except spinous dorsal. Latter whitish except upper anterior portion which is blackish-brown. Pectoral with brownish, especially proximally. Ends of elevated soft dorsal and caudal lobes dusky. Ventral and anal whitish. Iris dilute brassy-white. Peritoneum pale or silvery.

Length 7 inches.

Type No. 11,400, A. N. S. P. West coast of Africa. Dr. Savage.

One example which differs from *Scomberomorus tritor* (Cuvier)[21] in the fin radii. That fish cannot be identical with *Scomberomorus caralla* (Cuvier) as claimed by Dresslar and Fesler[22] if the original figure is correct as it shows the depth about $4\frac{1}{2}$. Bleeker's fish[23] is closer, though it may be different. This latter agrees best with *S. argyreus*. *Apodontis* may represent a distinct subgenus, as it is said to have strong conical teeth.[24]

(*Ἀργύρεος*, silvered.)

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[21] *Hist. Nat. Poiss.*, VIII, 1831, p. 129, Pl. 218.
[22] *Bull. U. S. Fish Comm.*, VII, 1887 (1889), p. 444.
[23] *Nat. Verh. Hol. Maat. Wet. Haarlem*, XVIII, 1863, p. 72.
[24] *Proc. Zool. Soc. London*, I, 1830–1, pp. 146, 169.

Scomberomorus guttatus (Schneider).

Scomber guttatus Schneider, Syst. Ichth. Bloch, 1801, p. 23, Pl. 5. Ad Tranquebariam pelagius inter saxa.

Head $4\frac{2}{3}$; depth $4\frac{1}{3}$; D. XVII–IV, 15, 8; A. V, 14, 9; P. I, 20; V. I, 5; width of head 2 in its length; depth of head $1\frac{1}{3}$; snout $2\frac{3}{4}$; eye 5; maxillary $1\frac{4}{5}$; mandible $1\frac{2}{3}$; interorbital space 3; least depth of caudal peduncle 4; pectoral $1\frac{7}{10}$; ventral about 3. Gill-rakers 2+9, short, barely half length of filaments. Color when fresh in arrack deep slaty-glaucous above, side and lower surface of body silvery-white. Back and upper portion of side with numerous round spots or elongate blotches of deep glaucous, much deeper than ground color. First dorsal black. Soft dorsal, caudal and pectoral grayish. Lower finlets, ventral and anal whitish, and upper finlets somewhat grayish. Length $13\frac{3}{8}$ inches.

Four examples, two of which are young. The latter have the body plain-colored, hardly evidences of spots or only a few ill-defined darker blotches. Spinous dorsal deep black, except white posterior base. Lateral line not forming a scaly keel on side of caudal peduncle, and no keels at bases of caudal lobes. Adult with 27 teeth in upper jaw.

Padang, Sumatra. Coll. A. C. Harrison, Jr., and Dr. H. M. Hiller. Acad. Nat. Sci. Phila. and Stanford University.

Scomberomorus regalis (Bloch).

Scomber regalis Bloch, Naturg. Ausl. Fisch., VII (X), 1793, p. 38, Pl. 333. (Based on Pater Plumier's MS., and evidently from the West Indies.)

Head $4\frac{1}{5}$; depth $4\frac{1}{3}$; D. XVII–V, 12, 8; A. V, 14, 8; eye 5 in head; snout $2\frac{3}{4}$; maxillary $1\frac{4}{5}$; interorbital space $3\frac{3}{5}$. Gill-rakers 3+12. Teeth in jaws $\frac{18-17}{15-15}$. Maxillary reaching posterior margin of eye. A dark longitudinal line just below dark color of back toward caudal peduncle where it becomes obsolete. Iris pale brassy. Lobe of soft dorsal above blackish-brown. Length $9\frac{3}{4}$ inches. One example from San Domingo, West Indies. Prof. W. M. Gabb.

SIERRA subgen. nov.

Type *Cybium cavalla* Cuvier.

Less than 8 gill-rakers below angle, on first arch. Dorsal spines XIV or XVI. Teeth about 30 in each jaw. Lateral line abruptly descending below soft dorsal.

(*Sierra* [Spanish], saw. Applied to these fishes by the Mexicans, in the United States corrupted into Cero.)

Scomberomorus cavalla (Cuvier).

Cybium cavalla Cuvier, Règne Animal, II, Ed. II, 1829, p. 200. (Basedon *Guarapucu* Marcgrave, Hist. Nat. Brasil., 1648, p. 178. Brazil.)
Cybium acervum Cope, Trans. Amer. Philos. Soc., XIV, 1871, p. 472.

Head $4\frac{2}{5}$; depth $4\frac{3}{4}$; D. XV–VI, 12, 9; A. V, 14, 8; snout $2\frac{3}{5}$ in head;

eye $5\frac{1}{3}$; maxillary $1\frac{2}{3}$; interorbital space $3\frac{1}{3}$; pectoral $1\frac{1}{2}$. Gill-rakers $1+7$ on first arch. Lobe of soft dorsal deep brown. Length 15 inches. San Domingo, West Indies. Prof. W. M. Gabb. Also a smaller example with same data.

The three examples recorded from St. Martins, West Indies, are also identical. They have depth 4 to $4\frac{1}{2}$, D. XV (one XVI), and rakers $2+6$ (one 7), more or less rudimentary.

LEMNISOMIDÆ fam. nom. nov.[25]

LEMNISOMINÆ subfam. nom. nov.

LEMNISOMA Lesson.

Voy. Aut. Mond. Coquille, Zool., July 25, 1827, p. 160 (*thyrsitoides*).
Gempylus Cuvier, Règne Animal, II, Ed. II, 1829, p. 200 (*serpens*).

Lemnisoma serpens (Cuvier). Plate LI, upper figure.

Gempylus serpens Cuvier, *l. c.* (Based on *Serpens marinus*, etc. Sloane Voy. Jam., I, 1707, p. 26, Pl 1, fig. 2. About the Tropick of Cancer.)
Gempylus ophidianus Poey, Mem. Hist. Nat. Cuba, II, 1856–58 (1861), p. 246, Pl. 18, fig. 1 (head). Cuba.

Head (damaged) about 5; depth about 17; D. XXXII, III, 10, 6; A. I, II, 9, 7; P. II, 12; V. I, 4; width of head about $5\frac{1}{2}$ in its length; depth of head about $3\frac{1}{2}$; mandible about $1\frac{2}{3}$; pectoral about $2\frac{1}{3}$; lower caudal lobe (damaged) about $1\frac{5}{6}$; snout about $1\frac{9}{10}$ in head, measured from tip of upper jaw; eye about $5\frac{4}{5}$; maxillary about $1\frac{4}{5}$; interorbital space about 7 (damaged); least depth of caudal peduncle about 8; seventh dorsal spine about $4\frac{1}{6}$.

Body very elongate, strongly compressed, and trunk of nearly uniform depth. Caudal peduncle compressed, its least depth about $\frac{4}{5}$ its length, measured from base of last lower finlet.

Head compressed, attenuate, and profiles of both jaws nearly straight, upper a little concave above nostrils. Snout long, conic, and pointed. Eye apparently circular, high, close to upper profile, and its anterior margin a little posterior in middle of length of head. Mouth large, not completely closing, and large mandible with a rather large hard, conic, fleshy point produced well beyond in front, tip of upper jaw fitting in lower anteriorly. Maxillary reaching a little beyond front rim of orbit, slipping below thin edge of preorbital for good portion of its length, and its distal expanded extremity about equal to infraorbital space. Teeth $\frac{17-\text{III}-15}{17\text{———}17}$, compressed, uniserial, broad, sharp pointed, and three medianly in front of upper jaw enlarged and posteriorly along edges barbed. A series of small irregular teeth on palatines, none on vomer. Tongue long

[25] *Lemnisoma* Lesson has priority over *Gempylus* Cuvier if identical, thus the above changes. Their generic status, however, needs investigation. It may also be noted that *Gempylinæ* Jordan and Evermann must give place to *Lemnisominæ*.

slender, smooth, and united to floor of mouth by membrane, only tip free. Nostrils small, far apart. Anterior circular, high on side of snout, and about $\frac{4}{5}$ of an eye-diameter before front rim of orbit. Posterior a small vertical slit in last third of space between anterior and front rim of orbit. Interorbital space a little broad and somewhat convex.

Gill-opening large. Rakers rather few small irregular obsolete pricks. Filaments about $\frac{2}{5}$ of orbital diameter. Pseudobranchiæ well developed, but smaller. Pharyngeal teeth in elongated series and thorn-like.

Narrow thin elongate small scales only evident on caudal peduncle and base of caudal. Lateral line double, and originating opposite base of first dorsal spine. Upper branch extends high along back till opposite anterior elongated dorsal rays, where it suddenly becomes incomplete. Lower branch, till it becomes median, along side well behind pectoral, then continuing straight to base of caudal.

Origin of spinous dorsal about an eye-diameter, or possibly a trifle more, in advance of that of pectoral, and base of fin about equal to $\frac{4}{7}$ of total length of specimen. Spines placed rather far apart, slender, longest about $\frac{2}{3}$ to $\frac{3}{4}$ of depth of body, and margin of fin not notched, membranes forming an entire edge. Posteriorly spines become shorter, so that soft dorsal is distinct. Entire fin depressable in a groove. Soft dorsal inserted near last $\frac{2}{7}$ of total length, elevated anteriorly, and rays graduated from second simple one which is longest. Finlets slender, rather high, and posterior margin of each adnate to back by a membrane. A small rudimentary spine a short distance in front of soft anal. Soft anal inserted opposite and similar to soft dorsal. Caudal forked, rudimentary rays strong, and with a slight elevation laterally on base at terminus of lateral line. Pectoral small, falcate, and upper rays much longer than others. Ventral rudimentary, inserted a little behind base of pectoral, and spine strong though short.

Color in alcohol brown with traces of leaden-silvery, and back apparently brown. Top of head brown. Dorsal brown, caudal brownish, and anal pale brown. Pectoral brownish, a little darker basally. Iris dull slaty. Peritoneum pale brownish.

Length $31\frac{3}{4}$ inches.

One example from San Domingo, West Indies. Prof. W. M. Gabb. This rare species is only known, since originally described, from the accounts by Poey and Lütken. The Polynesian form, *Gempylus coluber* Cuvier,[26] considered identical by Dr. Günther,[27] needs comparison.

[26] *Hist. Nat. Poiss.*, VIII, 1831, p. 155, Pl. 221.
[27] *Journ. Mus. Godef.* (Fische der Südsee), IV, 1875, p. 106, Pl. 68, fig. B.

Dr. Günther's figure does not indicate the maxillary reaching the front of the orbit, and the small scales on the caudal peduncle and base of the caudal. It shows what is probably intended for the lateral line originating apparently opposite and level with the base of the pectoral, but no dorsal branch is indicated. Poey also pointed out that the example figured by Valenciennes,[28] if correct, must be different from *L. serpens*.

Dr. Waite has pertinent remarks concerning this species in Australian waters.[29]

ISTIOPHORIDÆ.

Istiophorus nigricans (Lacépède).

Makaira nigricans Lacépède, Hist. Nat. Poiss., IV, 1803, p. 688. Sur un rivage de la mer voisin de la Rochelle. (M. Traversay.)

FIG. 1.—*Istiophorus nigricans* (Lacépède).

Head, figured above, of an example without data.

Tetrapturus imperator (Schneider).

Xiphias imperator Schneider, Syst. Ichth. Bloch, 1801, p. 93, Pl. 21. In mari Mediterraneo. [30]

Tetrapturus belone Bonaparte, Cat. Met. Pesc. Europ., Napoli, 1846, p. 80.

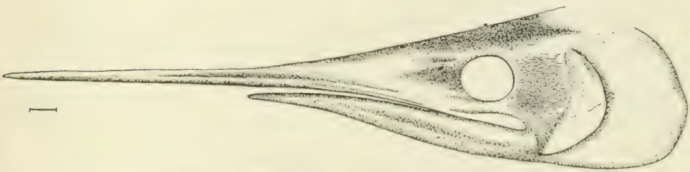


FIG. 2.—*Tetrapturus imperator* (Schneider).

A dried head, figured above, very probably belonging to the old Bonaparte collection, as it bears the number 457.

[28] *Règne Animal*, Ed. Grav., 18—, descr. Pl. 49, fig. 2.

[29] *Rec. Austral. Mus.*, VIII (7), June 15, 1900, p. 199. ——Also see reference, *l.c.*, V (3), March 11, 1904, p. 198 (based on same example).

[30] Based on *De l'Empereur ou Poisson à Epée*, Duhamel du Monceau and de Lamarre, *Trait. Gen. Pesch.*, IV, suite de la second partie, tome III, section V, 1769–82, p. 333, Pl. 25, fig. 2. Méditerranée.

XIPHIIDÆ.

Xiphias gladius Linnæus.

Syst. Nat., Ed. X, 1758, p. 248. In Oceano Europæ.——Bonaparte, Cat. Met. Pesc. Europ., Napoli, 1846, p. 80.

Two examples from Italy, Bonaparte Coll. (Nos. 367 and $\frac{39}{T}$.) Dr. T. B. Wilson. One of these is a dried skin about 3 feet in length.

LEPIDOPIDÆ.

Lepidopus caudatus (Euphrasen).

Trichiurus caudatus Euphrasen, Kön. Schwed. Akad. Wiss. Abhandl., IX, 1788, p. 48, Pl. 9, upper figure. In Oceano, ad Cap. b. Spei.
Lepidopus ensiformis Bonaparte, Cat. Met. Pesc. Europ., Napoli, 1846, p. 78.

Several examples in the Bonaparte Coll. from Dr. Wilson. Italy.

TRICHIURIDÆ.

TRICHIURUS Linnæus.

Syst. Nat., Ed. X, 1758, p. 246 (*lepturus*).
Encheliopus Klein, in Walbaum, Pet. Arted. Gen. Pisc., III, 1792, p. 583. (Type *Trichiurus lepturus* Linnæus.)
Enchelyopus Bleeker, Versl. Med. Kon. Ak. Wet. Amsterdam, (2) II, 1868, p. 292 (*haumela*).

LEPTURACANTHUS subgen. nov.

Type *Trichiurus savala* Cuvier.

Anterior anal spine enlarged, and the others all more or less distinct. Eye usually small.

(*Λεπτὸς*, slender; *οὐρά*, tail; *ἄκανθα*, thorn.)

Trichiurus savala Cuvier.

Hist. Nat. Poiss., VIII, 1831, p. 184, Pl. 224. Pondichéry. (MM. Leschenault et Dussumier.)

Head $7\frac{3}{4}$; depth 18; D. about 107?; A. LXXIV? (and a few more obsolete); snout $2\frac{3}{4}$ in head, from tip of upper jaw; eye 7; maxillary $2\frac{1}{4}$; interorbital space 7. Rakers 5+8. First anal spine enlarged. Iris silvery. Body apparently uniform silvery. Fins pale. Length $14\frac{3}{8}$ inches. Singapore, Malacca. Dr. M. Burrough.

Subgenus TRICHIURUS Linnæus.

First anal spine not enlarged.

Trichiurus lepturus Linnæus.

Syst. Nat., Ed. X, 1758, p. 246. America. China.

Many examples from San Domingo and St. Martin's (West Indies), Surinam and coast of Brazil. A number are small, and the largest is nearly 3 feet long. They range about as follows: Head $6\frac{1}{2}$ to $7\frac{3}{4}$; depth $12\frac{1}{2}$ to $16\frac{1}{4}$; D. 132 to 138; A. XCVIII to CVII; snout $2\frac{2}{3}$ to $3\frac{1}{6}$ in head, from tip of upper jaw; eye 5 to 7; interorbital space $6\frac{1}{2}$ to $7\frac{1}{6}$.

Trichiurus haumela (Forskål).

Clupea haumela Forskål, Descript. Animal., 1775, p. 72. Mochhæ. [Red Sea.]

Trichiurus haumela Fowler, Journ. Acad. Nat. Sci. Phila., XII (2), 1904, p. 506, Pl. 7, lower figure.

Head $6\frac{1}{3}$; depth 14; D. about 134; A. about CVII; P. I, 10; width of head $5\frac{1}{2}$ in its length; depth of head $2\frac{3}{10}$; mandible $1\frac{3}{4}$; pectoral 3; depth of body at anus $2\frac{1}{2}$; snout $2\frac{3}{4}$ in head, from tip of upper jaw; eye $6\frac{1}{2}$; tip of snout to end of maxillary $2\frac{3}{7}$; interorbital space $7\frac{1}{5}$. Tip of mandible broad and rounded in front, with a small fleshy papilla. Front of upper jaw armed with 4 large barbed fangs. Front of lower jaw with 2 smaller barbed fangs. Teeth uniserial, compressed, and becoming larger posteriorly, in sides of jaw. Teeth of upper jaw concealed posteriorly by broad preorbital. Small maxillary also concealed when mouth is closed, and reaching opposite front rim of pupil. Tongue elongate, pointed, and free. Interorbital space flat. Gill-opening extending forward below nostril. Rakers 5+8, short, sharp pointed, and with rather broad bases. Isthmus trenchant. Anal fin represented by broad short truncate spines. Color in arrack, when fresh, silvery-white, upper surface leaden-gray, darker on top of head and back. Dorsal pale or whitish on lower half, and upper or marginal half grayish, becoming dusky on anterior portion of fin. Pectoral grayish. Iris pale yellowish. Peritoneum gray. Length $27\frac{1}{16}$ inches. Two examples. Padang, Sumatra. Coll. A. C. Harrison, Jr., and Dr. H. M. Hiller. Stanford University and Acad. Nat. Sci. Phila.

A small example, $16\frac{1}{8}$ inches in length, from Beirut, Syria, probably belongs to this species. It has—Head $7\frac{2}{3}$; depth 17; D. about 124; A. LXXX? (and a few obsolete); snout 3 in head, from tip of upper jaw; eye $5\frac{1}{2}$; interorbital space 7; maxillary $2\frac{1}{2}$; pectoral 3.

This species is closely related to *Trichiurus lepturus* Linnæus, differing apparently in the less numerous dorsal rays and the deeper body. *T. haumela* was recorded a number of times from India,[31] although Day considered his *T. malabaricus*[32] from Cochin as identical.

[31] Based on *Savala* Russell, *Fishes of Coromandel*, I, 1803, p. 30, Pl. 41.

[32] *Proc. Zool. Soc. London*, 1865, p. 20.

December 6.

Mr. Arthur Erwin Brown, Vice-President, in the Chair.

Twenty persons present.

The death of T. M. Drown, a member, November 16, was announced.

Papers under the following titles were presented for publication:

"New, Rare and Little-known Scombroids, No. 1." by Henry W. Fowler (October 31).

"New Clausiliidæ of the Japanese Empire," by Henry A. Pilsbry (November 22).

"Description of a New Species of Earthworm (*Diplocardia longa*) from Georgia," by J. Percy Moore (November 30).

"A Catalogue of the Erigoneæ of North America," by Cyrus W. Crosby (December 5).

"A Contribution to the Knowledge of the Orthoptera of South and Central Florida," by James A. G. Rehn and Morgan Hebard (December 12).

"New, Rare and Little-known Scombroids, No. 2," by Henry W. Fowler (December 13).

Some Practical Color Tests.—Dr. Henry Emerson Wetherill explained a series of charts illustrating practical color tests as applicable primarily to man, although the charts can be used for work in other fields.

An ante-mortem blood-color scale represents the amount of Oxyhæmoglobin with 100 per cent. as normal. It is made circular to facilitate its use. There are perforations between the adjacent colors so that they may be the better matched. A similar series of colors represents the blood twenty-four hours after death.

The relative humidity of the air is illustrated by a moisture scale, which can also be used to measure the amount of cutaneous excretion.

The colors of the urine are represented by two charts, and a scale for the colors of the feces enables one to report numerically the conditions as found.

An improvement of the Dimethylamidoazobenzol test for HCL was shown, and remarks made on its application.

These scales serve as standards of comparison. A classification was contained in the book given to the Academy.

DECEMBER 20.

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

Thirty-four persons present.

The following were accepted for publication:

THE ORTHOPTERA OF THOMAS COUNTY, GEORGIA, AND LEON COUNTY, FLORIDA.

BY JAMES A. G. REHN AND MORGAN HEBARD.

The material on which the following study is based comprised over three thousand specimens, of ninety-four species. The majority of this extensive series is contained in the collection of the junior author, but a thoroughly representative series is in the collection of the Academy of Natural Sciences of Philadelphia, part being collected by Rehn and part presented by Hebard.

The series studied contains material taken on dates extending from December, 1902, to April, 1904. The junior author resided at Thomasville from December, 1902, to May, 1903, and from late November, 1903, to early April, 1904. During the summer of 1903 a collector was employed to work in the vicinity of Thomasville, and a very good series of the summer and early autumn species obtained. The senior author spent from March 14 to April 5, 1904, with Mr. Hebard and they together examined considerable of the surrounding country. Several trips were made over the State line into Leon county, the adjoining portion of Florida, one in 1903 and two in 1904.

The critical portion of the following paper is almost entirely the work of the senior author, while the field notes, which are followed by M. H., are the work of the junior author, but they agree in all the statements made.

As a general description of the country is usually of great value in a faunistic paper, we have summarized the principal features of the region under consideration and also made some notes on the occurrence, time of abundance and local environment of a number of the more interesting species of Orthoptera.

Thomasville, Georgia, the county seat of Thomas county, is situated in the southwestern part of the State, some twelve miles distant from the Florida line and about fifty miles from Alabama. The surrounding country is gently rolling and covered with fine pine forests, and divided into large plantations, many of which have the greater part of their area cleared and under cultivation, the chief crops being corn and cotton. Sweet potatoes, sugar cane and peanuts are also extensively produced. The pine forests are usually wholly composed of the long-leaf variety, but here and there a forest of nothing but the short-leaf pine is to be found. In the pine woods there are hardly any other trees excepting occasional oaks, sweet gums and dogwoods. These woods are very open and there being hardly any undergrowth, a wagon may be driven through them almost anywhere. The ground is in nearly all places thickly carpeted with wire-grass and other small plants, with here and there a dense clump of gall-berry bushes, while everywhere the long pine needles are thickly scattered. Throughout these woods the yellow jasmine grows in great luxuriance and when in flower is most beautiful. In each depression of the land a stream is to be found, called in this country a "branch." These streams are almost invariably filled with a thick growth of magnolias, bay, black gum, tulip, beech and other trees, while the undergrowth of blackberry, grape and other vines is usually very dense, and an occasional thicket of pipe cane adds to the difficulty of following the course of one of these streams. To this must be added the fact that in many places the ground on both sides of the "branch" is boggy and there are muddy holes covered by sphagnum between the roots of the trees. There are a few places where the pine forests have been cut down and the land left uncultivated; in these situations has sprung up a dense growth of scrub oak, which has completely choked out almost all other vegetation. In other unreclaimed fields the short-leaf pine thrives, and less frequently one finds a heavy growth of young long-leaf pines.

The Ocklockonee river flows within five miles of the town, and is a stream about thirty feet in width during the dry part of the year, but during the heavy rains it spreads for a mile or more over the nearby country, which is in most places low and swampy.

Along portions of the river bank are dense swamps of gum, cypress and other trees. Through these swamps run numerous ridges of clay and sand with here and there shallow lagoons, which with the great height of the trees and the numbers of fallow and mouldering logs lend to these bottoms a very wild aspect. These places are the only situations in this part of the country where deer, wildcats and an occasional bear may be found. The character of the country just across the line in Leon county, Florida, differs noticeably from that about Thomasville. It is more rolling, with small lakes in every depression. This country is unhealthy, for in the summer these lakes dry up exposing to the sun a great amount of decayed vegetable matter. The largest lakes near Thomasville are Iamonia and Miccosukee. They are distant from the town about fifteen and eighteen miles respectively.

The former, although some miles long, occasionally goes dry in a very short space of time, and fills up again with as great rapidity. The water has been found to flow in and out through a subterranean passage, and once, when the lake went dry, a peculiarly marine fish was taken from the opening through which the water had receded. This opening was filled with a great number of fish, although they had been left dead by the thousand on the bed of the lake when the water disappeared.

The soil of this region is rich, but not deep, the red clay, which is everywhere, often being within a few inches of the surface of the high ground where, however, the crops seem to grow as well as anywhere.

The Orthoptera of the country around Thomasville is best represented in the pine woods. Here among the wire-grass and pine needles which carpet the ground many interesting species are to be found. In early December, before the frosts have thinned their numbers, *Amblytropidia occidentalis*, *Aptenopedes sphenarioides* and *Radinotatum brevipenne* are most abundant through these forests; *Schistocerca damnifica, Melanoplus keeleri, M. nigrescens* and *M. scudderi* are then by no means common but more restricted to colonies. Among the really scarce species are *Melanoplus sylvestris* and *Gymnoscirtetes pusillus*. By December *Orphulella pratorum*, which swarms in the open spots of the woods in the fall, becomes quite scarce, as is the case with *Arphia xanthoptera*, and to a considerable extent that of *Dictyophorus guttatus*. By the end of December almost all Orthoptera disappears owing to the cold weather, and during the following two months the conditions usually remain the same. In March, at the advent of warm weather, *Amblytropidia occidentalis* and *Aptenopedes sphenarioides* are again very plentiful and *Schistocerca americana* appears common in certain localities, while *S. damnifica* and *Arphia sulphurea* are generally noticed. The *Forficulidæ* is represented by several species, only one of which, *Labia burgessii*, is abundant. Infrequently *Labia minor* and *Anisolabis annulipes* are found, and occasional small colonies of *Labia guttata* and *Spongophora brunneipennis* located. These colonies are usually found in dead magnolias or other hardwood trees, but occasional specimens may be taken from bark on pine logs. The *Blattidæ* is represented by *Ceratinoptera lutea*, which is sometimes very common among the dead leaves under oaks, sweet gums and hickories. In the pine logs between December and March many immature *Ischnoptera* may be taken by peeling off the loose bark; mature individuals begin to appear about the middle of April, and by May most specimens are fully developed. The most plentiful species of

Mantidæ is *Stagmomantis carolina* and its favorite habitat is a blackberry bush or other low growth, occasionally in the pine woods, but more often in branches and fields. The slender *Thesprotia graminis* is a purely pine woods species, and is found among the wire-grass, where it is so well protected by both form and coloration as to almost defy detection. In the spring *Conocephalus* appears in numbers in the broom sedge and other grasses throughout the pine woods. The *Gryllidæ* in the fall before the frosts is represented by a few species, of which *Nemobius ambitiosus* is most plentiful, and it may be found in diminished numbers throughout the winter. Under rubbish *Gryllus* are common, and *Orocharis gryllodes* may be found hibernating under signs on oak trees. During the spring, in certain restricted localities, *Falcicula hebardi* is quite plentiful among the wire-grass, and later in the summer *Hapithus brevipennis*, while *Œcanthus* appears frequenting the bushes and shrubs, especially those growing on the sides of the branches. The Orthoptera found in these branches differs greatly from that of the pine woods. Here in the late fall hardly anything is to be found except *Nemobius carolinus* and *exiguus* which are plentiful, the former in beds of sphagnum only; and some *Paroxya floridiana* restricted to a few sunny spots. In the spring, however, *Tettigidea lateralis* is very common in all grassy spots, and in certain localities *Tettigidea spicata* is found. In other locations *Acrydium arenosum*, *Paratettix texanus* and *Neotettix femoratus* may be taken, the best places being where these streams empty into a lake or flow through low sandy stretches of fields. The species of *Acrididæ* found in the fields just before the heavy frosts are *Chortophaga viridifasciata*, *Melanoplus propinquus* and *Orphulella pratorum*, all in great numbers; *Psinidia fenestralis*, *Melanoplus atlanis* and *Spharagemon wyomingianum* are moderately common earlier but soon disappear, while *Dichromorpha viridis*, which swarms in the summer, is not in evidence. Among the species found during the summer months are *Hippiscus phœnicopterus*, *H. rugosus*, *Spharagemon bolli*, *Dissosteira carolina* and *Trimerotropis citrina*.

Family FORFICULIDÆ.

Labidura bidens (Olivier).

This species is apparently not uncommon at Thomasville, as specimens were taken May 2, 21, 26 and 29; August 12, and a series of eight the first week in October, 1903. These individuals are indistinguishable from Cuban specimens, and exhibit considerable variation in size, but in color are quite constant.

These specimens were taken in hot weather only and were attracted to the arc lights. (M. H.)

Anisolabis annulipes (H. Lucas).

Specimens of this species taken at Thomasville, December 24, 1902 (under pine bark), August 20, September 9, December 9, 1903 (in house), and March 23, 1904, are the first individuals recorded from the United States. In one individual (December 9) the maculations on the limbs are rather weak.

The few specimens of this species taken were all met with accidentally. It appeared to be at all times very scarce. (M. H.)

Spongophora brunneipennis (Serville).

A number of specimens (ten) of this species were taken at Thomasville under magnolia bark, December 10, 11 and 13, 1903. They are equally divided between the sexes and are constant in size and coloration. An immature specimen was also taken under pine bark in Leon county, Florida, on April 7, 1903.

All the specimens of this species were taken from under the bark of a dead magnolia tree. They were found in colonies of three or four huddled closely together, and upon the bark which concealed them being pried off they made vigorous attempts to escape. The specimens of this species taken, with hardly an exception, were under bark five or more feet from the ground, where the decayed wood was dry and pithy and not as far gone as that at the foot of the tree. (M. H.)

Labia minor (Linnæus).

A specimen of this species from Thomasville, but without further data, was examined.

Labia guttata Scudder.

Three female specimens of this species have been examined from Thomasville, one taken January 1, 1903, another January 24, 1903, and the other in Georgia pine woods on March 1, 1904.

A scarce species in this locality, taken from under the bark of dead pine logs. In 1904 but one colony, consisting of four or five specimens, was discovered, although during the year many logs were thoroughly examined. (M. H.)

Labia burgessii Scudder.

This species is quite common at Thomasville under the bark of dead trees. A series of over a hundred and fifty specimens, representing the adult condition of both sexes and immature forms, has been examined. This series plainly demonstrates that there is considerable variation in the size of the adults of both sexes, but coloration appears to be quite uniform, such difference as is apparent being due to the extension of the abdomen, which causes the insect to appear more of a chestnut color than is the case when in normal position. The specimens were all taken in the months of December and March.

This species is seldom to be met with, but when found is almost invariably in very large numbers. In 1903 a few specimens were taken in the woods about Thomasville, and one colony of over forty specimens was discovered in Leon County in a dead pine log under the loose bark. In 1904 but one colony was observed; this was in the trunk of a large magnolia which, though long dead, was still standing. The specimens were all taken from the trunk less than five feet above the ground where the wood was soft, damp and pulpy and the bark loose. By visiting this tree several times and picking off all the loose bark and soft wood over one hundred and fifty specimens were obtained, the specimens usually found singly. This was the same tree on which *Spongophora brunneipennis* was found. Quite a number of immature specimens of *S. brunneipennis* were taken among individuals of this species. (M. H.)

Family **BLATTIDÆ.**

Ischnoptera inæqualis Saussure and Zehntner.

Immature specimens of what appears to be this species were taken at Thomasville, on March 23 and April 9, 1904. The individuals taken on the latter date were from Linton's Pond, a body of water several miles southeast of Thomasville. All were on oak. A single adult male was taken at Thomasville, on May 6, 1903, and this appears to be unquestionably *inæqualis*. Blatchley has recently recorded this species from Indiana, and with the original localities—North Mexico and Texas—and Costa Rica, we have some idea of the distribution of the species. The immature Thomasville specimens are in such condition that the identification is attended by a little uncertainty, but no other known North American species agrees with them as fully as *inæqualis*.

All the immature specimens taken were found under advertising signs on white oak trees only, and were extremely rapid in their movements. (M. H.)

Ischnoptera johnsoni Rehn.

This species is represented in the Thomasville collections examined by an adult male taken July 23, 1903, and a series of immature individuals taken December 1, 1903, March 1, 23 and 25, and April 9, 1904. The immature specimens were all taken under signs on trees or under bark. Naturally some little uncertainty is attached to the identification of the specimens, but they can safely be considered *johnsoni.* Some individuals possess light narrow lateral margins to the pronotum, mesonotum and metanotum.

All the immature specimens taken were found under signs on oak trees in company with immature individuals of other species of *Ischnoptera.* When revealed the majority in their hurry fell from the tree and hid in the leaves at its foot, but a few, relying in their protective coloration, would press themselves closely to the bark and remain motionless. (M. H.)

Ischnoptera uhleriana Saussure.

Adult Thomasville specimens of this species taken March 23, April 6, May, July 10 and 25, 1903, have been examined. They fully agree with specimens from Pennsylvania and New Jersey. Data with some specimens informs us they were taken from under pine bark.

This is the most abundant roach found in this region under the bark of dead pine logs. It was hardly ever met with except on pine. (M. H.)

Ischnoptera major (Saussure and Zehntner).

A large series of immature individuals, some nearly adult, we refer to this species. The larger specimens are undoubtedly *major*, but the smaller ones may represent other species as well. The localities represented are Thomasville, Tyty Plantation and the Ocklockonee river, and the dates range from February to October.

Almost all the immature specimens taken of this species were from under the bark of dead pine logs. (M. H.)

Ceratinoptera lutea Saussure and Zehntner.

Several immature specimens of this species were taken at Thomasville on December 31, 1902.

This species is occasionally very abundant in dead oak leaves. Many immature specimens were also seen under signs on trees, especially on sweet gum, in company with immature specimens of *Ischnoptera.* (M. H.)

Periplaneta americana (Linnæus).

This omnipresent species is represented in the collections by a number of Thomasville specimens taken in April, June and December.

Periplaneta truncata Krauss.

This species, which was previously known from the United States by one record from Victoria, Texas,[1] is represented by two females

[1] Caudell, *Proc. U. S. Nat. Mus.*, XXVI, p. 779.

from Thomasville, taken in October, 1903, and on January 9, 1904. These individuals, as is the case with the Texan specimens, are referable to the "var. a" of Saussure and Zehntner.

The specimen of this species which was taken on January 9, 1904, I found dead on the sidewalk of Jackson street, under a large live oak. (M. H.)

Family MANTIDÆ.

Stagmomantis carolina (Johansson).

This species is represented in the collection by immature individuals taken in July and August, and adults taken in August, September and October.

Gonatista grisea (Fabricius).

A single specimen of this species from Thomasville was examined. It was taken in early winter resting on the dead leaves of a small water oak.

Thesprotia graminis (Scudder).

This species is represented in the Thomasville material by two somewhat immature individuals taken August 19 and September 30, 1903.

This species is found in the wire-grass which carpets the pine forest, and which it so closely resembles that the closest scrutiny is required to reveal its presence. (M. H.)

Family PHASMIDÆ.

Anisomorpha buprestoides (Stoll).

This species is represented by specimens taken at Thomasville, March 20, 1903, and at Tyty Plantation, Thomas county, December 12, 1903. The latter individuals, a pair, were taken on pine in coitu.

A number of half-grown specimens of this species were taken by beating the gall-berry bushes growing near a "branch" which crosses the river road nearly two miles from town. (M. H.)

Family ACRIDIDÆ.

Acrydium arenosum (Burmeister).

This species is found common in the vicinity of water, on sandy beaches and wet soil, but probably is local in its distribution even in such environment, as it was taken at but three points. In a piece of bayou country, amid cypress and black gum, on the Ocklockonee river west of Thomasville, this species was taken on February 29, March 29 and April 1 and 9, 1904. In the vicinity of a small lake in northern Leon county, specimens were taken on March 21, 1903, and March 22, 1904. The series examined consists of sixty specimens, and exhibits a great amount of variation in the rugosity of the pronotum, the character of the median carina of the pronotum, and a slight amount of color variation, the latter chiefly in the intensity of the pair of spots posterior to the humeral angles.

Neotettix bolteri Hancock.

A single specimen of what appears to be this species was taken in Leon county, March 22, 1904, in swampy ground at the edge of a small lake.

Neotettix femoratus (Scudder).

A variable and interesting series of specimens from Thomasville, taken in late June, early July, September and October, 1903, and April 9 and 10, 1904, are referable to this species. While a great amount of variation is exhibited by the specimens examined, they appear, after comparison with the type, to represent Scudder's species. Three individuals belong to a type with the posterior portion of the pronotum elongate.

This species, during the summer, was found moderately plentiful. (M. H.)

Paratettix texanus Hancock.

Three Thomasville specimens, two males, one female, are contained in the series examined. They were taken on marshy meadow or sandy beach at Linton's Pond on March 21, April 10, 1904. This species has been recorded from Texas, Louisiana, Mississippi, Georgia and South Carolina. Its status appears to be more likely that of a mere subspecies of *P. cucullatus.*

Tettigidea spicata Morse.

This species is represented by a series of seventeen specimens taken at two localities in Thomas county. At one point about two miles west of Thomasville, in wet pine woods, it was taken on December 14, 1903, April 9, 1904; while on February 29, March 29 and April 1 it was taken in bayou country along the Ocklockonee river. A form with the pronotum elongate is represented by four specimens, two of each sex.

Tettigidea lateralis (Say).

This species was very abundant in moist localities in Thomas and Leon counties. In bottom land as well as on sandy stretches and moist meadow this interesting little locust was noted. Specimens examined were taken in the months of February, March, April, July, August and September. The series examined, over one hundred and thirty in number, exhibits a considerable amount of variation in size and in the angulation of the anterior margin of the pronotum.

Radinotatum brevipenne (Thomas).

This interesting and peculiar species is mainly a common inhabitant of pine woods in Thomas and Leon counties. It lives among the dried needles and apparently depends for safety more on protective resemblance and coloration than on anything else, as the saltatorial powers are limited and the flight organs useless. Three color types are represented in the series of one hundred and eleven specimens examined, one type being uniform brownish of varying shades, another brownish with the dorsal surface of the head, pronotum and tegmina grass green, and the third brownish with the lateral aspect greenish. From the material examined it would appear that around Thomasville the species is represented by mature individuals in late spring and early summer (April to July), September individuals being extremely small, while a large number of November, December and March specimens show a gradual increase in size. The peculiar character of the subgenital plate of the male is pronounced in specimens taken in November. Color notes from life: Green phase, nymph, Thomasville, Georgia, November 30, 1903; color of the dorsal surface, antennæ, eyes, mandibles, labrum, median and anterior limbs, posterior tibiæ and tips of the posterior femora wood brown; lateral aspects, face, meso- and metasternum and posterior femora (except the distal portions) apple green. Brown phase, nymph, Thomasville, Georgia, November 30, 1903; general color wood brown, obscurely and rather irregularly lined and spotted with broccoli brown, a rather distinct postocular and pronotal streak being developed; posterior femora with the apical portions blackish. The color of adult males is grass green on the dorsal surface of the pronotum and tegmina, the abdomen, lateral aspect and dorsal surface of the femora as in the immature; inferior margin of the lateral lobes of the pronotum pale ochraceous. The adult female is uniform wood brown, except the eyes, which are umber obscurely spotted with darker brown. One adult female, however, has a green and brown coloration, but the pattern is exactly the reverse of that found in the males, the green being lateral instead of dorsal. Several specimens examined are strongly overcast with blackish spots.

I noticed many immature specimens of this species pale straw brown in color, and one or two specimens taken were profusely marked with small black dots. On April 7, 1904, I noticed several mature males of this species in the sprouting broom sedge at the edge of the golf course near thick woods. Returning to this place two days later, I took a number of mature males and several females almost adult. These males were nearly all of the green form, while the females were entirely brown. Returning to this place on the next day, I at last succeeded in taking a mature female. (M. H.)

Syrbula admirabilis (Uhler).

Seven specimens of this species taken at Thomasville, in 1903, have been examined. Four of the seven are immature and were taken on June 30, July 6, 7 and 16. The four adults were taken June 30 (♂), July 6 (♀), September 30 (♀) and December 14 (♀). An interesting feature noticed in this series, and substantiated by other material from the Middle Atlantic States, is the transition from a depressed ensiform antennæ in the immature form to a slender, subfiliform type in the adult. From a phylogenetic standpoint this fact would indicate a type with ensiform antennæ, like *Mermiria*, as the ancestor of the genus *Syrbula*.

I captured one female specimen of this species in damp low pine woods in December. (M. H.)

Amblytropidia occidentalis (Saussure).

This modestly colored but lively species is almost without exception found in pine and black gum woods, but in pine woods the species is more abundant than elsewhere, being found in association with *Radinotatum* and *Aptenopedes*. The series examined contains ninety-eight specimens from Thomas and Leon counties, and exhibits a great amount of variation in color and some in structure. In some female specimens the pronotum is more expanded than in others, and the head also appears slightly stouter. The amount of color variation is remarkable, though confined to browns and grays. From an extreme blackish-brown form all intergrades are present to types of a uniform sienna and ashy gray. Some individuals are obscurely lined on each side of the median carina of the pronotum. The following color notes are from life: Female, Thomasville, November 30, 1903; general color mars brown and mummy brown spotted and streaked; eyes broccoli brown; posterior femora laterally mars brown, darkest dorsally, above wood brown with a few mars brown spots, beneath pinkish-vinaceous, internally milky white blotched with blackish and dull brown; posterior tibiæ basally wood brown becoming bluish-black apically; abdomen with the dorsal surface pale ochraceous-rufous, laterally wood brown washed blackish basally, each segment with the apical margin milky white; inferior surface pinkish-vinaceous. Female, Thomasville, November 30, 1903; similar to the specimen described above, except that the dorsal surface is overcast with a pale whitish suffusion and the lateral lobes of the pronotum, the pleura and the genæ and postocular regions of the head are suffused with dull orange-rufous. The only immature specimen in the series examined was taken on November 30. The adults were taken on dates extending from the latter part of October to the early part of April.

This species of the pine forest, although it is singularly protected by its coloration when in its favorite haunt among the pine needles, is, nevertheless, a most wary and active species. Both males and females fly with the greatest rapidity and when alarmed will keep on the wing for a considerable distance. When approached quietly they will spring up with great speed, but only fly a short distance. Diving into a tuft of wire-grass and pine needles, they seem to literally glide down to the most obscure place at the roots of the grass, where, although perfectly hid, they remain alert and upon the approach of anything make another rapid flight to some still safer place. I have never been able to ascertain how these insects are able to start out of the center of a thick tuft of grass at full speed and dive into the very center of another in the space of time required by them. This is the only species I know of that can slip out of one's hand when, after approaching within a few inches of the specimen, one pounces upon it. It can not only do this, however, but can escape with such speed that track of it is very easily lost. (M. H.)

Orphulella pratorum Scudder.

This species is, judging from the amount of material examined, exceedingly abundant at Thomasville from late June to late October, but particularly in September; while individuals taken in November, December, May and early June show its presence then, but probably not in such numbers as in summer and early fall. The series examined numbers four hundred and twenty-four specimens and represents all types and shades of coloration, as well as illustrating the great diversity in size exhibited by specimens of the female sex.

Dichromorpha viridis (Scudder).

This species is represented by a series of one hundred and forty-three specimens from Thomasville, taken in the months from June to December inclusive. As usual in the species, great variation in size is exhibited by the series, and both color forms are represented, the green being greatly in the majority.

Arphia xanthoptera (Burmeister).

This species is represented in the material studied by four specimens, one male and three females, taken at Thomasville, March 16, September 24, November 30 and December 10.

Between December and March a stray specimen of this species may occasionally be met with in the oak and hickory woods. (M. H.)

Arphia granulata Saussure.

A male and female of this species from Thomasville, taken May 27, 1903, have been examined.

Arphia sulphurea (Fabricius).

Specimens of this species were taken in Leon county, and at Thomasville, in March and April, in pine woods. An immature specimen taken in January has also been examined.

This species appeared to be moderately common in the spring of 1903 in pine woods with many scrub oaks about. I found the immature specimens of this species plentiful throughout the winter months in dead leaves under oak, hickory and sweet gum trees. (M. H.)

Chortophaga viridifasciata (DeGeer).

This common species is represented by a series of ninety-two specimens, the brown phase outnumbering the green form. The series covers adult specimens taken in every month of the year.

I have found this species late into December in colonies along the edge of woods. (M. H.)

Hippiscus phœnicopterus (Burmeister).

The species is represented by specimens taken in May (27th) and June (2d and 8th), 1903, at Thomasville.

Hippiscus rugosus (Scudder).

A single specimen taken at Thomasville on August 13, 1903, I have referred to this species. It has, however, cinnabar wings, but structurally is inseparable from Pennsylvania specimens of *rugosus*.

Dissosteira carolina (Linnæus).

This species is represented by specimens from Thomasville taken May 25 and 26, June 8 and 12, and July 27, and from Metcalfe taken September 17. One specimen taken July 27 is immature.

Spharagemon bolli Scudder.

A single male specimen of this species is included in the material examined. It was taken at Thomasville, July 14, 1903.

Spharagemon collare wyomingianum (Thomas).

A series of nine Thomasville specimens are assigned here with some uncertainty. They agree with New Jersey specimens of *wyomingianum* except for the sharper fastigium, which also forms a more acute angle with the face. Considerable color and minor structural variations are exhibited by this series. The specimens were taken in June, July, August and November.

Psinidia fenestralis (Serville).

This sand-loving species is represented by a series of eighteen specimens taken on dates extending from June to November.

I took one specimen of this species on November 30, a mature female so battered and worn it could scarcely fly. (M. H.)

Trimerotropis citrina Scudder.

This species which is here recorded from the Southeastern States for the first time, is represented by a series of sixteen specimens taken at Thomasville and Metcalfe. May, June and September are the months represented by the material studied.

Dictyophorus guttatus (Stoll).[2]

This large and striking species is fairly numerous in southern Georgia, and attains full size by August. Several imagos taken in August, September and October have been examined, one male being of small size. Another comparatively small male from Brunswick, Glynn county, Georgia, is in the collection of the Academy.

I have found very young specimens of this species as early as the first week in April. They were then in colonies of a dozen or more in the pine woods. (M. H.)

Stenacris[3] **chlorizans** Walker.

This cat-tail loving species is represented by several Thomasville specimens and eight individuals from Leon county, Florida. The former series was taken on March 7, 1903, and March 25, 1904, the exact locality being a large boggy meadow cut by numerous streams, formerly covered by a dammed body of water locally known as Mitchell's Pond. Several specimens were also noticed, but not taken, at a large pond several miles north of Thomasville. The Leon county specimens were all taken on the margins of a large pond in the extreme northern part of the county, within half a mile of the Georgia line, on March 21, 1903, and March 22, 1904.

But four of the series examined have the white lateral line distinct, the others being almost unicolorous, two, however, having the upper surface suffused with rosaceous.

I found this interesting species the most numerous among the cat-tails growing in the deep water at the edge of the pond. When alarmed

[2] It is evident that Stoll's *Gryllus guttatus* (*Natuurl. Afbeeld. Beschr. Zabel-springhanen, Trek-springhanen, Krekels en Kakkerlakken*, p. 23, and *Register*, p. 12, Pl. X*b*, fig. 34) is the same as Thunberg's *Dictyophorus reticulatus*, and is two years earlier.

[3] This generic name is revived in place of *Arnilia* Stål, which it antedates by three years. It was proposed (*Catal. Derm. Salt. Brit. Mus.*, IV, p. 651, 1870) for three species, *lanceolata concolor* and *chlorizans* the latter of which can be selected as the type.

it would at once fly swiftly and silently away to the stem of a cat-tail, apparently in a safe place, and would then, when approached, dodge around to the opposite side and remain motionless, pressing itself to the stem, which I noticed would almost invariably be the same color as itself. It could then be taken by a stealthy approach and a quick grasp of the hand, for it seemed to rely on its resemblance to its support and would not take wing unless alarmed by a quick movement or a too close approach. When badly alarmed I noticed several specimens fly up into the trees and hide on the small twigs, as they had before done on the cat-tails. Not one of the species was to be found on the brownish rushes where *Leptysma* was common, which latter species was precisely the color of its surroundings. The flight of this species is much stronger and more rapid than that of *L. marginicollis,* and owing to this fact and the locality in which it is found, it is quite difficult to take a specimen when thoroughly alarmed. Those specimens seen on the meadow where Mitchell's Pond had once been were afforded poor cover, as the grass was short, and I noticed that they would almost always take flight when I was still a number of feet distant, no matter how cautiously I approached. (M. H.)

Leptysma marginicollis (Serville).

This species, which is somewhat similar in habit to the preceding, is represented by specimens taken at Thomasville during March and in Leon county on March 22, 1904.

This species was most numerous among the dried rushes on the edge of the pond in Leon county mentioned as the habitat of the preceding species. The specimens were easily alarmed by a quick movement, but could be easily approached and grasped if this was done in a slow and careful manner. They were as well protected by their color on these brown rushes as the S. *chlorizans* were with their bright green coloration on the cat-tails whose stems were the same color; the latter species, however, showed much less confidence in its concealment and was much more difficult to approach. (M. H.)

Schistocerca americana (Drury).

This elusive and powerful species is represented by eight specimens taken at Thomasville in January, March, May, October and December. Leon county is represented by specimens taken in March.

Much of the time this species is common in the open pine woods. Its flight is powerful and it usually takes refuge on the pine trunks over eight feet from the ground. Its color blends remarkably with the bark, and it, remaining motionless, with hind femora drawn closely to the body ready to spring, does not take flight until closely approached.

Like the two preceding species, even the heaviest females fly well, and I have never seen one jump except when in such close quarters that flight was impossible. (M. H.)

Schistocerca damnifica (Saussure).

An interesting series of fifty specimens of this species is included in the material studied. The females are all larger than Northern specimens, and have the median stripe of the pronotum more obscure. The males, however, are very similar to New Jersey representatives, except that the tegmina appear to be slightly longer. The material comprises adults taken in every month in the year except August.

The males of this species are active and are found common in the dead leaves under scrub oaks, hickories, sweet gums and other trees in the pine woods. They fly well and are so much the color of their surroundings that they are very hard to follow. The females are, on the other hand, invariably large and unwieldy, and seem to find great difficulty in even jumping, and they very seldom fly. (M. H.)

Gymnoscistetes pusillus Scudder.

This very peculiar species was found by Mr. Hebard to be fairly common in one locality near Thomasville, and a series of twenty-one individuals, sixteen males and five females, are included in the series studied. They are quite constant in size, but in a number of other characters considerable variation is exhibited. The anterior and posterior margins of the pronotum are truncate in some, emarginate in others; the number of spines on the external margins of the posterior tibiæ varies from eight to ten; the median carina of the pronotum is quite distinct in some, absent in others, while the inferior portion of the frontal costa varies greatly in the strength of the constriction. Color is rather constant, such variation as is exhibited being in intensity and not pattern. The females are uniformly lighter in color than the males.

The following color notes were made from a fresh male specimen: Dark lateral bars seal brown, light lateral bars pale glaucous green becoming emerald-green on the meta- and mesopleura; dorsal surface a semi-metallic drab becoming quite pale toward the dark lateral bars; eyes of the same color as the dark lateral bars, obscurely spotted with drab; antennæ of the same color as the dorsal surface, strongly suffused with blackish apically; limbs very pale yellowish-green minutely blotched with umber.

I took one specimen of this species in the wire-grass of the pine forest near town on November 30, 1904, but although I searched the locality carefully for several days no more were taken. A short time later I discovered a colony of this species in a similar situation on the river road, about two miles from town. They were very difficult to capture, as it took the most intent searching before a specimen could be found, and even then it was by no means an easy matter to make the capture, for these small grasshoppers are masters of the art of jumping. They can jump so quickly that owing to their color the eye cannot follow them, and the strangest thing is that they can jump in any direction with such rapidity that it is wholly impossible to see in which direction they have gone. They jump from one tuft of wire-grass to the top of another tuft and there cling tightly to the highest straw ready to make another leap. Although they are so small I have seen them frequently spring several feet. The females, although much heavier than the males, are almost equally agile. This species has the habit of edging around its support when approached and remaining motionless with hind femora drawn close to the body. It can be seen, however, to be watching that which has alarmed it most closely, and on the first quick movement or on too near approach it jumps at once. (M. H.)

Melanoplus scudderi (Uhler).

It was with considerable surprise that this species was recognized in the collections, as the distribution of it is thus extended a considerable distance southward. Six male and sixteen female specimens from Thomasville have been examined, taken November 30, 1903, December 1, 3, 5, 6 and 10, 1903, and December 14, 1902. There is considerable variation in the coloration, some being unicolorous, others sprinkled with small blackish dots and maculations.

Color of live male: Thomasville, November 30, 1903; general colors burnt umber and cinnamon mingled in a pepper-and-salt combination, the paler tint predominating toward the lower surface; lateral bar on the upper part of the prozona seal brown; posterior femora with the external bars not very distinctly marked, the internal bars milky pink and dull seal brown, the whole overcast with the general "pepper-and-salt" suffusion; posterior tibiæ scarlet vermilion; under surface of the body and posterior femora gamboge yellow suffused anteriorly and posteriorly with gray-brown, clear on the basal segments of the abdomen. Female: color much as in the male, but the under surface duller and the pronotum dorsally suffused with fawn color and the lateral bar on the prozona rather indistinct; antennæ reddish-brown, grading from poppy red at the base to maroon apically.

This species is moderately plentiful during the fall months in the pine woods. Its color blends almost exactly with the pine needles, and it is for this reason that, although it is a slow species at taking alarm and poor at jumping, it is sometimes hard to capture. (M. H.)

Melanoplus sylvestris Morse.

This recently described species is apparently represented by three female specimens taken at Thomasville and Metcalfe in September, November and December, 1903. The original specimens were all from western North Carolina. When compared with specimens of *M. islandicus*, females of *sylvestris* can be separated by the precurrent median carina of the pronotum, the broader metazona, the more pronounced sulcation of the frontal costa, and the more quadrate interval between the mesosternal lobes.

Found in the same places as the preceding species, but more agile and easily alarmed. Its coloration affords it even greater protection than that of *M. scudderi*. (M. H.)

Melanoplus nigrescens (Scudder).

A series of fifteen males and seventeen females represents this large and rather striking species. All the specimens are from Thomasville, and were taken in November and December. Considerable variation is exhibited in the shape of the cerci of the males.

Color of live specimens: Female; Thomasville, November 30, 1903; general color mummy brown, the "pepper-and-salt" effect caused by a minute speckling of pale wood brown, postocular streak clear mummy brown, eyes mars brown, antennæ with the base wood brown and the apical portion vandyke brown; tegmina with the anal field clear wood brown, discoidal and costal regions mummy brown; stripe on the metapleura and the paler bars on the hind femora ecru drab, dark bars on the femora seal brown; posterior tibiæ blackish basally, dull maroon apically. Male; Thomasville, November 30, 1903; general color clove-brown becoming dull umber on the anal field of the tegmina; lateral lobes of the pronotum and lower part of head deep blue-gray blending into the general tint of the upper surface; eyes mottled clove brown and wood brown; stripe on metapleura and pale bars and spots on posterior femora almost pure white, suffused slightly with grayish toward the dorsal surface; dark bars on the posterior femora and base color of meso- and metapleura solid black; anterior and median limbs similar to the lower part of the head in color; posterior tibiæ apically poppy red, dull on the superior surface, basal portion blackish with a dull reddish-pregenicular annulus; surface of the meso- and metasternum dull glaucous green, of the under surface of the abdomen gamboge yellow.

During November and December I have found this splendid species in colonies among the pine woods. It preferred the vicinity of the scrub oaks, and it was among these that I found a group of over a dozen specimens of this species within the space of a few square yards. The males seemed peculiarly unwary, and occasionally one would be almost trodden before it would jump. Earlier in the season, during the warm fall weather, they probably exhibited much greater activity, for I noticed them to feel cold severely and the slightest cooler weather would greatly thin their numbers. All the specimens I took were probably at their prime several weeks earlier, and from this I conclude that the best time to take this species is toward the latter part of October and during early November. The females were more unwieldy than the males but were very powerful. Both sexes, owing to the shortness of their wings, were wholly unable to fly. (M. H.)

Melanoplus keeleri (Thomas).

This species is represented by a series of twenty males and twenty-nine females taken at Thomasville in September, October, November and December. The intensity of the coloration is quite variable.

This species is found in the same locality and at the same time as the preceding species, but in greater numbers. The males are much smaller than the females, and are therefore less powerful, but they are able to fly well and are occasionally quite shy. The females are usually unable to fly at the time I was collecting as it was late in the season, and all were more or less worn. (M. H.)

Melanoplus clypeatus (Scudder).

Four female specimens of this species from Thomasville, taken August 3 and December 17, 1903, have been examined. They have longer tegmina (22–22.5 mm.) than the female measured by Scudder.

Melanoplus propinquus Scudder.

This is the most abundant species of the genus at Thomasville, and in consequence it is represented by a very large series—three hundred and forty-eight in number. The months represented by the material are January, May, June, July, August, September, October and December.

This species has almost the exact habits of its close northern ally, *M. femur-rubrum*. It is found in great numbers in all open country during the summer and fall and is quite plentiful even in the spring. (M. H.)

Melanoplus atlanis (Riley).

This destructive species is represented by five male individuals from Thomasville, taken in April, July, October and December.

This species is common in the corn fields during warm weather. (M. H.)

Paroxya atlantica Scudder.

A series of thirteen specimens were taken at Thomasville and Tyty Plantation in June, August, October and December. The males agree very well with two specimens of that sex, one from Ormond, Florida, the other from Florida without further data.

Found along the branches. (M. H.)

Paroxya floridiana (Thomas).

This marsh-loving species is abundant at Thomasville in late summer and fall, and is represented by a series of one hundred and sixty-five individuals, taken in July, August, September and December. Considerable variation in color is exhibited by this assemblage, as is usual in the species, but the extremes are connected by numbers of intermediates.

Found in great abundance along all streams and in all damp spots during the warm weather. I took quite a series of tattered specimens of this species in a sheltered spot along the edge of a branch in December, 1903. (M. H.)

Aptenopedes sphenarioides Scudder.

This beautiful and common species is found usually in the pine woods among the dead needles and wire-grass. The series comprises two hundred and fifty-six specimens, about equally divided between the sexes. The months represented by the material are January, February, March, April, June, August, September, October, November and December. The species was observed in Leon county in the latter part of March. Some individuals possess but one tegmen, and in a few individuals both tegmina are missing. This latter condition appears to be abnormal, as the specimens are otherwise inseparable, and are quite distinct from a specimen of *aptera* from Miami, Florida. After comparing the types of *A. clara* Rehn[4] with individuals of *sphenarioides*, the former is seen to be immediately distinguishable by the peculiar cerci. Two color phases are present, one purplish-brown, the other a rich paris green. The following notes have been made from living adult specimens. Green phase: female; Thomasville, November 30, 1903; general color paris green, on the under surface becoming pale and on the sides of the abdomen suffused with whitish; eyes mummy brown; antennæ dull crimson, infuscate apically; lateral line on the pronotum and tegmina composed of two colors, above peach blossom

[4] *Ent. News*, XIII, p. 14.

pink, below blackish; lower margin of the pronotum very narrowly lined with white; anterior and median femora of the body color; tibiæ dull crimson; posterior femora with the lateral face of the body color, darkest above; inferior carina white, superior carina bicolor similar to the tegmina, genicular arches black; posterior tibiæ glaucous blue, spines whitish with the tips black. Green phase: male; Thomasville, November 30, 1903; general color of the upper surface paris green becoming apple green on the sides and under surface; eyes mummy brown finely sprinkled with wood brown; lateral lines practically the same colors as in the female, except that the rosy tint is paler on the pronotum than on the tegmina; abdomen with the median portion dull salmon flanked with pure black, the latter carrying a small white spot at the apical margin of each segment; in other respects similar to the female.

Brown phase: female; Thomasville, November 30, 1903; general color of the dorsal surface broccoli brown, overcast with an irregular hoary suffusion of ecru drab, this being limited to the median portions of the segments on the abdomen; lateral lines much as in the green phase, but more subdued and the usual pinkish stripe on the tegmina rather brownish; face, eyes, genæ, lateral lobes of the pronotum, pleura and external faces of the posterior femora, as well as the anterior and median limbs, vandyke brown obscurely scrumbled with broccoli brown; lower margin of the pronotum and lower carina of the external face of the posterior femora whitish; posterior tibiæ maroon. Brown phase: male; Thomasville, November 30, 1903; general color much as in the female, but the hoary suffusion weaker; lateral line well marked and more ecru than pinkish; pronotum with the blackish tint weak; the inferior external carinæ of the posterior femora with a broken white line; superior face of posterior femora scrumbled wood brown; antennæ whitish. Nymph; November 30, 1903; general color wood brown obscurely lined and spotted with mummy brown; upper portion of lateral lobes of the pronotum and postocular region blackish.

I have always found this species prevalent except during the cold weather of late December, January and the greater part of February. This species is to be found almost everywhere in the pine woods, but is more abundant where the wire-grass-grows heaviest near the "branches." The males are very active, springing with alacrity and often alighting on weed stalks and vines a foot or more above the ground, where they remain motionless but watchful, ready to spring to another place if approached. The females, being much heavier, are less spry, but nevertheless sometimes difficult to capture. (M. H.)

Family TETTIGONIDÆ.

Arethæa phalangium (Scudder).

A single male individual of this species was taken at Thomasville, June 29, 1903.

Scudderia texensis Saussure and Pictet.

This is the commonest species of the genus in the vicinity of Thomasville, and it is represented by a series of twenty-eight specimens representing both sexes. They were taken in May, June, July, September and October.

Scudderia furcata Brunner.

One female and three male specimens represent this species. They were taken at Thomasville in the second week of October and December 14, 1903.

The specimen taken in December was beaten from gall-berry bushes in the pine woods, and was in a battered condition. (M. H.)

Scudderia cuneata Morse.

This recently described species is represented by two male individuals taken at Thomasville, on August 17 and September 10, 1903. This record extends the range of the species east of the type locality—Alabama.

Amblycorypha oblongifolia (DeGeer).

This species is represented by four Thomasville specimens, two males, two females, taken July 29, August 4, 8 and 26, 1903. The males have the tympanum of the tegmina narrower than in Maryland, Delaware and Pennsylvania specimens of the species, but nevertheless do not appear separable.

Amblycorypha uhleri Stål.

One male and one female representative of this species have been examined, both taken at Thomasville, one on July 16, 1903, the other in the second week of October, 1903.

Belocephalus subapterus Scudder.

One female specimen of this species was taken at Thomasville, August 24, 1903. This is the first record outside of the State of Florida.

Conocephalus atlanticus Brunner.

A series of three males of this species from Thomasville have been examined. They were taken September 12, 15 and 17, 1903, and on comparison with paratypes prove inseparable.

Conocephalus retusus Scudder.

A single female taken at Thomasville, September 17, 1903, is referred to this species. The specimen has the tegmina and ovipositor slightly longer than Scudder's original measurements, but the specimen appears to belong here.

Conocephalus mexicanus Saussure.

Two female specimens of this species were taken at Thomasville, December 3, 1903, in undergrowth in pine woods, and on March 10, 1904.

Both specimens taken were in good condition; the first was taken among the dead brown leaves of a hickory in the pine woods, where it was very conspicuous on account of its bright green color. (M. H.)

Conocephalus fuscostriatus Redtenbacher.

Three male Thomasville specimens of this species have been examined. One is without date, the others were taken March 16 and April 4, 1904, and all are typical representatives of the species.

This species appeared early in March and was soon plentiful in the woods, especially in the broom sedge in damp locations. The specimens, when pursued, always took to wing and made off with a strong but zigzag flight, never alighting until quite a distance had been traversed. I followed one specimen for several hundred yards across a field and finally lost sight of it, as it had flown up until some forty feet above the ground, and could not be followed by the eye in the twilight. The males begin their serenade just as dusk begins to fall and keep up a continuous *zeeeee* late into the night. Their song is, however, not nearly so ear-splitting as that of *C. mexicanus*. (M. H.)

Orchelimum glaberrimum (Burmeister).

This large species is represented by a series of thirty-one individuals representing both sexes. They are all from Thomasville, taken in August and September, 1903. A considerable amount of variation is exhibited in the intensity of the brown markings on the pronotum.

Orchelimum nitidum (Redtenbacher).

A series of fifty-seven specimens of both sexes represents this species. They are all from Thomasville, taken in August and September, 1903. The remark made under *O. glaberrimum* regarding markings on the pronotum applies with equal force to this species.

Orchelimum nigripes Scudder.

A single female of this species was taken at Thomasville on August 4, 1903. This is the first record for the Gulf States.

Orchelimum cuticulare Serville ?

A single male individual, taken at Thomasville on August 28, 1903, is very doubtfully referred to this species.

Xiphidion fasciatum (DeGeer).

This widely distributed species is represented by a series of ninety-five specimens, all from Thomasville. The months represented are June, August, September, October and December (one specimen), 1903.

I took but one specimen of this species, that in December, 1903. It was procured among tall grass in a swampy hollow. (M. H.)

Xiphidion brevipenne Scudder.

Three females and four males of this species from Thomasville have been examined. They were taken in August, September, October and December, 1903.

The single specimen of this species which I took in December, 1903, was secured in the damp undergrowth of the pine woods near a "branch." (M. H.)

Xiphidion saltans Scudder.

Two females and five males of this species are included in the material studied. They were taken at Thomasville in September, October and November, 1903, the one taken in the latter month being from meadow land.

Odontoxiphidium apterum Morse.

This recently described genus and species is represented by a series of twenty males and twenty-two females, all from Thomasville, taken in September, October, November and December, 1903. Those individuals bearing information in addition to the date and locality are labelled as having been taken in undergrowth in pine woods. The series agrees very well with the description, exhibiting the color variation noted in the original series.

The specimens which I took of this species were all captured in the wire-grass of the pine woods. Although active, they were easily captured. (M. H.)

A male specimen of this species from Brunswick, Glynn county, Georgia, taken September, 1881, is in the collection of the Academy.

Atlanticus gibbosus Scudder.

As far as can be determined from the very inadequate description and the immature condition of the majority of the twelve specimens examined, I should refer the representatives of this genus to *gibbosus*. But one individual, a female, is fully grown, the others being in such condition as make them almost useless for study. The dates represented are March 16, 17, 22, 23, 24 and 29 April 9, July 23 (adult) and December 10, all from Thomasville.

In December, March and April I have found immature individuals of this species plentiful in the pine woods, where they live among the wire-grass. I found many in the locality which yielded the large series of *Gymnoscirtetes pusillus*. (M. H.)

Ceuthophilus virgatipes n. sp.

Types: ♂ and ♀; Thomasville, Thomas county, Georgia. August 13, 1903. Collection of Morgan Hebard.

Closely allied to *C. secretus* Scudder, but differing in the longer median internal calcaria and the much shorter ovipositor. Relationship also exists with *C. varicator* Scudder, but that species has the first tarsal joint as long as the others united, as well as having a long ovipositor.

Size medium; body compressed. Head with the occiput declivent, vertex somewhat flattened; interspace between the eyes equal to the long diameter of one of them; eyes inverted subpyriform; antennæ rather short and rather heavy, but slightly longer than the body; terminal palpal joint distinctly longer than the third. Pronotum strongly compressed; anterior margin with a slight median emargination, posterior margin truncate; lateral lobes slightly longer than high, inferior margin moderately arcuate, the anterior angle by no means as apparent as the posterior; surface of the pronotum as well as the mesonotum and metanotum obscurely tuberculate, more pronounced in the female than in the male. Abdomen strongly compressed, the exposed portion of each segment roughened and picked. Cerci short, thick basally, tapering. Ovipositor short, thick basally, apical half subequal, margins almost straight, superior angle produced into a distinct spiniform process, internal valves with five apical spines. Anterior femora a third as long again as the pronotum, armed on the anterior inferior margin with 3–0 spines, unarmed on the posterior margin. Median femora about equal to the anterior in length, armed on the anterior margin with three spines which are larger in the female than in the male, and increase in size distally, posterior margin armed with two or three spines. Posterior femora thick and short, strongly bullate, the apical third slender, inferior margins with irregularly disposed serrations, intervening sulcus comparatively broad; posterior femora distinctly more than a tenth longer than the femora, not bowed, spurs large, median calcaria extremely long, the internal equalling the metatarsus; second and fourth tarsal joints subequal, third decidedly less than half the length of second; metatarsus shorter than the other joints united.

General color cinnamon overlaid with bistre, the superior surface of the posterior femora with distinct diagonal bars of the two tints; under surface with little of the overlying tint.

Measurements.

	♂	♀
Length of body,	14.2 mm.	19.5 mm.
Length of pronotum,	4.2 "	6 "
Length of posterior femora,	13.5 "	17.2 "
Length of posterior tibiæ,	15 "	19 "
Length of ovipositor,		7.2 "

A series of nine specimens of this species, including the types, has been studied.

As all the specimens of this species were collected in my absence from home, I can only state that they were taken in a heavy swamp. (M. H.)

Family GRYLLIDÆ.

Gryllotalpa borealis Burmeister.

Several specimens of this species from Thomasville have been examined, taken March 25, August 31 and September 11, 1903. An individual was taken just over the line in Leon county, Florida, on March 17, 1903, in a very peculiar situation—a distance up a cherry tree.

Tridactylus terminalis Scudder.

Two individuals of this species were taken at Linton's Pond, near Thomasville, one on March 18, and the other April 10, 1904. The exact locality was a sloping sandy beach constantly dampened by the flow of several springs, situated in an overhanging bank and close to a stream.

Diligent search revealed two other specimens of this species, but owing to the absence of a net at the time they readily escaped. (M. H.)

Ellipes minuta (Scudder).

This species was found in several places in the vicinity of Thomasville and in Leon county. The locations are moist meadow land or sandy beaches, and here this active little species was very numerous. At Linton's Pond it was taken on April 10, and in northern Leon county on March 22. Nine specimens have been examined.

Cycloptilum squamosum Scudder ?

A single male specimen is questionably referred to this species. It was taken at Thomasville, August 13, 1903. The condition of the specimen is such that accurate identification is impossible, but the description of *squamosum* contains nothing radically different from the specimen examined.

Nemobius maculatus Blatchley.

This species is represented by a series of fifteen individuals of both sexes, taken at Thomasville. The months represented are June, July, August, September, October, November and December. As is usual with the species of this genus a great amount of variation in size is noticed in the series.

All the specimens of this species which I took were captured among the weeds of an unused field and in the grass in our yard. The males stridulate continually, and their constant *creeee-creee-creee* may be heard from every side on a warm day. This species fills the place which is occupied by *Nemobius fasciatus* in the North. (M. H.)

Nemobius socius Scudder.

This striking form is represented by one male and ten female specimens, all taken at Thomasville in May, June, July and September. But two of the specimens are brachypterous, the other nine possessing caudate wings.

These specimens were collected at night about the arc lights, to which they were attracted by the light. (M. H.)

Nemobius ambitiosus Scudder.

The beautiful but subdued coloring of the male of this species makes it an easily recognized form, and a series of thirty individuals of both sexes have been examined. They were taken at Thomasville in February, March, April, October, November and December. In the spring of 1903 several individuals were taken in Leon county. There is some variation in the depth of color in the females, ranging from dull blackish to blackish brown and umber.

This beautiful species is ever present, being astir on the coldest winter days. I heard one specimen stridulating in the pine straw on a morning when the mercury had just risen above freezing. The sound produced by the males is quite different from that of any other species, but it would be indeed difficult to describe the pitch which makes it so. (M. H.)

Nemobius cubensis Saussure.

This species, which bears quite a superficial resemblance to *N. socius*, is represented in the collection by five specimens, one male and four females, the male individual being referred here with a little doubt. All the specimens were taken in May and June, 1903, at Thomasville.

Nemobius exiguus Blatchley.

It was with considerable surprise that this species was recognized in the material studied, but a series of forty-seven specimens appear to be perfectly referable to this species, previously known only from Indiana. Thomasville individuals were taken in January, February and December, and one specimen was collected at the Ocklockonee river on March 29, 1904.

This species was very plentiful in certain localities in the pine woods along the branches, where the ground was low and marshy. The series of forty-seven could easily have been doubled. (M. H.)

Nemobius carolinus Scudder.

Thirteen specimens, five males and eight females, represent this beautiful species. They were all taken at Thomasville in December on sphagnum.

All of these specimens were taken at Thomasville during December in beds of sphagnum. The specimens were wary, and when in danger would hide in the sphagnum, from which they could then be easily taken. The bright lacquer color of the head, legs and body of these distinguished them at a glance from all other species. (M. H.)

Gryllus pennsylvanicus Burmeister.

Four specimens of this species are contained in the collection, two males and two females, from Thomasville, taken on August 29, 1903.

Gryllus rubens Scudder.

This species, which was described from a single female individual from Auburn, Alabama, is represented by a series of sixty specimens, almost equally divided between the sexes. They are all from Thomasville, taken in July and August; one immature individual, however, having been taken in March. A great amount of variation is exhibited in the intensity of the color pattern, some individuals having the dull reddish markings on the lateral portions of the pronotum obsolete, and the red on the posterior femora is more extensive in some individuals than in others.

Gryllus luctuosus Serville.

Specimens of this species from Thomasville, taken in May and June, 1903, have been examined.

Œcanthus quadripunctatus Bentenmüller.

This species is represented by a series of one hundred and twenty-two specimens from Thomasville. The months represented are June, September and October. Considerable variation is exhibited in the pattern and intensity of the black markings on the basal joints of the antennæ.

Anaxipha exigua (Say).

Three specimens of this species, one male, two females, have been examined, all taken at Thomasville in April and July. The females are slightly larger than Pennsylvania specimens.

Falcicula hebardi Rehn.

This interesting species is represented by a series of fifteen males, ten females and four immature individuals. The months represented are March, April and July. The immature individuals are considerably darker and more wine-colored than the adults, and are longitudinally striped with dark brown which gives them a rather peculiar appearance.

This species, although restricted to colonies among the wire-grass of the pine woods, may be taken in numbers at the right time of year. Although very active and resembling the wire-grass closely in color, they are easy to capture with the aid of a net. I noticed them to jump from clump to clump of the grass, clinging to the topmost blades. Both sexes are equally agile. (M. H.)

Hapithus brevipennis Saussure.

This species, which was described from Georgia and Louisiana, is represented by three adult males, two adult females and three immature individuals from Thomasville. The months represented are July, August and October. The males have the stripe on the margin of the dorsal field much more richly colored than in the females.

Orocharis gryllodes (Pallas).

This beautiful species is represented by a series of four male and seven female specimens, taken at Thomasville in December, 1903. One female individual is uniformly colored as in the males, but the others are sprinkled with umber. This species is easily separated from *O. saltator* by the broader and subequal pronotum and the greater number of rami of the mediastine vein.

All of these specimens were taken from under sign boards on oak trees, where they were evidently hibernating. On one occasion several specimens were taken from under the same sign. (M. H.)

DESCRIPTION OF A NEW SPECIES OF EARTHWORM (DIPLOCARDIA LONGA) FROM GEORGIA.

BY J. PERCY MOORE.

Forming part of a small collection of earthworms gathered by Mrs. T. W. Walker in Pulaski county, Georgia, and secured for the Academy through the interest of Mr. Joseph Willcox, are seven specimens of a hitherto unnoticed species of *Diplocardia*. Its most distinctive feature is found in the coexistence of the second gizzard and the first pair of spermathecæ in the same somite, in which respect it is unique among known species of the genus. In the presence of the gizzards in somites VI and VII it resembles *D. michaelseni*, but differs from that species in the possession of three pairs of spermathecæ. The latter character and numerous others which appear in the following description evidently ally it to the *communis* group, but the great number of segments, high level of the nephridial openings, form of the spermathecæ, etc., are diagnostic.

Diplocardia longa n. sp.

Size of *D. communis;* length in moderate extension up to 275 mm.; diameter at VII 5 mm., behind the clitellum 4 mm. Number of segments 270 to 330. Form slender, terete throughout; diameter increasing to VII, then diminishing to the clitellum which is slightly enlarged and prominent, then narrowing a little and remaining nearly uniform to near the end, where a slight club-shaped enlargement precedes a final shrinkage to the anal ring.

Prostomium very short, broad and nearly truncate, in most specimens scarcely projecting beyond the peristomium into which it is tenoned for about one-half the length of the latter. The exact form, however, differs in the several specimens; in some the two sides nearly meet within the peristomium; in others they are more nearly parallel and may be continued by grooves nearly to the posterior border of the latter, or they may merge into transverse grooves. Both prostomium and peristomium are much marked above with longitudinal wrinkles and the former has a deep ventral furrow.

The somites increase in length to VII, and then diminish to about one-half in the postclitellial region, after which they change but little till the posterior end is approached. Somites II and III are simple; IV is biannulate, with the furrow just behind the setæ and consequently nearer to the posterior margin; V has a median setigerous annulus partially cut off from the larger annulus. The remaining preclitellial segments are conspicuously triannulate, the middle or setigerous annulus being the narrowest but most prominent. Occasionally the first annulus is again subdivided into two. When the clitellum is present, as in most of the specimens, the segments of this region are smooth and undivided, dorsally at least, but in immature worms the annulation appears here also. In all but the most posterior of the postclitellial somites also the triannular structure is apparent, but is generally inconspicuous except in the more anterior ones or those strongly contracted.

The usual four pairs of setæ are present on all somites except the peristomium, a few preanal, and XIX, the latter of which lacks the ventral pairs only. All are strictly paired and strongly ventral in position, but the intervening spaces vary somewhat. On XVI the setal formula is $a\text{-}b < \frac{1}{4}\ a\text{-}a$, $a\text{-}a = 2\frac{1}{2}\ c\text{-}d$, $a\text{-}b = \frac{3}{5}\ c\text{-}d$, $b\text{-}c < a\text{-}a$, $d\text{-}d =$ about $\frac{2}{3}$ semi-circumference. Ordinary setæ stout, sigmoid, blunt-pointed, thickened distad of middle, the outer end slightly sculptured with a reticulum of fine lines giving to the setæ an appearance of being covered with delicate scales. Spermathecal copulatory setæ (the ventral ones on VII, VIII and IX) similar but with much bolder sculpturing and apparently unaccompanied by special glands. Penial setæ (the ventral ones on XVIII and XX) capillary, tapering, somewhat thickened within the body-walls, with slight sinuous curvatures, especially near the end, which may be slightly hooked. They are about twice as long, or somewhat more, than the ordinary setæ, and only $\frac{1}{3}$ to $\frac{1}{4}$ as thick. Near the end is a sculptured region marked with close transverse lines appearing as fine notches on the profiles, but the end itself for a considerable distance is smooth or longitudinally striated.

Dorsal pores begin at $\frac{IX}{X}$ or usually $\frac{X}{XI}$ and are conspicuous. The position of the nephridiopores is remarkable in being widely removed from the dorsalmost seta; while the former are situated at approximately the two ends of the transverse diameter of the body the latter are fully 15° to 30° below these points. Successive nephridiopores are usually alternately at a little higher and lower level and are on the extreme anterior borders of the somites—almost in the furrows—the first on III. Spermathecal pores are less easily found. They occur in line with seta a on the anterior part of somites VII, VIII and IX, and are consequently presetal and postseptal.

Though present in all but one, the clitellum is perfectly developed only in the largest specimen. It covers seven segments, XIII to XIX inclusive, and is completely annular and of uniform thickness on the first five, but interrupted or much thinner on the middle ventral region of the last two. On the posterior clitellial and several of the immediately succeeding segments occur certain papillæ and grooves utilized during copulation. Two pairs of papillæ, situated on the posterior part of XVII or on $\frac{\mathrm{XVII}}{\mathrm{XVIII}}$ and on the posterior part of XX or $\frac{\mathrm{XX}}{\mathrm{XXI}}$, are constant on all of the specimens; a third pair situated on XXI or $\frac{\mathrm{XXI}}{\mathrm{XXII}}$ is complete in one specimen, represented by a median papilla in one, by the left only in three specimens, by the right only in one, and is totally absent in the seventh, in which, however, indistinct thickened areas appear in the median field of $\frac{\mathrm{XXI}}{\mathrm{XXII}}$ and $\frac{\mathrm{XXII}}{\mathrm{XXIII}}$. In one specimen a small median papilla is present on XVII between those of the pair. When the papillæ overlap the contiguous borders of two segments, which is the normal condition, the affected furrows are obliterated ventrally. In most cases the first pair of papillæ are much the largest and the third the smallest, but in this respect also they are variable. All of the papillæ are low, broad disks of an irregular elliptical or sometimes circular form. The central portion is more translucent and either elevated or depressed above the more opaque, firmer rim which contains a circle of glands. The entire structure of these papillæ indicates that in addition to a secretory adhesive function of the rim the center acts as a true vacuum sucker. Just anterior and posterior to each pair of suckers transverse grooves usually extend across the venter and other shorter and less constant ones may occur. Very constant and conspicuous are a pair of longitudinal grooves reaching in the line of the ventral setæ from the middle of XVIII to the middle of XX. Each groove consists of three parts: a short anterior section reaching from the setæ of XVIII to the furrow $\frac{\mathrm{XVIII}}{\mathrm{XIX}}$, a longer middle section extending for the entire length of XIX, and a short posterior section completing the groove to the setæ of XX. All three sections are strongly curved, the anterior and posterior with the convexity outward, the middle with the convexity directed inward. At the point of junction of the anterior and middle sections, in the furrow $\frac{\mathrm{XVIII}}{\mathrm{XIX}}$, the groove enlarges into a small triangular sinus containing a minute papilla upon which the male pore opens. This is perhaps situated rather more on XIX than XVIII. At each end of the groove and just external to the closely approximated penial setæ of somites XVIII and XX are the external openings of the two pairs of prostate glands, the secretion of which is therefore brought to the sperm by means of this groove. The female pores are situated close together between the ventral setæ of XIV, but are invisible in surface views.

No complete cœlomic septa exist anterior to $\frac{V}{VI}$, this space being largely occupied by the radiating pharyngeal muscles; $\frac{XII}{XIII}$ is slightly thickened, $\frac{VI}{VII}$ and $\frac{XI}{XII}$ about twice as thick, and $\frac{VII}{VIII}$ to $\frac{X}{XI}$ each about four times as thick as ordinary septa and extremely muscular. From $\frac{VI}{VII}$ to $\frac{VIII}{IX}$ the septa are strongly funnel-shaped and "nested." The pharynx occupies III and IV, a short œsophagus V, the strongly muscular gizzards VI and VII; then follows a straight narrow canal which appears to lack calciferous pouches, but is slightly enlarged with yellowish, thickened and very vascular walls in the posterior part of X and presents a similar but less pronounced structure in XI. The true sacculated intestine begins in XVIII. The anus is a wide vertical slit. The brain is transverse, about five times as wide as long, without median constriction or any lobing, and is situated in II. The ventral cord is remarkable for the complete and extremely thick muscular sheath, which equals ½ the diameter of the cord proper at a ganglionic enlargement. Although present in other species of *Diplocardia,* the muscular sheath is in this one thicker than usual. Apparently there are no peculiarities of the vascular system. Unlike the type species the dorsal vessel is single and undivided throughout in the three examples dissected. Strongly enlarged hearts occur in XIII, and a slightly enlarged pair in XII. The nephridia begin in III, and appear to be present in every succeeding somite. Except for the first five pairs, which are more compactly coiled and of smaller size, they have the long-looped form described for other species of the genus.

Three pairs of spermathecæ exist in the anterior parts of somites VII, VIII and IX, attached to the body floor at the base of the corresponding septa, behind which they rise freely to a high level, though occasionally they pass through the neural arch of the septum into the preceding somite. All of the spermathecæ have the pouch and stalk very distinctly differentiated and are especially characterized by the great length of the latter and the very low position of the diverticulum which arises from its lateral side at the point at which it enters the body wall. The pouch has in general the form shown in fig. 1, which represents the second spermatheca, and in all of the specimens examined is strongly flattened laterally. The stalk is at least as long as and usually longer than the pouch, and also more or less flattened by the pressure of the

Fig. 1

neighboring organs. The flat, spreading diverticulum opens into the base of the stalk by a short, narrow duct. In three specimens dissected the pouch increases in size successively from the first to the third spermatheca and the diverticulum diminishes correspondingly. While completely divided into two or even three lobes in the first, the latter is in the second and third either simple or very faintly bilobed.

The testes occupy the usual position in somites X and XI, and two pairs of sperm sacs are borne on the anterior face of septum $\frac{\text{IX}}{\text{X}}$ and the posterior face of septum $\frac{\text{XI}}{\text{XII}}$. The latter are much and deeply lobulated, having the aspect of dense tufts of broadly clavate or stalked spheroidal bodies. The sperm funnels lie in somites X and XI attached to the posterior septa near the cœlomic floor and close to the ventral nerve cord. They are of simple form and consist chiefly of a pair of broad lobes partly folded together like the two lobes of a *Dionæa* leaf. After penetrating the septa the vasa deferentia plunge at once into the longitudinal muscular layer of the body wall which they penetrate to a depth of about $\frac{1}{5}$ of its thickness, and continue at this level in the line of the ventral setæ to a point near the male gonopore, when they bend sharply outward toward the surface. Throughout their course the two vasa deferentia of each side lie side by side, but are perfectly distinct until quite at the external orifice, where they coalesce at a common opening. The ovaries are conspicuous, fimbriated, fan-shaped structures consisting of numerous chains of ova attached to the posterior face of septum $\frac{\text{XII}}{\text{XIII}}$. Trumpet-shaped oviducts, the mouths of which are formed very much like the sperm funnels, perforate the septum $\frac{\text{XIII}}{\text{XIV}}$, and at once penetrate the body floor obliquely backward and inward. Near the external surface they bend sharply toward the median line and open in the setæ zone on the ventral surface of XIV, separated by an interval of about $\frac{1}{4}$ *a-a* or less than the transverse diameter of the nerve cord with its sheath. The external pores are so small that they can be detected only in sections. The prostate glands (fig. 2) are large and conspicuous, and are variously folded sharply back and forth several times within the limits of the single segments XVIII

Fig. 2.

and XX which the two pairs respectively occupy. The glandular portion and the muscular duct are sharply differentiated, and the latter arises directly from the end of the former. The former is about three times as thick and three and one-half times as long as the latter, cylindrical and tubular, with a distinct lumen throughout and thick walls composed of gland cells in various stages of activity.

The integuments are translucent and the colors dull in life. The anterior and usually the extreme posterior ends are hair brown, varying in shade; the clitellum is russet, and the remainder of the body nearly salmon pink or sometimes ecru. Through the less pigmented portions of the skin the blood vessels show conspicuously of a deep purple color. These worms are very sluggish, but may be stimulated to greater activity by exposure to light, which they seek to avoid. They occur in moist sandy soil.

NEW CLAUSILIIDÆ OF THE JAPANESE EMPIRE.—X.

BY HENRY A. PILSBRY.

In this tenth[1] article upon Japanese *Clausiliidæ*, the species discovered by Mr. Nakada in the Ryukyu Islands and by Mr. Azuma in Satsuma and its islands, are dealt with, together with a few forms from other parts of the empire. The two collectors mentioned, working under Mr. Hirase's direction, have about doubled the number of land mollusks known from the Ryukyu Islands. Tokunoshima has proved particularly rich. The transition from the Ryukyuan fauna to that of Japan proper is found in Yakujima and Tanegashima, Ōsumi, and in the Koshikijima group, south of Satsuma. In these islands there is a strong Ryukyuan strain, but the Kyushu faunal element predominates.

In the Ryukyu group the *Clausiliidæ* are present in abundance. Except *Stereophædusa*, none of the Japanese groups are represented, the species I formerly referred to *Hemiphædusa* being so far specialized that they may more properly be segregated as separate groups. *Luchuphædusa* and the Zaptychoid forms predominate. Some of them are wonderfully specialized. *Diceratoptyx*, for instance, has almost lost the lunella, which remains as a minute vestige only; the lower palatal plica has been crowded upward, and its place taken by the dilated subcolumellar lamella. *Oligozaptyx* and some Luchuphædusas are almost equally modified in other directions. As a whole, the *Clausiliidæ* are more specialized than those of either China or Japan, and bear out the proposition I have elsewhere advanced, that insular faunas age more rapidly than those of larger or continental areas.

HEMIPHÆDUSOID PHYLUM.

Section MEGALOPHÆDUSA Bttg.

Clausilia ducalis rex n. subsp.

Larger and especially wider throughout than *C. ducalis;* superior lamella contiguous to the spiral lamella, but not united with it; prin-

[1] Seven papers have appeared under the title "Additions to the Japanese Land Snail Fauna," Parts II to VIII; one as "Catalogue of Clausiliidæ of the Japanese Empire," and one, "Land Mollusks of the Loo Choo Islands, Clausiliidæ." All were published in these *Proceedings*, 1900 to 1903.

cipal plica short; upper palatal plica short but well developed, a low ridge (lunella) below it.

Length 42, diam. 9 mm.; whorls 11.

Length 39, diam. 9 mm.; whorls 10.

Amagisan, Izu. Types No. 85,730, A. N. S. P., from No. 1,139 of Mr. Hirase's collection.

Clausilia cymatodes n. sp. Pl. LIV, figs. 29, 30, 31, 32, 33.

Shell rimate, strong, the last two whorls of about equal diameter, occupying over half the length of the shell, those above rapidly tapering, somewhat attenuate toward the apex. Yellowish-brown.

Surface glossy, sculptured with coarse strong somewhat irregular ribs, rapidly decreasing to striæ on the spire, the early whorls smooth from wear. Whorls 10½, convex, the last flattened laterally. The aperture is rhombic-ovate, vertical. Peristome continuous, rather broadly reflexed and thickened within. Superior lamella marginal, rather high, continuous with the spiral lamella, which penetrates to a point above the superior lamella. Inferior lamella low and receding, thick below, obliquely ascending, as long inside as the spiral lamella. Subcolumellar lamella emerging. Principal plica dorsal and lateral, extending past the palatal plicæ, of which there are three, lateral in position.

Length 22, diam. 5 mm.

Length 21, diam. 4.7 mm.

Clausilium (Pl. LIV, figs. 29, 30, 31) narrow and parallel-sided, obtuse and obliquely rounded at the apex, bluntly angular in the middle of the palatal margin, not excised near the filament.

Tajiromura, Ōsumi. Types No. 87,610, A. N. S. P., from No. 1,249 of Mr. Hirase's collection.

This rib-striate little *Megalophædusa* is related to *C. hiraseana.* It differs in being much smaller, light colored, not quite so coarsely sculptured, with emerging subcolumellar lamella. *C. nagashimana* of the neighboring province Satsuma is more closely related, but that is also a large dark form. Both of these species differ widely from *C. cymatodes* in the shape of the clausilium, which in *cymatodes* is very obtuse at the distal end. The number of palatal plicæ will probably prove to be variable.

Clausilia nagashimana n. sp. Pl. LIV, figs. 25, 26, 27, 28.

The shell is similar to *C. hiraseana* Pils., but it is much more finely sculptured, and the superior lamella does not reach the margin.

Length 28, diam 6.6 mm.; whorls about 11½.

The clausilium (Pl. LIV, figs. 27, 28) is long and narrow, attenuated distally, and not excised near the filament.

Nagashima, Satsuma. Types No. 87,607, A. N. S. P., from No. 1,243 of Mr. Hirase's collection.

The type specimen is colored like *C. hiraseana;* the superior is continuous with the spiral lamella, and the subcolumellar lamella emerges, though it does not reach the lip-edge.

Another specimen, evidently from a more moist locality, is eroded, dull whitish, partially overgrown with green algæ. The subcolumellar lamella is immersed, and the superior lamella is separated from the spiral. The clausilium is like that of *C. hiraseana.* Without a larger series of specimens it is impossible to tell whether this represents another race or not.

Section HEMIPHÆDUSA Bttg.

Clausilia ventriluna n. sp. Pl. LV, figs. 58, 59, 60.

Shell slender, fusiform, attenuated toward the apex; rather solid and strong; brown, somewhat glossy; very closely and finely striate, the striæ a little closer on the back of the last whorl. Whorls 9½ or 10, the first one globose, sometimes self-amputated. The attenuated early whorls are very convex, the later ones less so, and the last whorl is somewhat flattened laterally, with a noticeable impression marking the position of the principal plica. The aperture is trapezoidal-ovate, somewhat oblique, the peristome reflexed, slightly thickened, continuous and well raised across the parietal wall. The superior lamella is small, marginal and oblique, continuous with the spiral lamella, which is very high within and penetrates *across the ventral side.* The inferior lamella recedes deeply, and within the back ascends obliquely, and is nearly straight. It is far smaller and lower than the spiral lamella, but penetrates as deeply. The subcolumellar lamella emerges to the lip-edge. *The principal plica is very long,* reaching nearly to the peristome, and penetrating inward to a point above the sinulus. The lunella with the upper and lower palatal plicæ is shaped like the letter I, and is nearly *ventral* in position.

Length 15.7, diam. 3 mm.

Length 15.3, diam. 3.4 mm.

The clausilium (Pl. LV, figs. 58, 59) is long and narrow, parallel-sided, obliquely rounded distally, and very deeply excised on the columellar side of the filament.

Yasuda-mura, Tosa. Types No. 87,576, A. N. S. P., from No. 1,011 of Mr. Hirase's collection.

In this *Hemiphædusa* of the group of *C. aulacophora* the plicæ and lamellæ penetrate very deeply—across the ventral side—and the lunella stands in a ventral position, above the columellar margin of the peristome. In *C. aulacophora* and *C. pigra* the lunella is lateral, but of the same shape. *C. ventriluna* is very closely related to *C. caryostoma* and *C. c. jayi*, which have the armature similarly deep-seated; but neither of these forms has a perfect lunella uniting the two palatal plicæ.

The clausilium is not thickened distally as in *Tyrannophædusa*, but otherwise *C. ventriluna* has much in common with *C.* (*Tyr.*) *aurantiaca*.

Other specimens from Tsushima, Awa (Shikoku), are smaller than those from Yasuda-mura, and the superior lamella is either separated from the spiral lamella or but weakly connected therewith. The principal plica is a little shorter inside. In some of the specimens the subcolumellar lamella emerges to the lip-edge, and is bounded by furrows. In others it is immersed or very feebly and slightly emerges. These shells are No. 1,187 of Mr. Hirase's collection.

Clausilia ikiensis n. sp. Pl. LV, figs. 45, 46, 50, 51.

Shell small, fusiform, dark or pale reddish-brown, somewhat shining, weakly striatulate, the last whorl becoming densely and finely striate on the back. Spire decidedly attenuate above. Whorls 9½, convex, the last somewhat flattened peripherally. Aperture rhombic-ovate, somewhat oblique, the peristome continuous, reflexed and somewhat thickened within; the parietal margin well raised, straight or a little emarginate over the superior lamella. Superior lamella slightly oblique, compressed, marginal, continuous with the spiral lamella, which extends inward scarcely to the middle of the ventral side. Inferior lamella deeply receding, straightly ascending within the back, not penetrating quite so deeply as the spiral lamella. Subcolumellar lamella very weakly emerging. Principal plica not long, dorsal and lateral. Upper palatal plica short, united in the middle to the oblique, narrow lunella, which curves inward below. *Below the lower end of the lunella there is a short, straight lower palatal plica.*

Length 12, diam. 3 mm.

Length 11.5, diam. 2.8 mm.

The clausilium (Pl. LV, figs. 50, 51) is parallel-sided, rounded distally, and deeply excised on the columellar side of the filament. It is decidedly arcuate.

Mushōzumura, Iki. Types No. 86,063, A. N. S. P., from No. 1,088 of Mr. Hirase's collection.

This *Hemiphædusa* is structurally similar to species of the group of

C. awajiensis, except in having a lower palatal plica distinct from the lunella—a structure not found in any other known species of that group. The lower end of the lunella curves inward less than in most species of the group of *C. awajiensis*. It has some characters of *Hemizaptyx*.

Clausilia platydera var. minoensis nov.

Shell smaller than *platydera*, with the last whorl built forward, carrying the aperture shortly free. Upper palatal plica rather long, arcuate, making an angle with the lunella instead of being merely a short curve continuous with the latter. The subcolumellar lamella is immersed or weakly emerges.

Length 18, diam. 3.9 mm.

Length 18, diam. 3.5 mm.

Length 15, diam. 3.3 mm.

Minakamimura, Mino. Types No. 86,468, A. N. S. P., from No. 1,172 of Mr. Hirase's collection.

Clausilia mikawa n. sp. Pl. LIV, figs. 39, 40, 41.

Shell subcylindric below, tapering above, the spire moderately attenuate and rather thick, the four or five upper whorls widening very little, then the intermediate whorls increase rapidly. Thin, pale greenish-yellow, imperfectly translucent. Sculpture of nearly regular, oblique and fine rib-striæ, the intervals very finely striate spirally. The sculpture is not noticeably coarser on the back of the last whorl. Apex obtuse. Whorls 11, convex. Aperture subvertical, widely ovate, the peristome white, narrowly reflexed, somewhat thickened within, adnate above, but continuous in a slightly raised ledge across the parietal wall. Superior lamella small and compressed, oblique, continuous with or contiguous to the spiral lamella, which penetrates to the middle of the ventral side. Inferior lamella receding, but visible as a rather sharp fold in the throat, slightly spiral as seen within the back, and penetrating a little deeper than the spiral lamella. Subcolumellar lamella immersed or weakly emerging. Principal plica short, dorsal and lateral. Palatal plicæ 3 or 4, visible through the shell, subequal or the intermediate 1 or 2 shorter.

Length 21 to 22, diam. 5 mm.

Clausilium thin and rounded distally, not excised near the filament.

Sanganeyama, Mikawa. Types No. 86,519, A. N. S. P., from No. 1,167 of Mr. Hirase's collection.

This pale and rather thin species is more distinctly decussate between the striæ than other forms known to me. It has the color of some species of the group of *C. sublunellata,* but the sculpture is stronger and the palatal armature better developed. The smaller *C. decussata* Marts., from Tsukuba-san, Hitachi, may be related, but I have not seen that species. The spiral striæ are not sufficiently indicated in fig. 41.

Clausilia hosayaka n. sp. Pl. LV, figs. 61, 62, 63.

Shell slender, regularly tapering from the penultimate whorl, the upper third attenuate, apex obtuse; thin but moderately strong, light brown. Surface glossy, very finely striate. Whorls about 13⅓, moderately convex, the last somewhat flattened on the back. Aperture small, oblique, squarish-piriform, the peristome reflexed, somewhat thickened within, continuous, the parietal margin shortly raised, and emarginate above the superior lamella. Superior lamella compressed, only slightly oblique, continuous with the spiral lamella, which penetrates to the middle of the ventral side. Inferior lamella receding, visible in the aperture as a small fold, straightly ascending within the back, penetrating a little further inward than the spiral lamella. Subcolumellar lamella either emerging to the lip-edge or immersed. Principal plica short, chiefly dorsal. Upper palatal plica short, oblique, not connected with the very weak lateral lunella, which is obsolete below, and curves inward above or connects with a short, weak second palatal plica. There is no lower palatal plica.

Length 22.5, diam. 4.5 mm.

Length 21.5, diam. 4.3 mm.

Kamomura, Shima. Types No. 86,521, A. N. S. P., from No. 1,176 of Mr. Hirase's collection.

By its palatal armature this species belongs to the Hemiphædusan group of *C. sublunellata.* It is readily distinguished from other known species of that group by the greater number of whorls and more slender spire. The lunella is very feebly developed, and probably will be found to be sometimes obsolete, as in some other species of the group.

Clausilia koshikijimana n. sp. Pl. LV, figs. 53, 54, 55, 56, 57.

Shell fusiform, much attenuated above, very solid and strong; pale yellow, somewhat glossy, closely and finely striate. Whorls 9, the first quite small, the rest convex, the last whorl somewhat flattened. The aperture is ovate and projects shortly free; peristome white, reflexed and thickened within. The superior lamella is marginal, low and oblique, continuous with the spiral lamella, which penetrates to a point above the sinulus. The inferior lamella recedes deeply, is straight and oblique within, and thickened at the lower end. It does not penetrate quite so far as the spiral lamella. The subcolumellar lamella is deeply immersed. The principal plica is dorsal and lateral, approaching the lip. There is an oblique series of about 5 small, slender palatal plicæ situated upon a low ridge.

Length 14.3, diam. 3.4 mm.

Length 13, diam. 3.3 mm.

Length 11, diam. 3 mm.

The clausilium (Pl. LV, figs. 55, 56) is narrow, the distal half tapering to the rounded apex. It is moderately excised on the columellar side of the filament.

Shimo-Koshikijima, Satsuma. Types No. 87,604, A. N. S. P., from No. 1,239 of Mr. Hirase's collection.

A small, solid, pale species, not closely related to any form I have seen. The several palatal plicæ stand upon a low callous ridge. There is a good deal of variation in size.

Section TYRANNOPHÆDUSA Pils.

Clausilia aurantiaca sakui n. subsp. Pl. LV, fig. 52.

Shell similar in form to *C. aurantiaca*, but *quite thin*, finely, distinctly and sharply striate, pale brownish-yellow; whorls 9 to 10. *Superior lamella separated from the spiral;* subcolumellar lamella emerging; clausilium with the upper and lower palatal plicæ imperfectly I-shaped (Pl. LV, fig. 52), latero-ventral. Clausilium similar to that of *C. aurantiaca*, but more delicate.

Length 13, diam. 3 mm.

Riujin (Akizu), Kii. Types No. 86,473, A. N. S. P., from No. 1,046 of Mr. Hirase's collection.

This form is also somewhat similar to *C. caryostoma* and *C. c. jayi*, both of which have the closing armature subventral; but the clausilium differs, and the palatal plicæ are shorter in *C. a. sakui*.

Section NESIOPHÆDUSA nov.

Group of *C. ptychochila* Pils., Proc. A. N. S. Phila., 1901, p. 418.

Phædusoid Clausiliæ of normal contour, with a tendency to weak interlamellar plication. Inferior lamella prominent in the mouth, *spirally ascending*, thick, sometimes indistinctly doubled within; palatal armature lateral, the lunella arising from the middle of a strong lower palatal plica, and curving inward above in a short upper palatal plica. Clausilium very convex on the palatal side, tapering distally to a blunt, thickened apex, channeled on the outer face. Type *C. bernardii* Pfr.

I formerly included the species of this section in *Hemiphædusa*, from which they differ totally in the form of the clausilium, and in the spirally ascending inferior lamella. *C. excellens*, of which the clausilium and palatal armature are unknown, will probably be found to belong to *Luchuphædusa*. The other species are closely related.

Clausilia okinoerabuensis n. sp. Pl. LII, figs. 13, 14.

Shell subcylindric below, the upper half tapering and somewhat attenuate; pale uniform yellowish-corneous. Surface glossy, finely, strongly striate, the striation coarser on the back of the last whorl. Whorls 10, the upper 3 smooth. Aperture ovate-piriform, the peristome reflexed and thickened, with a small notch on the right side of the superior lamella, and very indistinct traces of crenulation near it. Superior lamella marginal, small, subvertical, continuous with the spiral lamella which penetrates to the left side. Inferior lamella forming a rather prominent fold in the aperture, calloused and spirally ascending within, shorter than the spiral lamella. Subcolumellar lamella emerging to the lip-edge. Principal plica short, dorsal and lateral. Lunella strong, oblique, arising from the middle of a strong lower palatal plica, and bending inward above in a rather long upper palatal plica.

Length 22 to 23, diam. 5 mm.

Clausilium (Pl. LIII, figs. 23, 24) well curved, the columellar margin straight, slightly excised at the filament, the palatal margin very convex, then tapering and concave toward the apex, which is blunt and thickened.

Okinoerabushima, Ōsumi. Types No. 87,611, A. N. S. P., from No. 1,251 of Mr. Hirase's collection.

A smaller species than *C. crenilabium*, with the upper palatal plica better developed, with scarcely any interlamellar plication of the upper lip, and a callous but not internally double inferior lamella. The clausilium is less deeply channeled distally. It is not so coarsely sculptured as *C. bernardii*, and is more slender than *C. ptychochila*.

Fossil specimens from a deposit of calcareous sand on the shore of Okinoerabushima are similar to the living specimens in structure, but some specimens are shorter:

Length 23.6, diam. 5 mm.

Length 21, diam. 5.4 mm.

Section LUCHUPHÆDUSA Pils.

Clausilia azumai n. sp. Pl. LII, figs. 6, 7.

Shell solid and strong, cylindric below, the upper half regularly tapering, slightly attenuated above. Pale yellow. Whorls $11\frac{1}{2}$, convex, finely striate, the last whorl becoming coarsely striate behind. Aperture broadly piriform, white. Peristome with the outer and basal margins well reflexed and thickened within; columellar and parietal margins beautifully crenulate. Superior lamella marginal, compressed, continuous with the spiral lamella, which penetrates past the aperture to the left side. Inferior lamella forming a rather small, subhorizontal fold in the aperture, with an accessory fold below it extending to the margin; as long inside as the spiral lamella. Subcolumellar lamella emerging to the lip-edge, decidedly shorter inside than the other lamella. The principal plica is long, visible in the throat, extending across the ventral side. The upper palatal plica is very oblique. Lower palatal plica long and angularly bent, a very oblique and rather long lunella arising from the angle. It lies in a subventral position.

Length 25.3, diam. 6 mm.

Clausilium rather broad, truncated distally, with a wide and rather long, thick apical projection on the columellar side, and a slight projection on the outer side of the end; the palatal margin rounded.

Shimo-Koshikijima, Satsuma. Type No. 87,603, A. N. S. P., from No. 1,237 of Mr. Hirase's collection.

This fine species is related to *C. callistochila*, from which it differs in the following peculiarities: The striation is finer; the inferior lamella is more distinctly doubled below; the lunella is longer and more ventral in position, and the clausilium has a larger process at the apex. It is also related to *C. una* Pils., of Gotō, Hizen; but in that species the lunella is shorter and lateral, and the clausilium is much less specialized, being much like that of *Stereophædusa*.

C. azumai is one of the finest species collected this year by Mr. Azuma in the islands of Satsuma.

Clausilia una, which I formerly placed in *Stereophædusa*, should probably be transferred to *Luchuphædusa* or to a separate and special section allied to *Luchuphædusa*, characterized by the unspecialized clausilium, while all other structures are Luchuphædusoid.

C. azumai idiopylis n. subsp. Pl. LII, fig. 8.

Somewhat smaller than *C. azumai* and dull reddish-brown; inner lip less strongly crenate; inferior lamella thickened but not distinctly doubled below; subcolumellar lamella immersed. Clausilium (Pl. LIII, fig. 17) more oblique and more distinctly notched distally.

Length 22, diam. 5.3 mm.; whorls $11\frac{1}{2}$.

This form, sent with *azumai*, may prove to be included in the range of variation of that species, but in the absence of intermediate specimens it seems best to call attention to its differential features.

Clausilia nakadai n. sp. Pl. LII, figs. 9. 10, 11.

Shell fusiform, moderately attenuate above; yellow, the worn early whorls whitish, nearly lusterless, finely striate. Whorls 10, convex, the latter half of the last flattened. Aperture piriform, white within, with distinct, slightly retracted sinulus. Peristome broadly reflexed, with a fold or doubling behind, thickened within. *Columellar and parietal margins crenulated.* The superior lamella is compressed, vertical and marginal, and continuous with the spiral lamella, which is very high, and penetrates past the ventral side to the middle of the left side. The inferior lamella projects as a very strong columellar fold in the aperture, and penetrates inward slightly farther than the spiral lamella. The subcolumellar lamella emerges to the lip-edge, and penetrates as deeply as the spiral lamella. *The principal plica extends nearly to the lip,* and enters deeply. There is a rather long, oblique upper palatal plica, and an obliquely ascending and entering lunella arising from the summit of a long, angularly bent lower palatal plica; all lying in a nearly ventral position. The lower end of the lower palatal plica is visible in the aperture in an oblique view.

Length 20.5, diam. 5 mm.

Length 18.5, diam. 4.8 mm.

Clausilium (Pl. LIII, figs. 18, 19) strongly curved spirally, the columellar side of the apex projecting in a thick blunt process, the palatal side rounded, a wide shallow notch in the middle. Proximally it tapers gradually and without excision into the filament.

Matsubara, Tokunoshima. Types No. 87,594, A. N. S. P., from No. 1,205*a* of Mr. Hirase's collection.

C. nakadai is intermediate between *C. callistochila* and *C. oshimæ* in size, geographic position and morphology. The aperture resembles that of *oshimæ* in shape, but is wider, and the right lip is more crenulated. The lamellæ are not quite so long as in *oshimæ*. The lunella is better developed than in either of the other species, and the lower palatal plica is far shorter than in *C. oshimæ*, but differs from that of *callistochila* in shape.

This handsome *Luchuphædusa* is named in honor of Mr. Nakada, who has brought to light more Riukiuan land snails than all other collectors combined.

C. nakadai degenerata n. subsp. Pl. LII, fig. 12.

Fresh specimens are pale corneous-buff, very glossy, and typically more slender than *nakadai*, with the aperture a little narrower and more projecting, the right lip less reflexed, thin, irregularly and more or less *obsoletely* crenulate. In internal structure it agrees with *nakadai*. The clausilium (Pl. LIII, fig. 22) is more deeply notched distally than in *C. nakadai*.

Length 24, diam. 4.6 mm.; whorls 11½.

Length 21, diam. 4.5 mm.; whorls 10½.

From Sanmura and Matsubara specimens were sent (No. 1,205) agreeing with Nakada's Clausilia in internal structure, but with the right lip thin and crenulate only at the edge. Some are glossy and slender, others somewhat stouter and decorticated throughout.

Clausilia tokunoshimana n. sp. Pl. LII, figs. 4, 5.

Shell cylindric below, the upper half rapidly tapering, solid, very pale brownish-yellow. Surface glossy when unworn, costulate, more coarsely so on the back of the last whorl. Whorls 10½, moderately convex, the last half of the lower whorl contracted. Aperture trapezoidal-ovate, white, the outer margin of the peristome well reflexed and thickened within; columellar and parietal margins narrower, closely and finely crenulate (the crenulation sometimes subobsolete). Superior lamella marginal, rather small, continuous with the spiral lamella, which penetrates to the middle of the left side. Inferior lamella forming a prominent columellar fold, more or less distinctly doubled below, penetrating inward as deeply as the spiral lamella. Subcolumellar lamella emerging to the lip-edge, ascending within nearly as far as the other lamellæ. The principal plica is rather *short, latero-ventral, not visible in the aperture.* Upper palatal plica small, oblique. Lower palatal plica long and bent; the long and very oblique, ventral lunella arising from it in the middle. The lower palatal plica is not visible in the aperture.

Length 17, diam. 4.2 mm.

Length 16, diam. 4 mm.

The clausilium (Pl. LIII, figs. 20, 21) is very broad distally, and has a long projection on the columellar side; the palatal side is broadly rounded. It is not excised at the filament.

Tokunoshima, Ōsumi, the types from Sanmura, No. 87,586, A. N. S. P., from No. 1,200 of Mr. Hirase's collection. Other similar specimens were sent from Teteyama, near Sanmura (No. 1,200*a*).

This species is allied to *C. mima* of Ōshima, but differs in being larger and very coarsely sculptured; the lunella is nearly ventral, and there is a whorl or two more. The clausilium is similar in the two species.

Section OOPHÆDUSA nov.

The clausilium is well curved, spatulate, with *a thick rib near the columellar side of the distal half, continued and projecting finger-like at the apex;* proximally it tapers into the filament, and is not emarginate.

The shell is short, oblong, *of few whorls* (6–6½ in the species known), the *summit very obtuse,* entire. Superior continuous with the spiral lamella. *Inferior lamella strongly spiral within,* bifid below. Upper and lower palatal plicæ long, the latter united with an oblique lunella.

The only species now known has a crenulate lip, like *Luchuphædusa,* and the palatal armature and clausilium are similar in the two groups; but in *Luchuphædusa* the shell is shaped like ordinary Clausilias, while in *Oophædusa* the thick-set shell is not in the least attenuate above, being shaped like a snake's egg, and there are but few whorls.

Clausilia ophidoön n. sp. Pl. LII, figs. 1, 2, 3.

Shell oblong, fusiform with blunt ends, the penultimate whorl widest; moderately strong; brown; finely striate throughout except the first whorl, which is whitish and smooth; somewhat shining. Whorls 6½, the first rather large, not projecting, forming a large, *very obtuse apex;* last whorl tapering. Aperture slightly oblique, piriform, the peristome white, reflexed, thickened within, the *columellar and parietal margins closely and strongly folded,* the edge crenulate. Superior lamella thin and high, marginal, continuous with the spiral lamella, which penetrates past the aperture to the left side. Inferior lamella emerging to the lip-edge, spirally ascending within, and penetrating about as far as the superior lamella; below it branches off in a columellar lamella which also emerges to the lip-edge. Subcolumellar lamella emerging. Principal plica extending from the middle of the dorsal side to a point above the sinulus, visible through from the outside. Upper palatal plica latero-ventral, long, converging inward toward the principal plica. Lower palatal plica very long and very oblique, united with a very oblique lunella, nearly parallel with the plica.

Length 14.4, diam. 5 mm.

Length 13, diam. 4.5 mm.

Clausilium (Pl. LIII, figs. 15, 16) strongly curved, spatulate, the palatal margin strongly arcuate. A callous rib arises about midway of the columellar margin, and projects in a finger-like process at the apex.

Shimo-Koshikijima, Satsuma. Types No. 87,602, A. N. S. P., from No. 1,235 of Mr. Hirase's collection.

This remarkable species has no near allies among known Clausiliæ.

One specimen sent with the type lot is smaller, length 11.7, diam. 4 mm., with 6 whorls, pale yellowish in color, and the inferior lamella proper, while visible in the throat, does not extend to the lip (Pl. LII, fig. 3).

Section STEREOPHÆDUSA Bttg.

Clausilia subhickonis n. sp. Pl. LIV, figs. 34, 35, 36, 37, 38.

Shell fusiform, attenuate above, but terminating in a rather large apex, solid, light yellow, rather strongly rib-striate. Whorls 12 to 12½, *convex*, the first 3 or 4 cylindric, the penultimate whorl swollen as seen dorsally, last whorl flattened, convex below, not noticeably different in sculpture. Aperture ovate, subvertical, the peristome white, reflexed and thickened within, continuous in a slightly raised ledge across the parietal wall, a little sinuous or notched at the position of the superior lamella. Superior lamella decidedly oblique, marginal, continuous within with the spiral lamella, which penetrates inward to the middle of the ventral side. Inferior lamella appearing in front as a strong, subhorizontal fold crossing a much more oblique callous columellar fold which continues weakly upon the lip; the whole appearing as two nodules. Within the back the inferior lamella is strongly spiral but not very high. It penetrates inward more deeply than the superior lamella. The subcolumellar lamella emerges to the lip-edge. The principal plica is very short and lateral. Palatal plicæ 4, strong, somewhat oblique and parallel, the lower one a little arcuate, the two intermediate plicæ shorter than the others.

Length 21 to 22.5, diam. 5 mm.

The clausilium (Pl. LIV, figs. 34, 35) is narrower than usual in *Stereophœdusa;* the columellar margin is straight, a little excised near the filament; the palatal margin convex, contracting distally; the distal end is compressed and ridged inside, and the apex is rounded and noticeably thickened.

Isobe, Shima. Types No. 86,499, A. N. S. P., from No. 1,168 of Mr. Hirase's collection.

This *Stereophœdusa* is related to *Cl. hickonis* Kobelt, but *hickonis* is more attenuate above, has more whorls, which are less convex, finer sculpture, longer upper and lower palatal plicæ, the latter more curved, and the superior lamella in *C. hickonis* is usually separated from the spiral lamella, or at least much lower at their junction.

C. subhickonis has been taken also at Gokasho-mura, Ise, a place not very far from the type locality. The columella is not quite so conspicuously binodose in these specimens, two of which measure—

Length 24, diam. 5.5 mm.

Length 23.5, diam. 5 mm.

Like most of the larger Clausiliæ, it is sometimes overgrown with green algæ, and the original surface destroyed.

Clausilia hickonis saucia n. subsp.

Shell fusiform, solid, brown. Surface glossy, rather coarsely striate, the striæ nearly as wide as the intervals. Penultimate whorl widest, the spire regularly tapering, *summit broadly truncate*. Whorls remaining about 8½ (several whitish empty ones sometimes persisting above the apical plug), moderately convex, the last tapering downward. Aperture vertical, piriform, brown within. Peristome white, continuous, reflexed, and thickened within; the parietal margin short, straightened, barely free. Superior lamella marginal, high and compressed, very oblique, continuous with the spiral lamella, which penetrates past the middle of the ventral side. Inferior lamella strong, approaching the superior, appearing below like a strong lamella crossing an oblique, callous columellar fold; extending inward as far as or further than the spiral lamella. Subcolumellar lamella more or less emerging, but not reaching the lip-edge. Principal plica short, lateral. Upper palatal plica rather long, obliquely converging inward to the principal plica. Lower palatal plica nearly as long, strong, somewhat arcuate, parallel to the upper; a shorter plica midway between them.

Length 26.3, diam. 6.4 mm.

Length 27, diam. 6.5 mm.

Clausilium rather long and nearly parallel-sided, well curved, obtuse and noticeably thickened apically, a little excised on the palatal side of the apex, the rest of the palatal margin being arcuate. Both margins regularly taper to the filament.

Sodayama, Tosa. Types No. 84,784, A. N. S. P., from No. 1,023 of Mr. Hirase's collection.

The broadly truncate summit and robust stature distinguish this from *C. hickonis*. *C. fultoni* Sykes, which is merely a weakly characterized variety of *C. vasta* Bttg., differs by its more straightly ascending inferior lamella as well as by the entire apex.

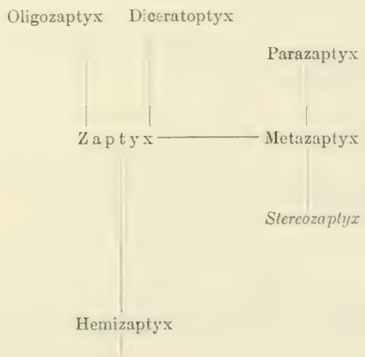
Zaptychoid phylum.

The material brought together by Mr. Hirase's collector in the islands of the Ryukyu curve this year, enlarge our knowledge of this phylum to such a degree that a revision of the group is required.

The entire series of Zaptychoid Clausiliæ consists of small, often very small, species, few-whorled, with a clausilium very deeply excised on the columellar side of the filament, and abruptly bent and twisted there. The closing apparatus is always lateral or dorso-lateral, the lamellæ rarely penetrate as far as the middle of the ventral side, and the spiral lamella is usually low.

The sections *Oligozaptyx* and *Diceratoptyx* constitute two new secondary phyla, independently evolved from the typical group. In both the clausilium is notched, and the whole structure shows great specialization. Another line of differentiation is represented by the sections *Metazaptyx* and *Parazaptyx*, in which the inferior lamella has become spiral, thereby obstructing the throat, and the clausilium is strongly curved. In *Parazaptyx* the clausilium is further modified in a peculiar and unexampled manner. Then we come to a series of groups in which the shell is without accessory plicæ and lamellæ, and now defined as *Hemizaptyx* and *Stereozaptyx*. The species of these groups I had formerly appended to various sectional divisions as aberrant forms. The evidence now at hand indicates that they are either degenerate or primitive branches of the *Zaptyx* phylum. *Stereozaptyx* may well be a secondarily simplified form of *Parazaptyx*, in which the accessory plicæ and lamellæ have been obliterated in the general and extreme thickening of the shell walls. If so, immature shells might possibly still show some trace of them.

The interrelations of the subordinate groups and their approximate phylogeny, so far as I understand the recent and fossil forms now known, may be represented by the following diagram. The names of those groups of which the position is hypothetical are in *italics*.



A key to the sections follows:

I.—Lunella oblique, straight, becoming more or less incurved below; above united with or contiguous to a short or moderate upper palatal plica, somewhat in the shape of the letter J (except in a few forms where the upper palatal plica is absent).

a.—Inferior lamella receding, obliquely ascending and straightened within the last whorl; clausilium parallel-sided, rounded or acuminate distally, usually rather straight except near the filament.

b.—Shell without sutural plicæ, fulcrum or parallel lamella, Section *Hemizaptyx.*

b[1].—Shell thin; sutural plicæ, fulcrum and parallel lamella developed, ... Section *Zaptyx.*

a[1].—Inferior lamella spirally ascending within the last whorl, usually projecting into the aperture; clausilium strongly curved.

b.—Clausilium tapering distally to an acuminate apex; shell solid and strong, without sutural plicæ or accessory lamellæ within; no upper palatal plica, Section *Stereozaptyx.*

b[1].—Clausilium wide, the apex obtuse; shell thin, the inferior lamella approaching the superior as a thin fold in the aperture.

c.—Clausilium smooth on the outer (convex) face; sutural plicæ present, . . Section *Metazaptyx.*

c[1].—Clausilium buttressed on the outer face by an erect, transverse plate; shell without sutural plicæ, Section *Parazaptyx.*

II.—The lunella arises from the middle of a long, arched lower palatal plica, and curves inward at its upper end; no superior lamella; 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; superior lamella and sutural plicæ developed. Clausilium notched on the palatal side near the apex, ... Section *Diceratoptyx.*

These groups are new with the exception of *Zaptyx.* They are reviewed below except *Stereozaptyx* (=group of *C. entospira, Proc. Acad. Nat. Sci. Phila.*, 1901, p. 644), type *C. entospira* Pils. No other species of *Stereozaptyx* is known.

Section HEMIZAPTYX nov.

A group of small species differing from *Zaptyx* in lacking sutural plicæ and accessory lamellæ, and often in the texture of the shells. They are all small, mostly under 11 mm. long. Most of those known are from Tanega-shima and Yaku-shima, but the group extends south to Tokuno-shima. Type *C. pinto*.

The following species belong here:

C. pinto Pils. Tanega-shima, Ōsumi.

C. ptychocyma Pils. Tanega-shima, Ōsumi.

C. ptychocyma yakushimæ Pils. Yakushima, Ōsumi.

C. asperata Pils. Shimo-Koshikijima, Satsuma.

C. caloptyx Pils. Yakushima, Ōsumi.

C. agna Pils. Yakushima, Ōsumi.

C. purissima Pils. Miyakejima, Izu.

C. hyperaptyx Pils. Tokunoshima, Ōsumi.

C. munus Pils. Ōshima, Ōsumi.

Key to Species of Hemizaptyx.

I.—Clausilium rounded at the distal end.

a.—Upper palatal plica extremely short or apparently absent; merely an enlargement of the upper end of the lunella.

b.—Solid and strong, nearly smooth; lip very thick, hardly free above; superior lamella contiguous to the spiral; subcolumellar lamella emerging. Tanegashima, *C. pinto.*

b[1].—Extremely solid and strong; almost smooth, the last whorl coarsely wrinkled behind the lip; superior lamella seprated from spiral; subcolumellar lamella emerging or immersed. Tanegashima and Yakushima, *C. ptychocyma.*

b[2].—Moderately strong; very finely striate, the last whorl with spaced riblets behind; superior lamella continuous with the spiral; subcolumellar lamella immersed. Shimo-Koshikijima, Satsuma, ... *C. asperata.*

a[1].—Upper palatal plica short but distinctly developed.

b.—Solid and strong; surface sculptured with strong straight ribs; length 7 to 8 mm. Yakushima, . *C. caloptyx.*

b[1].—Surface smooth, brilliantly glossy; more or less transparent.

c.—Whorls $6\frac{3}{4}$ to 8; shell stoutly fusiform, the diameter contained $3\frac{1}{2}$ to 4 times in the length; subcolumellar lamella weakly emerging. Yakujima, . *C. agna.*

c[1].—Whorls 10; shell slenderly fusiform, the diameter contained 5 times in the length; subcolumellar lamella immersed. Miyakejima, Izu, . . *C. purissima.*

II.—Clausilium angular or acuminate at the distal end; superior lamella continuous with the spiral; upper palatal plica rather short, scarcely connected with the slightly curved lunella.

a.—Shell dark, glossy and rather thin, 10 to 11 mm. long; about $7\frac{1}{2}$ whorls; sides of the clausilium strongly reflexed. Tokunoshima, ... *C. hyperaptyx.*

a^1.—Shell brown, 13 to 15 mm. long; about 9 to 10 whorls. Distal half of the clausilium flat. Ōshima, ... *C. munus.*

Clausilia purissima n. sp. Pl. LV, figs. 47, 48, 49.

Shell slenderly fusiform, rather thin, *transparent*, with a greenish tint, the surface polished, with a brilliant gloss, faintly marked with slight growth-wrinkles. Spire regularly tapering to the obtuse apex, the lateral outlines nearly straight. Whorls 10, convex, parted by a well-marked suture, the last whorl a little compressed laterally. Aperture oval, the peristome slightly expanded, a little thickened, continuous, the parietal margin barely free, short and straightened. Superior lamella marginal, rather high and thin, oblique, continuous with the spiral lamella, which penetrates about to the middle of the ventral side. Inferior lamella hardly visible in a front view, receding, straightly ascending, shorter within than the superior lamella. Subcolumellar lamella very deeply immersed, penetrating inward about as far as the inferior lamella. Principal plica short, dorso-lateral, visible in the throat, penetrating slightly past a lateral position. Upper palatal plica short, dorso-lateral. Lunella oblique, straight, strongly curving inward at the lower end, not quite reaching the upper palatal plica.

Length 12.3 to 12.8, diam. 2.3 mm.

Clausilium (fig. 47) parallel-sided, the apex rounded; abruptly and deeply excised on the columellar side of the filament.

Miyakejima, Izu. Types No. 85,731, A. N. S. P., from No. 1,089 of Mr. Hirase's collection.

In this exquisite species the shell is so pellucid that the plicæ, lamellæ and axis may be seen through. It is not closely related to any known species, but seems to belong to a group characteristic of the islands south of Kyushu. It is with some doubt, however, that I place *C. purissima* in the group *Hemizaptyx*. It may belong to *Hemiphædusa*.

Clausilia asperata n. sp. Pl. LV, figs. 42, 43, 44.

Shell fusiform, the spire noticeably attenuated above, moderately strong, grayish-brown; glossy; very finely striate, the back of the last whorl sculptured with narrow, widely spaced riblets. Whorls $8\frac{1}{2}$ to $9\frac{1}{2}$, convex, the last tapering. Aperture ovate, the peristome thin, expanded and reflexed, shortly free and projecting above. Superior lamella small, marginal, continuous with the spiral lamella, which is rather high within, and penetrates nearly to the middle of the ventral side. Inferior lamella deeply receding, not visible from in front; inside it is nearly straight, thickened and quite high; penetrating a little less deeply than the spiral lamella. The subcolumellar lamella is wholly immersed. Principal plica short. The upper palatal plica is extremely short, a mere enlargement of the summit of the narrow lunella, which is straight above, curved inward below.

Length 11.2, diam. 2.3 mm.; whorls 9½ (figs. 43, 44).

Length 9, diam. 2 mm.; whorls 8½ (fig. 42).

The clausilium is parallel-sided, nearly straight, rounded at the apex, excised on the columellar side of the filament. The palatal margin is recurved and dilated.

Shimo-Koshikijima, Satsuma. Types No. 87,606, A. N. S. P., from No. 1,242 of Mr. Hirase's collection.

This species is the only Zaptychoid form yet known from the Koshikijima group. It is related to *C. pinto* from Tanegashima, but differs in the anteriorly projecting aperture, thinner lip, less solid shell, immersed subcolumellar lamella and the somewhat differently shaped clausilium. Moreover, the back of the last whorl is sculptured with spaced riblets, while the rest of the shell has very close, delicate striæ, becoming imperceptible above the middle of the shell. The largest specimen (figs. 43, 44) is extensively worn, and therefore figured in outline. The sculpture is well shown in fig. 42.

Clausilia hyperaptyx n. sp. Pl. LVI, figs. 85, 86, 87, 88.

The shell is fusiform, glossy, dark reddish-brown, weakly, finely striate, the back of the last whorl densely and sharply striate. Upper half of the spire rapidly tapering to a rather acute apex. Whorls 7½. Aperture like that of *C. hyperoptyx*, but the peristome is somewhat more widely expanded. *Superior lamella continuous with the spiral lamella,* which penetrates to the middle of the ventral side, and is much dilated within. There is no fulcrum or parallel lamella. The inferior lamella recedes deeply, is high, strong and nearly straight within the last whorl, and penetrates nearly as deeply as the spiral lamella. The subcolumellar lamella emerges. The principal plica is a half whorl long, dorsal and lateral. The upper palatal plica is short, and lies mainly inward from the upper end of the lunella, with which it is scarcely connected. The lunella is slightly arcuate. There are *no sutural plicæ.*

Length 10.9, diam. 2.3 mm.

Length 10, diam. 2 mm.

Clausilium (Pl. LVI, figs. 85, 87, 88) rather long, parallel-sided, the two sides very strongly recurved (see fig. 85), the columellar side is narrowly thickened; the distal end is somewhat acuminate.

Tokunoshima, Ōsumi. Types No. 87,597, A. N. S. P., from No. 1,230 of Mr. Hirase's collection.

This species closely resembles *C. hyperoptyx* in color and sculpture, but is somewhat more obese, with more acute apex, and it is quite different in internal structure and in the shape of the clausilium. It is not closely related to any other species now known.

The clausilium resembles that of *C. munus* in shape, except that in *munus* it is flat, not rolled back on the two sides.

Section ZAPTYX Pilsbry, *s.str.*

Proc. A. N. S. Phila., 1900, p. 672.

To the definition of this group may be added: Inferior lamella but slightly curved and obliquely ascending within the last whorl; superior and spiral lamellæ sometimes continuous; end of the clausilium rounded.

The following species belong to this group:

C. hirasei Pils. Kagoshima and Sakura Island, Satsuma.

C. kikaiensis Pils. Kikaiga-shima, of the Ōshima group.

C. sarissa Pils. Okinoerabu-shima, of the Ōshima group.

C. hyperoptyx Pils. Ryukyu.

C. hyperoptyx yoronjimana Pils. Yoronjima.

C. yaeyamensis Pils. Yaeyama.

It is likely that *C. strictaluna* Bttg., of Kyushu, a species I have not seen, will prove to belong to *Zaptyx;* but the clausilium is still unknown.

Clausilia hirasei Pils. Pl. LVI, figs. 64, 65, 66, 67.

Acad. Nat. Sci. Phila., 1900, pp. 446, 673.

The original figure was in outline, and new ones are now given for comparison with the other species herein described.

The clausilium (figs. 66, 67) is more dilated on the palatal side of the filament than in *C. hyperoptyx, C. sarissa,* or other related species.

The types were from Kagoshima, Satsuma. The specimens now illustrated are from Sakura Island, in Kagoshima Bay. It is not known from any other localities.

Clausilia kikaiensis n. sp. Pl. LVI, figs. 68, 69, 70, 71.

C. hirasei, a more slender form, etc., *from Kikai,* Pilsbry, Proc. A. N. S. Phila., 1901, p. 465.

C. hirasei var. *kikaiensis* Pils., Proc. A. N. S. Phila., 1901, p. 651 (no description).

Shell small, slender, fusiform, tapering from the penultimate whorl to the small but obtuse apex, near which it is slightly attenuated. Chestnut-brown of varying shades, the last whorl often darker. Surface glossy, faintly striate, nearly smooth, the back of the last whorl striate, the striæ usually widely spaced. Whorls about 8. Aperture piriform, the peristome very narrowly reflexed, whitish. Superior lamella small and low, widely separated from the low short spiral lamella. Inferior lamella receding, not visible in a front view; low and obliquely ascending within. Subcolumellar lamella emerging, very slender, rising angularly on the palatal wall below the lunella. A short fulcrum and parallel lamella are present. Principal plica dorsal and lateral, visible in the aperture. Upper palatal plica extremely short, weakly connected with the lunella, which is straight above, but curves inward slightly at the lower end. There are three short sutural plicæ, the middle one often inconspicuous.

Length 9, diam. 2.1 mm.

Length 7.2, diam. 1.7 to 2 mm.

Clausilium (Pl. LVI, figs. 68, 69) rather long, parallel-sided, rounded at the apex, deeply excised at the columellar side of the filament.

Kikaiga-shima, Ōsumi. Types Nos. 79,728 and 80,787, A. N. S. P., from Nos. 557 and 557*b* of Mr. Hirase's collection. It has also been found by Mr. Nakada at Tokuno-shima, Ōsumi (No. 1,203 of Mr. Hirase's collection). It will probably turn up on the intermediate islands of the Ōshima subgroup.

This species is closely related to *C. hyperoptyx* of Ryukyu (Okinawa), but it differs in the less swollen embryonic whorls, shorter upper palatal plica, less developed superior lamella and usually smaller size, though the largest specimens of *kikaiensis* are equal to *hyperoptyx*. *C. hirasei*, from Satsuma, along Kagoshima Bay, is a decidedly wider shell, with less attenuated spire. The clausilium in *C. kikaiensis* resembles that of *C. hirasei* and *C. sarissa*, but it is decidedly less dilated on the palatal side of the filament than in *C. hirasei*.

I formerly considered the Kikai specimens to be a variety of *C. hirasei* (these *Proceedings* for 1901, p. 465), but further study of much larger series of both forms shows that their differential features are constant. They are rather widely separated geographically.

Clausilia sarissa n. sp. Pl. LVI, figs. 72, 73, 74, 75.

Shell cylindric below, tapering and a little attenuated above; brown, the fully adult shells marked with whitish or creamy lines and streaks. Surface somewhat glossy, very faintly striatulate, nearly smooth, the last third of the last whorl sharply, finely striate. Whorls 8, quite convex. Aperture ovate, the peristome narrow, reflexed, and in fully adult shells somewhat thickened at the edge. Superior lamella small, vertical, not continuous with the low small spiral lamella. Inferior lamella receding, visible only in an oblique view in the aperture, high and a little curved within, not continued parallel to the spiral lamella, but a very small inserted lamella (*l. inserta*) appears near the end of the spiral lamella. *Subcolumellar lamella wholly immersed.* There is a fulcrum and a parallel lamella. Principal plica short, dorsal and lateral, visible in the mouth. Upper palatal plica short, joined in the middle to the long lunella, which is straight above, curved inward below. A single sutural plica is developed, with the trace of a second upper one.

Length 10, diam. 2.2 mm.

Length 9, diam. 2.3 mm.

Clausilium (Pl. LVI, figs. 72, 73) parallel-sided, rounded at the apex, deeply excised on the columellar side of the filament.

Okinoerabushima, Ōsumi. Types No. 87,613, A. N. S. P., from No. 1,253 of Mr. Hirase's collection.

This species resembles *C. hirasei*, but differs in the decidedly stronger striation of the last whorl behind the lip, the wider peristome, immersed subcolumellar lamella, the more convex whorls and the poorer development of sutural plicæ. It is nearly opaque. As in *C. hirasei*, the inferior lamella is interrupted within. The palatal side of the filament is less dilated above than in *C. hirasei*. The specimen figured has a thicker peristome than most of those sent. The figure is too distinctly streaked.

Clausilia hyperoptyx Pilsbry. Pl. LVI, figs. 76, 77, 78, 79.

Proc. Acad. Nat. Sci. Phila., 1900, pp. 446, 472; 1901, pp. 423.

The statement in the original description that the "upper palatal plica is very short" was an error, which the figure (Pl. 14, fig. 12) corrects. The upper palatal plica is rather long, united in the middle with the lunella. The superior lamella is higher, better developed than in *C. hirasei* and *C. kikaiensis*. The tapering spire is distinctly attenuated above, but the apex is larger than in the related species; and the striation is better developed than in *C. hirasei* or *C. kikaiensis*. It is known only from Great Ryukyu Island (Okinawa); the specimens reported from Yaeyama prove to be specifically different.

Length 9 to 10, diam. 2 mm.

The clausilium (Pl. LVI, figs. 76, 77) is rather wide, rounded distally. It is wider than that of *hirasei*, *kikaiensis* or *sarissa*.

Clausilia hyperoptyx yoronjimana n. subsp.

The superior and spiral lamellæ are more or less completely disconnected, and the lunella joins the middle of the short upper palatal plica, as in *C. hyperoptyx;* but the shell is perceptibly wider, and the last whorl is decidedly less striate. It is also paler and somewhat more transparent.

Length 10 to 10.5, diam. 2.4 mm.

Yoronjima, Ōsumi. Types No. 88,767, A. N. S. P., from No. 1,253*a* of Mr. Hirase's collection.

Clausilia yaeyamensis n. sp. Pl. LVI, figs. 80, 81, 82, 83, 84.

Shell cylindric below, regularly tapering from the penultimate whorl to the apex; dark chestnut, paler near the apex. Surface glossy, *evenly, finely and sharply striate,* the back of the last whorl a little more irregularly so. Whorls $8\frac{1}{2}$, the earlier ones quite convex, the later much less so. Aperture piriform, the peristome expanded, whitish. Superior lamella rather high, compressed, weakly continuous with the spiral lamella, which penetrates nearly to the middle of the ventral side. Inferior lamella deeply receding, nearly straight and obliquely ascending within, shorter than the spiral lamella. Subcolumellar lamella emerging. A parallel lamella and fulcrum present. Principal plica about one-half a whorl long, dorsal and lateral, visible in the aperture. *Upper palatal plica very short,* connected with the straight lunella, which bends inward at its lower end. There are two sutural plicæ.

Length 11, diam. 2.3 mm.

Length 10.5, diam. 2.3 mm.

Clausilium (Pl. LVI, figs. 80, 81, 82) wider above than below, obtusely rounded distally, abruptly excised at the filament.

Yaeyama, Ryukyu. Types No. 80,963 and 87,561, A. N. S. P., from No. 457*b* of Mr. Hirase's collection.

This species is related to *C. hyperoptyx,* from which it differs in the even striation and very short upper palatal plica, and the weakly continuous superior and spiral lamellæ. The clausilium closely resembles that of *C. hyperoptyx.* I reported this species under the name *hyperoptyx* in these *Proceedings* for 1901, p. 651, not having at that time opened the specimens. *C. hyperoptyx* has not been found on Yaeyama, and probably does not occur in the southwestern group of islands.

Section METAZAPTYX nov.

Similar to *Zaptyx,* except that the inferior lamella ascends spirally within and in the mouth is visible as a fold approaching the superior lamella; the base of the shell is somewhat sack-like. The clausilium is broad, strongly curved distally, shorter than that of *Zaptyx,* and rounded at the apex.

The few species now known of this group are scattered over a wide expanse:

C. hachijoensis Pils. Hachijo-jima, Izu group.

C. dæmonorum Pils. Kikaiga-shima, Ōshima group.

C. dæmonorum viva Pils. Tokuno-shima, Ōshima group.

C. pattalus Pils. Tarama-jima, Ōshima group.

C. pattalus miyakaensis Pils. Miyaka-jima, Ōshima group.

Clausilia pattalus n. sp. Pl. LVII, figs. 93, 94, 95, 96, 97.

Shell cylindric below, tapering from the penultimate whorl in a long, somewhat attenuate spire; brown, becoming whitish at the apex. Surface glossy, finely and rather weakly striate, becoming finely and sharply striate on the last third of the last whorl. Whorls 8½ to 9, convex, the *second disproportionately long*, the last compressed laterally, very convex beneath. Aperture irregularly ovate, the peristome whitish, reflexed, somewhat thickened within. Superior lamella small marginal, continuous with the low spiral lamella, which penetrates to a point above the columellar lip. Inferior lamella deeply receding, scarcely visible in a front view, but seen in an oblique view as a small fold approaching the superior lamella; within it ascends spirally, and penetrates as far as the spiral lamella. *The subcolumellar lamella is immersed.* Fulcrum and parallel lamella are developed. Principal plica about one-third of a whorl long. Upper palatal plica rather long, connected in the middle with the lunella, which curves inward below. There are two sutural plicæ, the upper one weak or indistinct.

Length 11.2, diam. 2.5 mm.; whorls 9.

Length 10, diam. 2.3 mm.; whorls 8½.

Clausilium (Pl. LVII, figs. 93, 94, 95) rather short, parallel-sided, the distal end very strongly curved; the apex is blunt, tapering a little on both sides. It is somewhat thickened along the palatal side, and is very abruptly and deeply excised near the filament.

Taramajima, one of the Miyako subgroup of the Southwestern group.

Types No. 87,639, A. N. S. P., from No. 1,301*a* of Mr. Hirase's collection.

This species is stronger than *C. dæmonorum viva*, from which it differs in the immersed subcolumellar lamella, the less dilated, more immersed inferior lamella, and the better development of the peristome and internal lamellæ. There are also differences in the shape of the clausilium.

C. pattalus miyakoensis n. subsp.

Shell thinner, paler, and often smaller than *C. pattalus*, with the superior lamella smaller. All of the lamellæ and plicæ are weaker.

Length 10.3, diam. 2.3 mm.; whorls 9.

Length 9, diam. 2 mm.; whorls 8.

Miyakojima. Types No. 87,638, A. N. S. P., from No. 1,301 of Mr. Hirase's collection.

As the differences between these specimens and those from Taramajima, though slight, are constant, I have thought it best to signalize them by a name.

Clausilia dæmonorum Pils. Pl. LVII, figs. 98, 99.

Proc. A. N. S. Phila., 1902, p. 381.

Having only fossil specimens without the clausilium, I described this species originally as a *Stereophædusa*. Recent discoveries by Mr. Hirase have now made it clear that there exists a group of species closely related to *Zaptyx*, in which the inferior lamella is spiral within. The types of *C. dæmonorum* show, now that they are more perfectly cleaned, *two sutural plicæ*, which I did not see when originally describing the species.

C. dæmonorum differs from *C. kikaiensis* in the more swollen, sack-like base, larger superior lamella and the less immersed, spirally ascending inferior lamella.

The species is apparently extinct in the type locality, Kikaiga-shima, a small, low island which has been pretty thoroughly examined for land shells; but a closely related living form has been sent from Tokunoshima.

The figures are drawn to a smaller scale than the others on the same plate.

C. dæmonorum viva n. subsp. Pl. LVII, figs. 89, 90, 91, 92.

Shell cylindric below, tapering from the penultimate whorl to the apex, pale yellow or brownish-yellow, more or less transparent; thin. Surface glossy, with low wrinkles of growth, and behind the lip some stronger striæ. Whorls $8\frac{1}{2}$, those of the spire quite convex, the last two somewhat flattened; last whorl compressed laterally, *very convex and sack-like below.* Aperture trapezoidal-ovate, the sinulus a little retracted; lip thin, expanded and narrowly reflexed, white. Superior lamella marginal, small, vertical and compressed, continuous with the spiral lamella which is low and delicate. Inferior lamella receding, forming a high compressed fold and approaching the superior lamella in the throat; within the back of the last whorl it is dilated and ascends in a broadly spiral curve. It is short within, and does not run parallel to the spiral lamella. The subcolumellar lamella emerges. The fulcrum and parallel lamella are very small. The principal plica is about one-third of a whorl long. The upper palatal plica is very short, and connected with the very oblique and curved lunella. There are two weak sutural plicæ.

Length 9.8, diam. 2.2 mm.

Length 9.5, diam. 2 mm.

The clausilium (Pl. LVII, figs. 90, 91) is rather short, wider below than above, and strongly curved near the rounded apex; it is abruptly and deeply excised near the filament, as usual.

Bomayama, Tokunoshima, Ōsumi. Types No. 87,588, A. N. S. P., from No. 1,201 of Mr. Hirase's collection.

This little Clausilia has much in common with the fossil *C. dæmonorum* of Kikaiga-shima, but it is somewhat less specialized in having the superior and spiral lamellæ continuous. The upper of the two sutural plicæ is very weak, and in some specimens hardly perceptible. In one opened I saw a very weak *lamella inserta.*

Section PARAZAPTYX nov.

The shell is similar to *Zaptyx*, except that the inferior and subcolumellar lamellæ ascend spirally, as in *Metazaptyx;* fulcrum and parallel lamella and sutural plicæ are absent. The clausilium is wide, *tapers strongly to the apex*, and is strengthened by *a transverse lamellar rib on the convex side.*

The extraordinary clausilium of this group finds no parallel in Asiatic *Clausiliidæ*. *Parazaptyx* is another of the highly specialized phyla of the Riukiu Islands which give evidence of the ancient origin of these insular faunas.

In its spirally ascending lamellæ and wide clausilium, this Section resembles *Metazaptyx*, but it is like *Hemizaptyx* in lacking accessory plicæ, and the clausilium is unique.

Clausilia thaumatopoma n. sp. Pl. LVII, figs. 100, 101, 102, 103, 104.

Shell cylindric below, the upper half tapering and a little attenuated near the apex; brown, the apex pale. Whorls 9, convex, the first two smooth, the second whorl disproportionately wide; third and subsequent whorls closely, finely and sharply striate, shining, the striation coarser behind the lip. The aperture is trapezoidal-ovate, retracted at the sinulus, not projecting, brown inside; the peristome is pale-edged, very narrowly reflexed, obtuse but hardly thickened. The superior lamella is subvertical, marginal, rather high, and continuous with the low spiral lamella, which penetrates to the middle of the ventral side. The inferior lamella recedes very deeply, and is not visible in a front view, though seen obliquely from the base it appears as a rather high thin lamella. Within it ascends in a widely spiral curve. The subcolumellar lamella emerges to the lip-edge, and ascends in a sigmoid curve. The principal plica is about a half whorl long, dorsal and lateral. The upper palatal plica is very oblique, and weakly joined to the lunella, which is oblique, straight above, arcuate, curving inward below.

Length 10.5, diam. 2.5 mm.

Clausilium (Pl. LVII, figs. 100, 101, 104) short and wide, well curved, at the distal end tapering to a blunt apex, somewhat excavated on the palatal side. It is deeply excised on the columellar side of the filament. On the outer, convex surface there is a transverse plate extending from side to side.

Kumejima, Ryukyu. Types No. 87,631, A. N. S. P., from No. 1,293 of Mr. Hirase's collection.

Externally this species is much like the striate species of *Zaptyx*, but the sigmoid lamellæ and unique clausilium distinguish it.

Section OLIGOZAPTYX nov.

The shell is very small, fusiform, with no superior lamella. The inferior lamella forms a squarish fold in the throat and the subcolumellar lamella is obsolete below. There is a long lower palatal plica and short upper united with the lunella. Sutural plicæ and a lamella fulcrans are developed. The clausilium is notched on the palatal side of the projecting apex, and excised on the columellar side of the filament.

Type *C. hedleyi*.

In this extraordinary phylum the clausilium resembles that of *Diceratoptyx*, while the palatal armature is totally unlike any other known Zaptychoid form by the development of a large lower palatal plica. The whole closing apparatus is of a highly evolved type.

Clausilia hedleyi n. sp. Pl. LVII, figs. 105–110.

Shell very small, *fusiform*, attenuated above, amber-colored, transparent; *almost smooth*, with a brilliant gloss, the last whorl slightly striate behind the lip. Whorls 7¾, convex, the last narrow and tapering downward. Aperture projecting free in front, piriform, the white lip narrowly reflexed. *Superior lamella obsolete*, represented merely by a slight thickening of the peristome. Spiral lamella small, low and short, lateral. Inferior lamella receding, forming a strongly projecting squarish and bifid fold in the throat, low within. Subcolumellar lamella wholly immersed, subobsolete. Principal plica long, extending from a ventral position nearly to the aperture. Lunella lateral, united to the middle of a long, curved lower palatal plica, and with its upper end continued inward in a shorter upper palatal plica, much as in *C. platydera* and its allies. There are two minute sutural plicæ and a short *lamella fulcrans.*

Length 7.8, diam. 1.7 mm.

Clausilium (Pl. LVII, figs. 105, 106, 107, 108) rather short, parallel-sided, abruptly bent at the apex and twisted into a sort of spout, notched on the palatal side of the projecting apex.

Tokunoshima, Ōsumi, at Matsubara. Types No. 87,589, A. N. S. P., from No. 1,202 of Mr. Hirase's collection.

This is one of the smallest as well as one of the most specialized of Asiatic Clausiliæ. It is named in honor of my friend, Charles Hedley.

The clausilium is both abruptly curved and twisted near the apex, so that its true shape is not easily conveyed by figures. The apical end, however, is well shown by figs. 105 and 108, while it is seen much foreshortened in figs. 106 and 107.

Section DICERATOPTYX nov.

The glossy shell is Zaptychoid, the superior lamella developed, inferior lamella receding, calloused below. Subcolumellar lamella rising high on the palatal wall, dilated in a lateral position. *Upper palatal plica very long*, an *extremely short lunella* descending from near its inner end. Lamella fulcrans and parallela and sutural plicæ are developed. Clausilium deeply excised as usual at the filament, and with a deep notch excavated near the apex on the palatal side.

The very long upper palatal plica and diminutive lunella, and the peculiar clausilium, are characteristic. The dilated subcolumellar lamella, which rises high on the palatal wall, takes the place of a lower palatal plica.

The clausilium resembles that of *Oligozaptyx*, but the notch near the distal end has been independently evolved in the two groups; that of *Diceratoptyx* being adapted to fit over the dilated subcolumellar lamella, while in *Oligozaptyx* the notch fits over the lower palatal plica, and has been evolved with the evolution of the latter.

The internal structure is partially shown in Pl. LVII, fig. 113: *f*, fulcrum; *p*, parallel lamella; *sp*, spiral lamella; *inf*, inferior lamella; *sc*, subcolumellar lamella. The characteristic dilation of the latter is well shown, as well as its course upon the palatal wall of the shell, through which it is seen by transparence.

Clausilia cladoptyx n. sp. Pl. LVII, figs. 111–115.

Shell cylindric below, the upper half regularly tapering; amber or brownish-amber colored; almost entirely smooth, with a varnish-like gloss. Whorls 9, quite convex. Aperture ovate; peristome reflexed, slightly thickened. Superior lamella small, vertical, marginal, contiguous to or continuous with the spiral lamella, which penetrates nearly to the ventral side. Inferior lamella more or less receding, forming a very strong fold in the throat, ascending in a *very broad sigmoid plate*, abruptly diminishing to a small thread above, which revolves parallel to the spiral lamella, but does not penetrate so deeply. Subcolumellar lamella emerging to the lip-edge; inside it dilates, rising in an angle in a lateral position. Outside of the spiral lamella there are two short equal, parallel lamellæ (*lamella fulcrans* and *l. parallela*). The principal plica is dorsal and lateral, visible in the throat, and nearly a half whorl long; below it there is a very long upper palatal plica, which at its inner end gives out a very short oblique branch downward, the lunella. Below this there is a short palatal plica, at least in some specimens. Above the principal plica there are two sutural plicæ, the lower one well developed, the upper small.

Length 10, diam. 2.2 mm.

Length 9, diam. 2 mm.

The clausilium (Pl. LVII, figs. 111, 112) is short and wide, parallel-sided; there is a deep semicircular notch near the apex on the palatal side, and a deep excision on the columellar side of the filament. A marginal rib runs along the columellar side from the excision to the notch.

Tokunoshima, at Teteyama, near Sanmura. Types No. 87,592, A. N. S. P., from No. 1,204*a* of Mr. Hirase's collection.

Specimens from Sanmura, Tokunoshima, differ from typical *C. cladoptyx* in the smaller size: length 9, diam. 2 mm. to length 7.5, diam. 1.8 mm.

The plicæ are visible from the outside through the shell, as in *Oligozaptyx*.

Euphædusoid phylum.

Section EUPHÆDUSA Bttg.

Clausilia tryoni var. **miyakejimana** subsp. nov.

This race differs from *C. tryoni* in having two or three small, short palatal plicæ below the upper one. The striation of the last whorl is also denser and finer.

Miyakejima, Izu. Types No. 86,464, A. N. S. P., from No. 1,068 of Mr. Hirase's collection.

Explanation of Plates LII–LVII.

Plate LII, Figs. 1, 2, 3.—*Clausilia ophidoön* Pils.
Figs. 4, 5.—*Clausilia tokunoshimana* Pils.
Figs. 6, 7.—*Clausilia azumai* Pils.
Fig. 8.—*Clausilia azumai idiopylis* Pils.
Figs. 9, 10, 11.—*Clausilia nakadai* Pils.
Fig. 12.—*Clausilia nakadai degenerata* Pils.
Figs. 13, 14.—*Clausilia okinoerabuensis* Pils.

Plate LIII, Figs. 15, 16.—*Clausilia ophidoön* Pils. Clausilium.
Figs. 17.—*Clausilia azumai idiopylis* Pils. Clausilium.
Figs. 18, 19.—*Clausilia nakadai* Pils. Clausilium.
Figs. 20, 21.—*Clausilia tokunoshimana* Pils. Clausilium.
Fig. 22.—*Clausilia nakadai degenerata* Pils. Clausilium.
Figs. 23, 24.—*Clausilia okinoerabuensis* Pils. Clausilium.

Plate LIV, Figs. 25, 26, 27, 28.—*Clausilia nagashimana* Pils.
Figs. 29, 30, 31, 32, 33.—*Clausilia cymatodes* Pils.
Figs. 34, 35, 36, 37.—*Clausilia subhickonis* Pils.
Fig. 38.—*Clausilia subhickonis*, variety.
Fig. 39.—*Clausilia mikawa* Pils., palatal aspect.
Figs. 40, 41.—*Clausilia mikawa* Pils., type.

Plate LV, Figs. 42, 43, 44.—*Clausilia asperata* Pils.
Figs. 45, 46.—*Clausilia ikiensis* Pils.
Figs. 47, 48, 49.—*Clausilia purissima* Pils.
Fisg. 50, 51.—*Clausilia ikiensis* Pils. Clausilium.
Fig. 52.—*Clausilia aurantiaca sakui* Pils.
Figs. 53, 54, 55, 56, 57.—*Clausilia koshikijimana* Pils.
Figs. 58, 59, 60.—*Clausilia ventriluna* Pils.
Figs. 61, 62, 63.—*Clausilia hosayaka* Pils.

Plate LVI, Figs. 64, 65, 66, 67.—*Clausilia hirasei* Pils.
Figs. 68, 69, 70, 71.—*Clausilia kikaiensis* Pils.
Figs. 72, 73, 74, 75.—*Clausilia sarissa* Pils.
Figs. 76, 77, 78, 79.—*Clausilia hyperoptyx* Pils.
Figs. 80, 81, 82, 83, 84.—*Clausilia yaeyamensis* Pils.
Figs. 85, 86, 87, 88.—*Clausilia hyperaptyx* Pils.

Plate LVII, Figs. 89, 90, 91, 92.—*Clausilia dæmonorum viva* Pils.
Figs. 93, 94, 95, 96, 97.—*Clausilia pattalus* Pils.
Figs. 98, 99.—*Clausilia dæmonorum* Pils. These figures are drawn to a smaller scale than the others on the plate.
Figs. 100, 101, 102, 103, 104.—*Clausilia thaumatopoma* Pils.
Figs. 105, 106, 107, 108, 109, 110.—*Clausilia hedleyi* Pils.
Figs. 111, 112, 113, 114, 115.—*Clausilia cladoptyx* Pils

The following reports were ordered to be printed:

REPORT OF THE RECORDING SECRETARY.

Sixteen meetings have been held during the year, on the first and third Tuesdays from October to May inclusive, with an average attendance of thirty-six. Verbal communications were made by Messrs. A. E. Brown, Sharp, Keeley, Calvert, Chapman, Pilsbry, Fowler, Stone, Borden, Goodspeed, Phillips, Conklin, Nelson, Willcox, S. Brown, Moore, Wetherill, Miss Wardle and Miss Keller.

Fifty-two papers were presented for publication, as follows: James A. G. Rehn, 7; Henry W. Fowler, 4; Henry A. Pilsbry, 4; J. Percy Moore, 4; Thomas H. Montgomery, Jr., 2; T. D. A. Cockerell, 2; Henry C. Chapman, 2; J. A. G. Rehn and Morgan Hebard, 1; Nathan Banks, 1; N. M. Stevens, 1; Addison Gulick, 1; Harold Heath, 1; Thomas L. Casey, 1; James A. Nelson, 1; Harry C. Oberholzer, 1; A. E. Brown, 1; John H. Harshberger, 1; Benjamin Sharp and H. W. Fowler, 1; M. F. Thompson, 1; William F. Allen, 1; David H. Tennant, 1; Sarah P. Monks, 1; Witmer Stone, 1; Witmer Stone and A. S. Bunnell, 1; H. A. Pilsbry and E. Vanatta, 1; H. A. Pilsbry and Y. Hirase, 1; R. W. Shufeldt, 1; Mary H. Greenwalt, 1; Adele M. Fielde, 1; Adele M. Fielde and G. H. Parker, 1; Everett F. Phillips, 1; R. V. Chamberlin, 1; Charles W. Johnson, 1; Albert M. Reese, 1.

One of these, Fowler's *Fishes of Sumatra*, forms the concluding number of Volume XII of the *Journal*, six were returned to the authors, two were transferred to the Entomological Section, one is held under consideration, four have been accepted for publication in the volume for 1905, and the others constitute the current volume of the *Proceedings*.

A paper by Edward G. Conklin, Ph.D., entitled *The Organization and Cell-Lineage of the Ascidian Egg*, to form the first number of the *Journal*, Volume XIII, is going through the press, and will be ready for publication as soon as five of the plates in color, now being prepared in Germany, are received.

Eight hundred and ninety-five pages of the *Proceedings* and 59 plates, 70 pages and 22 plates of the *Journal*, 352 pages and 20 plates of the *Entomological News*, 299 pages and 20 plates of the *Transactions of the American Entomological Society* (Entomological Section of the

Academy), and 353 pages illustrated by 60 plates of the *Manual of Conchology* have been published.

The issues of the *Proceedings* and *Journal* have been distributed as follows:

PROCEEDINGS, delivered to members,		498
" exchanged,		560
" to subscribers,		40
		1,098
JOURNAL, exchanged,		72
" to subscribers,		34
		106

The decrease in the number of copies of the *Proceedings* sent out is due to a careful revision of the Exchange List, those societies being dropped, after due notification, from whom it is unlikely that a return will be received.

Sixteen members and two correspondents have been elected. The deaths of sixteen members and four correspondents have been announced. The following have resigned their membership: William J. Scott, Norris J. Scott, H. B. Gross, O. S. Paxson, William D. Joyce, William R. Reineck, C. M. Thomas and H. H. Furness.

In consequence of a decrease in the membership of the Conchological Section it ceased to exist in March, and the publication of the *Manual of Conchology*, the property of the Section since the death of the first editor, Mr. George W. Tryon, Jr., has been assumed by the Academy. The work will be continued under the direction of Henry A. Pilsbry, Sc.D. Mr. S. Raymond Roberts, formerly Treasurer of the Conchological Section, has kindly consented to retain the financial administration of the *Manual*, and has reported on the receipts and expenditures since the dissolution of the Section.

Dr. Charles B. Penrose was elected a member of the Council to fill the vacancy caused by the absence of Mr. Charles H. Cramp.

The resignation of Mr. Harold Wingate from the Committee on Accounts, because of removal from the city, was accepted.

The meetings of a number of related societies continue to be held in the rooms of the Academy.

I desire to acknowledge my obligation to Mr. William J. Fox for most efficient assistance in the preparation and distribution of the publications and in other matters connected with my office.

EDWARD J. NOLAN,
Recording Secretary.

REPORT OF THE CORRESPONDING SECRETARY.

During the past year, as usual, the bulk of the correspondence with scientific societies and institutions was concerned with the exchange of periodical publications, the number of which acknowledged shows a material increase. Several proposals to exchange publications were referred to the Publication Committee, and requests for the loan of collections or offers of specimens to the Curators.

The year has been noteworthy for the number of deaths of prominent scientific men and for the importance of its international congresses of learning. Formal notices of no fewer than eight deaths of Presidents of societies and Directors of museums were received and duly acknowledged in letters of condolence.

Invitations to the Academy to participate were received from the Organizing Committees of four international congresses, but in each case, beyond an expression of interest, no formal action was taken by the Academy and no delegates were appointed.

The deaths of four distinguished correspondents—Karl A. Zittel, Henry M. Stanley, R. A. Phillippi and Eduard von Martens—occurred during the year and were announced from the Chair. In the election of Profs. A. A. W. Hubrecht, of Utrecht, and Frantisek Vejdovsky, of Prag, the high standard of scientific attainment now required by the Academy as a condition of corresponding membership is maintained. Fourteen correspondents have contributed their photographs, accompanied in most cases by biographical sketches.

Following are the statistics of the year's correspondence:

Communications Received.

Acknowledging the Academy's publications,	197
Transmitting publications,	71
Requesting exchanges and the supply of deficiencies,	7
Invitations and notices,	6
Announcements of deaths of scientific men,	8
Circulars concerning the administration of scientific institutions, etc.,	11
Photographs and biographies of Correspondents,	14
Letters from Correspondents,	13
Miscellaneous letters,	35
Total received,	362

Communications Forwarded.

Acknowledging gifts to the Library,	877
Acknowledging gifts to the Museum,	77

Acknowledging photographs,	14
Requesting the supply of deficiencies,	50
Correspondents' diplomas and notices of election,	3
Letters of sympathy and congratulation,	10
Letters to Correspondents,	23
Miscellaneous letters,	36
Copies of Annual Reports,	262
Total forwarded,	1,352

Respectfully submitted,

J. Percy Moore,

Corresponding Secretary.

REPORT OF THE LIBRARIAN.

Six thousand three hundred and ninety-two additions were made to the Library during the past year. Of these 5,078 were pamphlets and parts of periodicals, 1,066 were volumes. There were, in addition, 181 photographs, drawings, etc., and 67 maps. They were derived from the following sources:

Societies, Museums, etc	2,261
I. V. Williamson Fund	1,890
Editors	684
General Fund	372
Authors	176
Mrs. M. T. S. Schaeffer	169
United States Department of Agriculture	102
J. A. Meigs Fund	94
Manuel E. Griffith	76
Wilson Fund	66
United States Department of Interior	65
Daniel D. Berolzheimer	51
Comité Géologique Russe	27
Imperial Geological Survey of Japan	24
Horatio C. Wood, M.D	20
University of Chicago	17
Paul Hagemans	14
Thomas Biddle, M.D	14
Trustees of British Museum	14
Geological Survey of Canada	14
Pennsylvania Department of Agriculture	13
Ministère des Travaux Publics, France	13
Clarence B. Moore	12
Sveriges Geologiska Undersökning	11
National Committee of Audubon Societies	11
Ministerio de Fomento, Peru	10
Geological Survey of India	10
H. A. Pilsbry	10
William J. Fox	9
United States Department of State	8
Department of Agriculture, Cape of Good Hope	7
Secretario de Estado, Mexico	7
Government of India	7
Department of Mines, Victoria	6
Pennsylvania State Library	6
Estate of James G. Meigs	6
H. C. Chapman, M.D	5
Albert I, of Monaco	5
Department of the Interior, Canada	5
Library of Congress	4

United States Department of Commerce and Labor	4
United States Treasury Department	4
Conchological Section, Academy	4
Department of Mines, New South Wales	4
United States War Department	3
Botanical Survey of India	3
Instituto Geologico de Mexico	3
Wisconsin Geological and Natural History Survey	3
Kommission zur Wissenschaftlichen Untersuchungen der Deutschen Meere in Kiel	3
Edward Potts	3
United States Commission of Fish and Fisheries	2
Alfred Sharpless	2
Trustees, Bernice Pauahi Bishop Museum	2
Royal Society	2
Vlaamsch Natuur-en Genesskundig Congres	2
Geological Survey of New Jersey	2
Monsieur le Duc de Loubat	2
Danish Government	2
Department of Geology and Natural History, Indiana	2
Bureau of Geology and Mines, Missouri	2
United States Coast and Geodetic Survey	1
Bureau of American Ethnology	1
J. A. G. Rehn	1
Botanical Garden, Kew	1
Howard Crawley	1
S. Raymond Roberts	1
P. P. Calvert, Ph.D	1
Department of Public Gardens, etc., Jamaica	1
Martin I. J. Griffin	1
Museo Nacional de Mexico	1
Dr. H. Burgin	1
F. J. Keeley	1
Philippine Government Board in the United States	1
Norske Gradmalingskommission	1
Geological Survey of Alabama	1
Free Public Museum, Liverpool	1
R. Accademia Petrarca di Arezzo	1
Miss A. R. Murphy	1
Home Secretary's Office, Queensland	1
Council of the Fridtjof Nansen Fund for the Advancement of Science	1
Surveyor General's Department, Natal	1
Philippine Weather Bureau	1
Iowa Geological Survey	1

They have been assigned to the following departments of the Library:

Journals	4,738
Botany	466
Geology	330
General Natural History	134
Ornithology	83
Ichthyology	76
Voyages and Travels	71
Entomology	70
Agriculture	67
Anatomy and Physiology	52
Conchology	47
Mammalogy	46
Anthropology	43
Geography	36
Bibliography	27
Mineralogy	17
Helminthology	17
Physical Science	12
Herpetology	9
Chemistry	6
Medicine	4
Encylcopedias	4
Philology	3
Mathematics	2
Unclassified	22

Shelf-lists of the special departments of the Library were compiled in 1885, 1886 and 1887. A careful comparison of the books on the shelves with these lists leaves nineteen works unaccounted for. With the exception of two volumes of bound pamphlets and four of somewhat antiquarian interest, they are recent works of small pecuniary value which can readily be replaced.

That a like account of stock may be taken of the journals and periodicals it will be necessary that a similar shelf-list be made of this department. This will be a work of some magnitude and of undoubted importance. It is hoped that it may be accomplished next year.

Ten hundred and twenty-six volumes have been bound, and 72 maps trimmed, backed with linen and added to the collection.

A collection of twenty-six catalogues, announcements, etc., issued by the University of Athens, were transferred to the library of the University of Pennsylvania; 3 volumes and 13 pamphlets on theology to the Seminary of St. Charles Borromeo, 19 volumes and 175 pamphlets on miscellaneous literature to the Free Library of Philadelphia. An accumulation of 103 State documents, in no way related to the Academy's work, were returned to Harrisburg.

A set of fine mahogany cases, formerly containing the library of the late Dr. Charles Schaeffer, has been presented to the Academy by Mrs. Schaeffer. They have been placed in the Council room, replacing those received in 1895 with the Meigs library, and greatly improve the appearance of the apartment.

As heretofore, I am glad to acknowledge the intelligent service of my assistant, Mr. William J. Fox, in all departments of the library work.

EDWARD J. NOLAN,
Librarian.

REPORT OF THE CURATORS.

The collections in the care of the Curators are in an excellent state of preservation, with all the data carefully recorded. During the past year important progress has been made in the details of arrangement and identification.

Additions and alterations to the heating plant have permitted the heating of the Museum. Many needed repairs have been made to the roof and other parts of the building.

Additional window-shades have been placed in the Museum and in the alcoholic department to protect the specimens from the light.

The Council room has been completely renovated and handsomely furnished with mahogany book cases, the gift of Mrs. Charles Schaeffer, who has likewise presented a lantern and screen.

The grounds adjoining the Museum have been sown with grass and carefully tended during the year, greatly improving their appearance.

In the Museum the installation of plate glass and mahogany cases has continued, 3,500 cubic feet of exhibition space having been provided during the year for mammals, birds and invertebrates. An oak wall-case has been placed in the Archæological department and the woodwork of most of the old cases has been refinished. Numerous storage cases for birds, mammals, insects, plants and mollusks have been purchased.

Through the liberality of Mr. Clarence B. Moore, Messrs. Stewardson Brown and H. W. Fowler were sent on a six-weeks' trip to the southwestern Florida keys in search of specimens of *Liguus* to supplement a valuable series collected and presented by Mr. Moore from the eastern and western coasts and adjacent keys. Though unsuccessful in its immediate object, the expedition obtained valuable collections of fishes, plants, etc. Later Mr. Moore sent out a second expedition, securing a series of the desired mollusks.

Dr. H. A. Pilsbry spent two months in Cuba investigating the molluscan fauna in the interests of the Academy, and Mr. J. A. G. Rehn was engaged for one month in collecting insects and birds in southern Georgia.

Mr. Clarence B. Moore has added a number of valuable specimens to his collection of Indian antiquities from Florida. Among other notable gifts of the year may be mentioned a large series of Indian implements, plants, birds and minerals, the collection of the late Dr. Charles Schaeffer, presented by Mrs. Schaeffer, a collection of ethnological material from Lieut. Frederick Schober, and numerous valuable specimens of mammals, birds and reptiles from the Zoological Society of Philadelphia. Several important collections have also been secured by purchase.

Besides the work detailed in the appended reports of the Sections, Mr. Fowler has continued the arrangement and identification of the fishes, and made numerous local collections.

Dr. Moore has cared for and added to the helminthological collection.

Dr. Pilsbry and Mr. Vanatta have made important advances in the identification and arrangement of the mollusca. The report of the Special Curator of this department is added.

Mr. Rehn has cleaned the greater part of the small mammal skulls belonging to the Rhoads and Bunnell collections, upward of 3,000 being thus added to the study series.

Mr. Stone, with the assistance of the Jessup students, has rearranged the entire series of reptiles and batrachians, relieving their overcrowded condition, and has labelled and tagged with metal numbers the entire series of Garter Snakes, as well as all recent accessions. Twelve thousand metal tags have been prepared and the work of tagging the whole collection will be pushed as rapidly as possible.

Miss H. N. Wardle has been constantly engaged in labelling, cataloguing and arranging the archæological collections, rendering them much more instructive to the student and visitor.

The preparator, Mr. McCadden, has mounted a number of mammals, notably an African Buffalo, and has prepared many specimens for the study collections.

Besides the services rendered by the Museum staff and the students of the Jessup Fund, the Curators are indebted to Dr. Philip P. Calvert, Mr. Erich Daecke, Mr. H. W. Wenzel, Mr. H. L. Viereck and Mr. E. T. Cresson, Jr., for assistance in the Entomological department.

The Anti-Tuberculosis Society, Philadelphia Botanical Club, Nomenclature Committee Botanical Club A. A. A. S., Mycological Club, Delaware Valley Ornithological Club, Pennsylvania Audubon Society and Delaware Valley Naturalists' Union have held meetings in the Academy building during the year.

The collections have been extensively studied by visiting specialists, while material has been loaned to the following: Robert Ridgway, H. C. Oberholser, G. S. Miller, Jr., E. B. Williamson, O. P. Hay, C. F. Sands, T. H. Montgomery, Jr., E. S. Steele, W. B. Scott, Florence Bascom, W. E. Meehan, James H. Lambert, J. F. Holt, C. V. Piper, E. L. Morris, W. B. Clarke, Paul Bartsch, J. W. Harshberger, Lawrence Bruner, H. W. Fowler, J. A. Allen and A. E. Ortman.

Samuel G. Dixon,
Curator.

Report of the Special Curator of the Department of Mollusca.

The accessions to the collection of mollusks during 1904 have exceeded in number those of any year since the reception of the A. D. Brown collection in 1887. Specimens have been received from 78 sources, the most valuable or extensive being the following:

A series of 330 lots of shells from the keys and adjacent mainland of Florida, from Mr. Clarence B. Moore, part collected by his own party, part by others sent by him to collect mollusks. This is by far the most extensive series of mollusks ever obtained on the Florida keys. The specimens have been determined and studied, and it is hoped that the results, suitably illustrated, will be published during the coming year.

A series of Japanese mollusks, some 650 lots, received from Mr. Y. Hirase, of Kyoto, has also been studied, but only the new forms have been published, comprising about 140 new species and about 30 new subspecies.

Mr. J. H. Ferriss has generously divided his valuable Arizona collections with us. The study of this material, with that collected by Mr. Ferriss and the Special Curator in 1903, is nearly complete. An unexpectedly large number of new and interesting forms were found.

Early in the year an attempt was made to increase our collection of fresh-water bivalves of the genus *Pisidium*. Some 70 lots were obtained from various correspondents, 10 of them cotypes and a large number of them topotypes. With the specimens already in our possession, these additions probably make our collection the most complete in existence.

A series of the mollusks of the Alabama river system, collected this year by Mr. H. H. Smith, has been purchased. It consists of about 17,000 specimens. These remain to be determined and installed.

During the spring the Special Curator explored a portion of central Cuba for mollusks, obtaining a collection of some 500 lots, about 10,000 specimens. This collection also remains to be studied.

The chief work in the Museum has been the revision of the African *Achatinidæ*. Much other work of correction and relabelling has been done in connection with studies on new material.

Four papers have been published in the *Proceedings* of the Academy by the Special Curator, one with Mr. Vanatta, and one in conjunction with Mr. Hirase, while ten have been published by the Special Curator in the *Nautilus*. These have chiefly dealt with the classification and description of new material.

The time of the Special Curator has been largely occupied, as hitherto, in the publication of the *Manual of Conchology*. The volume for this year treats of the African family *Achatinidæ*.

The efficient assistance of Mr. E. G. Vanatta in the work of the department throughout the year should be acknowledged.

H. A. Pilsbry,
Special Curator of the Department of Mollusca.

REPORTS OF THE SECTIONS.

Mineralogical and Geological Section.

The Section has this year kept up its meetings and field excursions even more zealously than last year, with about double the number of communications, one-third larger attendance on the meetings, one-half more on the excursions, and an increase of more than one-quarter in membership.

There have been nine meetings, with an average attendance of over 11. Communications were made by Miss Emma Walter, on old stream-beds; by B. S. Lyman, on the immense time indicated by erosion; by Prof. B. L. Miller, on graphite occurring in Chester County, Pa.; by B. S. Lyman, on the Bechtel graphite mine, near Boyerstown, Berks County, Pennsylvania; by Miss Mary S. Holmes, on the Virginia Natural Bridge; by B. S. Lyman, on topography an aid to geology; by Miss Emma Walter, on clay near Saylorsburg, Monroe County, Pennsylvania; by Mr. F. J. Keeley, on the trap of Cape Ann, Massachusetts; by Miss Mary S. Holmes, on some problems suggested by the excursion along the Perkiomen; by Mr. T. Chalkley Palmer, on serpentines of Delaware County, Pennsylvania; by Mr. F. J. Keeley, on serpentines under the microscope; and about 20 shorter communications, besides various discussions.

There were 7 field excursions, with an average attendance of 43. The excursions visited: 1. The crystalline rocks and their minerals, particularly kaolin, between Hockessin, Delaware, and Kennett Square, Chester County, Pennsylvania; 2. The crystalline rocks near Glen Mills and Lenni, on Chester Creek, and at Mineral Hill, Delaware County, Pennsylvania; 3. The crystalline rocks near Avondale, Strath-Haven, Rose Valley and Media, Delaware County, Pennsylvania; 4. Portions of the New Red Perkasie shales and Pottstown shales and trap, from Lodel Creek to Spring Mountain, near the Perkiomen, and Schwenksville, Montgomery County, Pennsylvania; 5. Portions of the New Red Norristown shales and Gwynedd shales, and some of the gneiss southward, between Noble Station and Doylestown; 6. The crystalline rocks near Newtown Square, Delaware County, Pennsylvania; 7. The crystalline rocks between Newtown Square and Media, Delaware County, Pennsylvania.

The membership of the Section has increased by ten in all, namely, seven contributors and three members of the Academy, one of whom became a member through his interest in the Section. The Section now contains 27 members of the Academy and 21 contributors, or 48 in all.

The following officers of the Section have been elected for the year 1905:

Director,	Benjamin Smith Lyman.
Vice-Director,	George Vaux, Jr.
Recorder and Secretary,	Miss Mary S. Holmes.
Treasurer,	Miss Emma Walter.
Conservator,	Frank J. Keeley.

Respectfully submitted by order of the Section,

Benj. Smith Lyman,
Director.

The Biological and Microscopical Section.

The numerical strength of the Section is the same as that of last year, two members having withdrawn and two having been admitted.

The interest in the regular sessions has been increased by the discussions at the informal meetings which have formed a pleasant feature of the year's work. Numerous communications have been made, among which may be especially mentioned those of Mr. F. J. Keeley on various accessories of microscopic manipulation; by Mr. T. C. Palmer on *Trachelomonas;* by Dr. D. E. Owen on dredgings in Saco Bay, and by Mr. Hugo Bilgram on *Myxomycetes*. Every member present has made an effort to offer at each meeting some object or subject which, if not new, has at least stimulated the work of others. A special topic which has occupied the attention of the Section is that of the microscopic structure of rocks.

The Conservator reports that the instruments belonging to the Section are in good working order, and the following additions have been made during the past year: One Zentmayer Portable Histological Stand, one Dissecting Microscope, one Beck Microscope Lamp, one Acme Microscope Lamp, one Balance, two large Slide Cabinets with Drawers, four small Slide Cabinets with Trays, some miscellaneous accessories and over 500 mounted slides, all presented by Mrs. Charles Shaeffer. One hundred and fifty-eight slides, prepared by L. Woolman, were presented by Mr. F. J. Keeley.

One Tolles $\frac{1}{50}$-inch Objective was purchased.

The officers elected for the following year are as follows:

Director,	J. Cheston Morris, M.D.
Vice-Director,	T. Chalkley Palmer.
Conservator,	F. J. Keeley.
Recorder,	C. S. Boyer.
Corresponding Secretary,	S. L. Schumo.
Treasurer,	Thomas S. Stewart, M.D.

Charles S. Boyer,
Recorder.

The Entomological Section.

Ten meetings were held with an average attendance of twelve persons. The communications made were of scientific interest, and have been published in the *Entomological News and Proceedings of the Entomological Section.* This journal has been continued and Volume XV completed with 352 pages and 20 plates. One hundred and five book or Schmitt boxes have been purchased, and three of the new tin pest-proof cases to hold them. Rearrangements have been made of portions of the collections and new material added by gift, purchase and exchange, to the number of over 7,000 specimens. The collection of Orthoptera has been increased by the presentation of nearly 500 specimens, the gift of Mr. Morgan Hebard. This order has also been enriched by the reception of over 700 specimens from Dr. Henri de Saussure, containing many genera and species new to the collection.

Valuable additions have been made to the cabinets by purchase, including 766 Orthoptera from Japan and the Loo Choo Islands; 274 Orthoptera from the Philippines; 1,000 Hymenoptera from Mexico; 342 Chilean Orthoptera, and 2,000 insects from Georgia, collected for the Academy by Mr. J. A. G. Rehn.

Three associates have been elected, and at the annual meeting, held December 22, the following persons were elected officers to serve for 1905:

Director,	Philip Laurent.
Vice-Director,	H. W. Wenzel.
Treasurer,	E. T. Cresson.
Recorder and Conservator,	Henry Skinner.
Secretary,	Frank Haimbach.
Publication Committee,	C. W. Johnson,
	J. H. Ridings.

Henry Skinner,
Recorder.

The Botanical Section.

During the year much progress has been made in the arrangement of the Herbarium, the collections now being in better condition and more readily accessible than ever before.

The erection of new cases in the centre of the south herbarium room has resulted in the rearrangement of all the flowering plants, thus relieving the congested condition of many of the cases.

The large case containing seeds, etc., formerly in the south room, has been moved to the north gallery room, where it is readily accessible to any one desiring to study its contents.

Over 18,000 sheets have been added to the collection during the year, acquired principally by purchase and exchange, although many liberal donations have been received.

These include the herbarium of the late Dr. Charles Schaeffer, containing his collections for many seasons in the British Columbia region, presented by Mrs. Mary S. Shaeffer; and the gift by Dr. Ida A. Keller of her entire herbarium, including a number of plants from Europe.

Smaller collections were received from Mr. Charles S. Williamson, from the eastern United States; Mr. Benjamin H. Smith, from south Florida; the United States National Museum and Messrs. Witmer Stone, E. G. Vanatta, Dr. Campbell E. Waters, Edward Potts, Henry S. Conard, and the Conservator. These are noted in detail in the *Additions to the Museum.*

The Section has purchased a collection of 178 sheets of Washington plants from Mr. Henry S. Conard, and 365 sheets of California plants from Mr. A. A. Heller, the collections of the past season, containing many novelties.

The important collection made by Mr. Herbert H. Smith in the Santa Marta region of Colombia has been purchased by the Academy, and numbers 2,500 sheets; also the West African collections of Dr. Pritzel, numbering 1,776 sheets, and the herbarium of Alexander MacElwee, acquired through purchase and exchange, numbering approximately 10,000 sheets, a considerable proportion of which are mounted.

The Academy's expeditions added 450 sheets, as follows:

Thomasville, Georgia, 50 sheets, collected by Mr. J. A. G. Rehn; Cuba and southern Florida, 125 and 25 respectively, collected by Dr. H. A. Pilsbry, and from the Florida keys, 250 sheets, collected by the Conservator.

All the specimens received have been poisoned, and a considerable number mounted and distributed through the Herbarium.

The series of field excursions conducted during April and early May by the Conservator were largely attended.

Much assistance was rendered during the year to students and visiting botanists desiring to consult the collections.

The Philadelphia Botanical Club has continued to hold its meetings during the year, its members having contributed over 400 sheets to the local Herbarium, which collection has been placed in excellent condition through the unremitting labors of Mr. Samuel S. Van Pelt.

At the meeting of the Section held December 13, 1904, the following were elected as officers for the ensuing year:

Director,	Mr. Benjamin H. Smith.
Vice-Director,	Mr. Joseph Crawford.
Recorder,	Dr. Ida A. Keller.
Secretary,	Mr. John T. Pennypacker.
Treasurer and Conservator,	Stewardson Brown.

Respectfully submitted,

STEWARDSON BROWN,
Conservator.

THE ORNITHOLOGICAL SECTION.

The ornithological collections of the Academy were never in better condition nor more accessible to the student than at present.

During the past year three additional exhibition cases have been erected in the new gallery, permitting the transfer of the entire series of Raptorial birds, as well as the Pigeons. The rearrangement and labelling of the former group has been completed and many duplicate specimens not required for exhibition have been arranged in the study series. At the present time only the Passerine and Picarian birds remain in the old building, and the majority of these will be transferred next year.

Thirteen additional tin storage cases and ten wooden cases have been provided for the accommodation of the study collection, greatly facilitating the arrangement of many groups, especially the birds of prey, and providing needed space for the numerous accessions.

The Conservator has examined practically all the large bird skins during the year, and carefully rearranged the old unmounted material which has been listed to facilitate consultation.

Many important additions have been made to the collection, foremost among which is a series of 360 Philippine birds purchased by the Academy; a handsome collection of mounted Humming-birds, the gift of Calvin Pardee, Esq., and collections from the West Indies, Colorado and California, presented respectively by Dr. J. Percy Moore, Robert T. Young and W. O. Emerson.

The Delaware Valley Ornithological Club has continued to hold its meetings at the Academy, and has done much to stimulate ornithological study. The collections have been largely consulted during the year, and considerable assistance has been rendered to visiting ornithologists.

The Conservator would acknowledge valuable assistance in the care of the collections to Mr. Paul L. Lorrilliere.

At the annual meeting of the Section, held December 19, 1904, the following officers were elected:

Director, ...	Spencer Trotter, M.D.
Vice-Director, ...	George S. Morris.
Secretary, ...	William A. Shryock.
Recorder, ...	Stewardson Brown.
Treasurer and Conservator, . . .	Witmer Stone.

WITMER STONE,
Conservator.

The annual election of Officers, Councillors and Members of the Committee on Accounts to serve during 1905 was held with the following result:

PRESIDENT, ...	Samuel G. Dixon, M.D.
VICE-PRESIDENTS, ...	Arthur Erwin Brown, 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, Samuel G. Dixon, M.D. Henry A. Pilsbry, Sc.D. William S. Vaux, Jr.

Councillors to serve three years,	Thomas H. Fenton, M.D. Edwin S. Dixon, John Cadwalader, William Sellers.
Committee on Accounts, . . .	Charles Morris, Samuel N. Rhoads, Dr. C. Newlin Peirce, John G. Rothermell, Howard Crawley.
Councillor to serve for unexpired term of two years, . . .	Frederick Prime.

COUNCIL FOR 1905.

Ex-officio.—Samuel G. Dixon, M.D., Edwin G. Conklin, Ph.D., Arthur Erwin Brown, Edward J. Nolan, M.D., J. Percy Moore, Ph.D., George Vaux, Jr., Henry A. Pilsbry, Sc.D., and William S. Vaux, Jr.

To serve Three Years.—Thomas Fenton, M.D., Edwin S. Dixon, John Cadwalader and William Sellers.

To serve Two Years.—Dr. C. Newlin Peirce, Philip P. Calvert, Ph.D., Thomas Biddle, M.D., and Frederick Prime.

To serve One Year.—Thomas A. Robinson, Charles B. Penrose, M.D., Charles Morris, Isaac J. Wistar.

Curator of Mollusca, . . .	Henry A. Pilsbry, Sc.D.
Assistant Librarian, . . .	William J. Fox.
Assistants to the Curators, . .	Witmer Stone, Henry Skinner, M.D., Stewardson Brown, J. Percy Moore, Ph.D., Edward G. Vanatta, Henry W. Fowler, J. A. G. Rehn, H. Newell Wardle.
Taxidermist, ...	David McCadden.
Jessup Fund Students, . . .	H. Newell Wardle, J. A. G. Rehn, Paul L. Lorrilliere.

Janitors, ... Charles Clappier,
Daniel Heckler,
James Tague,
Jacob Aebley.

ELECTIONS DURING 1904.

MEMBERS.

January 19.—Harold Sellers Colton, James K. Clarke, Walter B. Smith, William Morgan, Gilbert Van Ingen, Frank P. Hendley.

March 15.—Henry Tucker, M.D., Waldemar Lee.

April 19.—Everett F. Phillips, Herbert Guy Kribs, Henry R. M. Landis, M.D.

May 17.—Henry D. Jordan, M.D., James Harold Austin.

October 18.—Mrs. Charles Roberts, M. F. McDonough, Charles D. Hart, M.D.

CORRESPONDENTS.

October 18.—Frantisek Vijdovsky, of Prague; A. A. W. Hubrecht, of Utrecht.

ADDITIONS TO THE MUSEUM.

Archæology.

Bishop Museum (in exchange). A collection of tapa cloths, Hawaiian Islands.

H. W. Hand. A piece of tapa cloth.

Allen Irwin. Collection of boomerangs, Solomon Island spears, shield, etc.

Clarence B. Moore. Numerous specimens from the Florida mounds.

Mrs. Charles Schäffer. Collection of Indian baskets, etc., and Chilkat blanket.

Lt. Frederick Schober. Twenty-two lots of archæological specimens, Samoa, Alaska, Japan, etc.

Mrs. James M. Willcox. Indian vessel, mound at Mecklenberg, Va.

Mammals.

Jacob Aschenbrand. Mounted Fox Terrier.

W. E. Hughes, M.D. Little Chief Hare (*Ochotona princeps*), Idaho.

P. L. Lorilliere. Muskrat (*Fiber zibethicus*), Collingdale, Pennsylvania.

Charles J. Pennock. Six Muskrats, Delaware.

R. A. F. Penrose, Jr. Mounted Jack Rabbit.

Purchased. Five skins and skulls of *Oryzomys palustris*, Salem county, New Jersey; three Deer, two Peccaries and several skulls, from Mexico.

Purchased (for mounting). Puma (*Felis concolor oregonensis*), two Musk Oxen (*Ovibos moschatus wardi*), three Mountain Sheep (*Ovis canadensis cremnobates*), one Mindoro Buffalo (*Bubalis mindorensis*), male Bison (*Bison bison*).

J. A. G. Rehn (Academy Expedition to Georgia). Two skins and skulls of *Lepus floridanus*, Thomasville, Georgia.

Samuel N. Rhoads. Two black Muskrats (*Fiber zibethicus*), Audubon, New Jersey.

Mrs. Charles Schäffer. Human skeleton, mounted.

Mrs. Charles Schäffer (on deposit). Collection of mounted heads of mammals and two skins.

E. G. Vanatta. Four skulls of Muskrats (*Fiber zibethicus*), Chestertown, Maryland.

C. S. Welles. Deer Mouse (*Peromyscus leucopus*), Delaware county, Pennsylvania.

Zoological Society of Philadelphia. Specimens prepared as follows: Mounted: Flat-headed Cat (*Felis planiceps*), Cat Squirrel (*Sciurus niger*), Long-tailed Porcupine (*Hystrix longicaudata*), Spotted Dasyure (*Dasyurus maculatus*), Common Dasyure (*D. viverrinus*), Prong-horned Antelope young (*Antilocapra americana*), African Buffalo (*Bos caffer æquinoctialis*). To be mounted: Kangaroo (*Macropus robustus*), *Semnopithecus* sp., Thick-tailed Gallago (*Gallago crassicaudata*), Mongoose Lemur (*Lemur mongoz*), Sambur Deer (*Rusa unicolor*). Skin and skull: Two Vulpine Phalangers (*Trichosurus vulpecula*), Texan Wild Cat (*Lynx ruffus texensis*), Stanley's Chevrotain (*Tragulus stanleyanus*), Spotted Chevrotain (*Tragulus memmina*), Binturong (*Arctictis binturong*), Siberian Marmot (*Arctomys bobac*), young Puma (*Felis concolor*), Indian Antelope (*Antilope cervicapra*), Kangaroo Rat (*Dipodomys* sp.), Deer Mouse (*Peromyscus texanus*). Skin and skeleton: Female Bison (*Bison bison*), Formosan Macaque (*Macacus cyclopis*), two Rocky Mountain Goats (*Oreamnos montanus*), skull of young Bison (*Bison bison*), skin of Black Bear (*Ursus americanus*), skeleton of Antelope (*Antilocapra americana*). Alcoholic: Echidna (*Tachyglossa aculeata*), young Vulpine Phalanger (*Trichosurus vulpecula*), young Pig-tailed Macaque (*Macacus nemestrinus*), young Kangaroo (*Macropus robustus*).

Birds.

E. Allen. Wood Thrush (*Hylocichla mustelina*).

C. B. Moore (collected by S. Brown and H. W. Fowler). Skins of *Centurus carolinus* and *Ardea occidentalis*.

W. O. Emerson. Seventy-five skins of Californian birds.

W. E. Hughes, M.D. Two skins of *Dendroica cærulea* and two of *Buteo lineatus*, Choptank Mills, Delaware.

William M. Mfigs. Two skins of Caracara from Florida.

J. Percy Moore. Collection of bird skins from Jamaica and Bahamas.

Calvin Pardee. A collection of mounted Humming-birds and a Lyre-bird.

C. J. Pennock. Three Grebes (*Podilymbus podiceps*), Delaware.

Purchased. Three hundred and seventy skins of Philippine birds.

Carlos S. Reed. Two bird's eggs, Chili.

J. A. G. Rehn (Academy Expedition to Georgia). Collection of bird skins, Thomasville, Georgia.

Mrs. Charles Schäffer. Collection of mounted birds.

Mrs. F. Schick. Case of mounted birds.

A. B. van der Weilen. Four skins of Wyoming birds.

Joseph Willcox. Skin of White-tailed Kite (*Elanus leucurus*).

Robert T. Young. Fifteen bird skins, Boulder, Colorado.

Zoological Society of Philadelphia. Skins of the following: *Pternistes leucoscepus*, *Cereopsis novæ-hollandiæ*, *Cissa chinensis*, *Anser anser*, *Trupialis superciliosus*, *Zonotrichia leucophrys*, *Icterus bullocki*, *Ajaia ajaia*, *Dryonastes chinensis*, *Anthropoides virgo*, *Euphonia laniirostris*.

Reptiles.

Albert Alber. Horned Toad (*Phrynosoma blainvillei*).

William M. Beeckley. *Tantilla coronata*, Florida.

Mrs. P. P. Calvert. Rattlesnake and House Snake swallowing Water Snake, Pennsylvania.

H. C. Chapman, M.D. Specimens of *Menobranchus* and *Siren*.

Otto Eggeling. Two *Chondrotes tenebrosus*, Felton, Santa Cruz county, California.

H. W. Fowler. Snapping Turtle (*Chelydra serpentina*), Holmesburg, Philadelphia.

H. W. Fowler and Thomas D. Keim. Several reptiles, Port Alleghany, Pennsylvania.

W. E. Hughes, M.D. Two specimens of Skinks (*Eumeces fasciatus*).

Charles Leby. *Phrynosoma blainvillei.*

Carlos S. Reed. Two specimens of batrachians, Chili.

J. A. G. Rehn (Academy Expedition to Georgia). Collection of reptiles and batrachians, Thomasville, Georgia.

Zoological Society of Philadelphia. Two spiny soft-shelled Turtles (*Aspidonectes spinifer*), *Zamenis mucosus*, *Viper* sp., *Crotalus scutulatus*, Rough-eyed Caiman (*C. sclerops*), *Varanus bengalensis.*

Fishes.

Charles C. Abbott, M.D. Jar of fishes from the vicinity of Trenton, N. J.

Captain E. E. Bates. *Hippocampus*, Key West, Florida.

Dr. Bergen. Gold Fish.

C. B. Moore (collected by S. Brown and H. W. Fowler). Collection of fishes, Florida Keys.

H. C. Chapman, M.D. *Hippocampus.*

James K. Clarke. Jar of fishes from Florida.

H. W. Fowler. Collections of fishes, Holmesburg, Philadelphia; Crosswicks Creek, New Jersey; Neshaminy Falls and Kennett Square, Pennsylvania. Collection of breeding Suckers. Collection of marine fishes, Grassy Sound, New Jersey. Series of fresh-water fishes, Chadd's Ford, Pennsylvania.

H. W. Fowler and Thomas D. Keim. Six jars of fishes, Port Alleghany, Pennsylvania.

H. W. Fowler and Witmer Stone. Collection of fishes from Speedwell, New Jersey.

William Friedericks. Gold Fish.

Asa Hodgkins. Jaws of a Shark (*Lamna cornutum*), Bar Harbor, Maine.

Philip Laurent. Three dried fishes.

Leland Stanford University. Large series of Japanese fishes.

William E. Meehan. Five Sticklebacks.

Petrel Fishing Company. A collection of fishes from Nantucket.

C. P. Ray, Jr. Jar of fishes.

J. A. G. Rehn (Academy Expedition to Georgia). Collection of fishes, Thomasville, Georgia.

C. Schmalzried. Gold Fish.

Benjamin Sharp, M.D. Jar of gobioid fishes, Swatow, China.

E. I. Simpson. Two fishes, Salem, New Jersey.

Visitor. Burr Fish, Atlantic City, N. J.

H. T. Wolf. Two jars of fishes, Dingman's Ferry, Pennsylvania; Moor Gold Fish.

Mollusca.

Helen Abbott. Fifteen species of land and fresh-water shells from Lake Minnetonka, Minnesota.

John A. Allen. Fifty-nine trays of land and fresh-water shells from Maine and Ohio.

REV. E. H. ASHMUN. Seven species of land shells from Arizona, Idaho and Mexico.

F. C. BAKER. Six species of *Lymnæa* and a *Testacella* from Illinois.

P. BARTSCH. *Polygyra hopetonensis* Shutt. from Brighton, Virginia.

C. E. BEECHER. Forty-nine sets of fresh-water shells.

C. R. BIEDERMAN. Four species of land and fresh-water shells from Arizona.

A. C. BILLUPS. *Pyramidula alternata* Say from Calhoun Falls, South Carolina.

STEWARDSON BROWN. Two species of land shells from York county, Pennsylvania.

F. W. BRYANT. *Physa virgata* Gld. from Lakeside, California.

OWEN BRYANT. *Vitrea lucida* Drap. from the Botanical Garden, Bermuda.

H. C. CHAPMAN, M.D. *Mya arenaria* L. and *Purpura lapillus* L. from Bar Harbor, Maine.

T. D. A. COCKERELL. Five species of mollusca from California and New Mexico.

GEORGE H. CLAPP. Fifty-one sets of land shells from Alabama.

O. COLLETT. Twenty-five jars of land shells from Ceylon.

H. S. COLTON. Thirty-one lots of marine shells from Mt. Desert, Maine.

ANNIE P. COPE. Two species of *Muricidæ* from Flint Island.

W. H. DALL, M.D. *Lymnæa atkensis* Dall from Alaska and six species of *Cerion* from Bermuda.

L. E. DANIELS. Fifteen trays of American *Pisidium* and seven species of other American land and fresh-water shells.

C. ABBOTT DAVIS. Thirty-seven sets of Bermuda shells.

I. N. DE HAVEN. *Oreohelix cooperi* W. G. B. from Yellowstone Park.

S. G. DIXON, M.D. Three species of *Polygyra* and *Pyramidula* from Cranberry, North Carolina.

J. H. FERRISS. One hundred and forty trays of land shells from Arizona and New Mexico.

W. H. FLUCK. Four species of marine shells from Nicaragua.

DR. GRABHAM. Thirty-one lots of land and marine shells from Madeira.

H. A. GREEN. Two species of *Polygyra* from Tryon, North Carolina.

R. E. GRIFFITH, M.D. Four species of marine shells.

G. K. GUDE. Four species of Asiatic land shells.

A. GULICK. Twelve trays of fossil land shells from Bermuda.

MRS. FRANK GUPTIL. *Odostomia impressa* Say and two other marine shells from Osprey, Florida.

MISS A. C. HARTSHORNE. One hundred and three trays of Japanese shells.

H. HEATH. One jar of *Cymbuliopsis vitrea* Heath from Monterey Bay, California.

MORGAN HEBARD. Seven species of land shells from Key West, Florida, and Nassau, New Providence.

J. B. HENDERSON, JR. Three species of *Urocoptis* from Haiti and Jamaica.

JUNIUS HENDERSON. Thirty-one lots of land and fresh-water shells from Colorado.

A. A. HINKLEY. Eighty-five sets of fresh-water shells from Alabama.

Y HIRASE. Six hundred and forty-one species of Japanese land and marine shells.

WILLIAM E. HUGHES, M.D. *Polygyra ptychophora* from the Bitter Root Mountains, Idaho.

P. W. Jarvis. Seventy-eight trays of Jamaican *Urocoptis*.

C. W. Johnson. *Anoma radiata* Chitty from Jamaica.

T. D. Keim and H. W. Fowler. Seventeen species of land and fresh-water shells from McKean county, Pennsylvania.

Ida A. Keller, Ph.D. Two species of marine shells from New Jersey.

R. J. Kirkland, M.D. Twenty-six trays of *Pisidium* from Michigan.

C. M. Latourette. *Limax maximus* L. from Oak Lane, Pennsylvania.

Herbert N. Lowe. One Chiton.

D. N. McCadden. *Fulgur perversum* L. from Stone Harbor, New Jersey.

Mrs. M. C. W. Merrihew. Three species of *Muricidæ* from Newport, California, in exchange.

Thomas H. Montgomery, Jr., Ph.D. Eleven species of land and fresh-water shells from Austin, Texas.

Clarence B. Moore. Three hundred and thirty lots of shells from the Florida Keys and adjacent mainland, including one hundred and fourteen collected by Messrs. Brown and Fowler.

A. E. Ortman. Two species of fresh-water shells from Western Pennsylvania

George A. Phillips, M.D. *Zirphæa crispata* L., in alcohol from Bar Harbor, Maine.

H. A. Pilsbry, Sc.D. Two hundred and seventy trays of shells from Florida.

George Pine. Two lots of *Unio* and *Ampullaria* from Florida.

John Ponsonby. *Dorcasia* and *Coptocheilus* in alcohol.

Edw. Potts. Twenty-three trays of marine shells from Tarpon Springs, Florida, collected by W. Beeckley.

Princeton Patagonian Expedition. Fifty-seven species of marine and fresh-water shells.

Purchased. A set of *Polygyra vannostrandi* Bland from Aiken, South Carolina; three hundred and thirty-nine trays of Californian shells, collected by H. Hemphill; large collection of land and fresh-water shells from Alabama.

P. B. Randolph. Three slugs from Alaska.

C. Paul Ray, Jr. Six species of land and fresh-water shells from Sparrow Lake, Canada.

J. A. G. Rehn (Academy Expedition to Georgia). Three species of land and fresh-water shells from Thomasville, Georgia.

S. N. Rhoads. Thirty-five trays of land and fresh-water shells from Delaware and Mexico.

John Ritchie, Jr. Eight species of land and fresh-water shells from Nevada, Mauritius and Japan.

S. Raymond Roberts. One specimen of *Ampullaria* and a *Hyalea* from Japan.

Mrs. T. E. Ruggles. *Nacella mytilina* Helb.

William P. Seal. *Planorbis magnificus* Pils. from Wilmington, North Carolina.

C. T. Simpson. *Pleurodonta gigantea* Scop. from Haiti.

Miss Ruth Spencer. *Goniobasis proxima* Say from Green River, North Carolina.

Dr. V. Sterki. Eleven trays of *Pisidium*.

Curwen Stoddart, Jr. *Polinices heros* Say from Prout's Neck, Maine.

Rev. H. H. Thomas. Nine species of land and marine shells from New Jersey and New York (in exchange).

E. G. VANATTA. *Philomycus carolinensis* Bosc. from New Garden, Pennsylvania.

T. VAN HYNING. Twenty-one sets of land and fresh-water shells from Des Moines, Iowa.

H. L. VIERECK. *Arca* and *Planorbis* from Connecticut and North Carolina.

BRYANT WALKER. Eighteen trays of *Pisidium* and sixteen other fresh-water shells from the Eastern States.

REV. W. H. WEBSTER. *Calliostoma pellucidum* Val., Devonport, New Zealand.

H. W. WENZEL. Four *Polygyra* from Pennsylvania and New Jersey.

JOSEPH WILLCOX. Forty-nine trays of shells from North Carolina and Florida.

H. T. WOLF. Five species of land and fresh-water shells from Dingman's Ferry, Pennsylvania.

INSECTS.

AUSTRALIAN MUSEUM. Sixty-seven Orthoptera (exchange).

C. F. BAKER. Eighty-six Orthoptera, California, Nicaragua.

W. J. BAUMGARTNER. Three Orthoptera, Illinois.

W. M. BEECKLEY. One Hemiptera, one Orthoptera, Florida.

C. R. BEIDERMAN. Two thousand five hundred insects, Arizona (purchased).

W. L. BLATCHLEY. Ninety-four Orthoptera, Indiana, Florida.

W. E. BRITTON. Thirteen Hemiptera, Connecticut.

P. P. CALVERT. Six Lepidoptera, Pennsylvania; ten Hymenoptera, Africa.

D. M. CASTLE. Five Coleoptera, Florida; four Hymenoptera.

J. D. CHANDLER. Four Coleoptera.

T. D. A. COCKERELL. Fourteen Orthoptera, Colorado; one Hemiptera, New Mexico; *Kermes gillettei* type, Colorado.

E. DAECKE. One Lepidoptera, New Jersey; one gall, New Jersey; two Diptera, New Jersey; ten Lepidoptera, Germany.

E. DIETRICH. Two hundred and seventy-four Orthoptera, Philippines (purchased).

S. G. DIXON. Three Lepidoptera, Pennsylvania.

CHARLES DURY. Four Coleoptera, Ohio.

SIGMUND GRAENICHER. Twenty Hymenoptera, Wisconsin.

G. M. GREENE. Four Coleoptera, Pennsylvania.

F. HAIMBACH. Four Diptera, Philadelphia.

R. V. HARVEY. Twenty-seven Hymenoptera, Colombia.

M. HEBARD. Two Lepidoptera, Michigan; two hundred and seventy-four Orthoptera, North America; two hundred and eleven Orthoptera, Georgia, Florida.

Y. HIRASE. Three hundred and twenty-five Orthoptera, Japan; four hundred and thirty-one Orthoptera, Loo Choo Islands (purchased).

H. HORNIG. Five Lepidoptera, New Jersey.

W. D. HUNTER. Twenty-five Coleoptera, Texas.

LOUIS JACKSON. One Orthoptera, Philadelphia.

UNIVERSITY OF KANSAS. Sixteen Orthoptera.

W. D. KEARFOOT. Forty Lepidoptera, United States.

P. LAURENT. One Lepidoptera, Philadelphia.

J. F. MCCLENDON. One thousand Hymenoptera from Mexico (purchased); six hundred and forty-six insects from Mexico.

Marian Mackenzie. One Lepidoptera, Cuba.

W. M. Meigs. Five Lepidoptera, Florida.

L. W. Mengel. Nine Lepidoptera, East Indies.

L. Navas. Eighty-two Odonata, Spain.

W. D. Pierce. One Coleoptera, Nebraska.

H. A. Pilsbry. Ten insects, Cuba.

C. S. Reed. Three hundred and forty-two Orthoptera, Chili (purchased); sixty-two insects, Chili.

J. A. G. Rehn. Two thousand insects, Georgia (Academy expedition); one Coleoptera, Philadelphia.

Wirt Robinson. Twenty-four insects, Cuba.

Henri de Saussure. Seven hundred and sixty-seven Orthoptera, Mundus.

Charles Schäffer. Three Coleoptera, Texas.

E. A. Schwarz. One Coleoptera, Arizona.

W. J. Seal. Twenty-five Diptera, New Jersey.

F. Sharpless. Two insects, South America.

Henry Skinner. Fifteen Lepidoptera, New Jersey; nineteen Lepidoptera, British Columbia.

B. H. Smith. Ninety-six insects, Florida.

Witmer Stone. One Orthoptera, Pennsylvania.

H. L. Viereck. One Diptera, New Jersey.

H. W. Wenzel. One hundred and three Coleoptera, Pennsylvania; seventeen Lepidoptera, New Jersey; two Coleoptera, New Jersey.

Joseph Willcox. Thirty-six insects, Florida; twenty-five insects, Pennsylvania.

J. D. Windsor. Ten Hymenoptera, Pennsylvania.

H. J. Wolf. Fifteen insects, United States.

Other Invertebrates.

Helen Abbott. *Helicopsyche arenifera*, Lake Minnetonka, Minnesota.

John A. Allen. *Cypris*, Nesqually, Washington.

Capt. E. E. Bates. *Palinurus*, Key West, Florida.

Francis Beeckley. *Limulus*, Tarpon Springs, Florida.

William M. Beeckley. *Spirobolus marginatus*, Florida.

C. Biederman. One bottle *Allolobophora*.

H. C. Chapman, M.D. Three parasitic Worms, two vials of parasitic Nematodes.

H. W. Fowler. *Macrobdella decora*, Trenton, New Jersey; *Ascaris* and *Placobdella; Cambarus bartoni* and *robustus*, Port Alleghany, Pennsylvania.

G. M. Gray. *Autolytus cornutus*.

Miss A. C. Hartshorne. Two lots of Crustacea, Sagami, Japan.

Junius Henderson. *Helicopsyche arenifera*, Colorado.

T. H. Montgomery, Jr., Ph.D. *Sabelleria*, Florida.

J. P. Moore. Forty-five bottles of Polychæta, fifty-seven bottles of Nereidæ, ninety-three bottles of Leeches.

Clarence B. Moore. Twelve lots of invertebrates from Florida Keys, collected by Messrs. Brown and Fowler.

Miss Caroline W. Murphy. Starfish, Point Pleasant, New Jersey.

A. E. Ortman. Collection of Crawfish.

Charles B. Penrose, M.D. Four species of Nematodes and Cestodes, two parasites.

H. A. Pilsbry. Nineteen lots of invertebrates from the United States and Cuba.

Edward Potts. Scorpion and *Siphostoma fuscum*, Florida; collection of mounted slides of fresh-water slides, being the types of his species.

Maj. Robert P. Robins. Two glass Sponges, Philippines.

Mrs. Chas. Schäffer. Collection of microscopical slides.

James Tague. *Phagocata gracilis*, Philadelphia.

H. A. Linville. *Placobdella rugosa.*

U. S. Fish Commission. Four bottles of Polychæta, including co-types of three species, several bottles of Serpulidæ and *Pœcilasma kaempferi.*

H. L. Viereck. Two specimens of *Nautilograpsus minutus*, Cape May, New Jersey.

B. Walker. *Rhynchodemus*, Michigan.

Joseph Willcox. *Nereis*, Florida; *Erpobdella punctata*, Little Sarasota Bay, Florida.

Fossil Invertebrates.

R. E. Griffith, M.D. A set of Pentremites.

Frank J. Keeley. A specimen of rock containing bones and shells from Durham Furnace, Pennsylvania.

A. L. McDonald. Thirty-six trays of fossils from St. Joseph, Missouri (in exchange).

T. Van Hyning. *Polygyra albolabris* Say from a deposit opposite Fort Madison, Iowa.

Joseph Willcox. *Polygyra carpenteriana* in rock from Manatee county, Florida, and *Mitra carolinensis* Conr. from Duplin county, North Carolina.

Lewis Woolman. Fifteen fossils from United States and England.

Vertebrate Fossils.

Harvey J. Mitchell. Fossil fish remains.

Plants.

American Philosophical Society (on deposit). Collections of plants from the herbaria of Muhlenberg, Barton, Lewis and Clarke, Short, Pursh, Baldwin, Mary Forest, and five volumes marked *Herbarium Britanicum* by G. Don, and *Herbarium Americanum*, 1795, all received in 1897, and one package of Muhlenberg Mosses, received in 1904.

Botanical Section. One hundred and seventy-eight Washington plants, three hundred and sixty-five Californian plants.

Stewardson Brown. One hundred and fifty species, Pennsylvania and New Jersey.

Henry S. Conard. *Artemisia gnaphaloides.*

Campbell E. Waters, Ph.D. Fifty sheets of ferns.

Ida A. Keller, Ph.D. One thousand five hundred sheets of plants in case.

Edward Potts. Flowers of *Grevillea robusta*.

Purchased. H. H. Smith collection, two thousand five hundred sheets, from Santa Marta, Colombia; Alexander McElwee herbarium, ten thousand sheets, mainly North America.

John T. Reeder. *Agaricus* from mine at Calumet, Michigan.

Mrs. Charles Schäffer. One thousand plants from British Columbia, herbarium of Dr. Charles Schaeffer.

Benjamin H. Smith. One hundred and eighty-eight Florida plants and two European species.

Witmer Stone. Twenty-nine species from Choptank Mills, Delaware, and fifty-eight sheets of local Violets.

U. S. National Museum. Forty-three sheets of Fungi, Williams collection.

E. G. Vanatta. Sixty-five species of Maryland plants.

C. S. Williamson. Two hundred and seventy-two North American plants.

Rev. Milton Waldo. Distorted branch of Water Beech.

J. A. G. Rehn (Academy expedition to Georgia). Fifty sheets.

H. A. Pilsbry (Academy expedition to Cuba). One hundred and forty-eight sheets.

Stewardson Brown (Clarence B. Moore expedition to Florida). Two hundred and fifty sheets.

Minerals, Etc.

Mrs. E. J. Bartol. Piece of flexible Sandstone.

Harry T. Carson. Mineral specimen.

S. G. Dixon, M.D. Magnetic Iron Ore, Cranberry, North Carolina.

Fritz Gleim. Specimens of Pyrite, Elba, Italy.

M. E. Griffith. Several specimens of minerals.

John T. Reeder. Specimens of native sheet Copper, Calumet, Michigan.

Joseph C. Roop. Water from phosphorescent lake in Bahamas.

Mrs. Charles Schäffer. Collections of minerals and rocks.

George Vaux, Jr. Ores from silver mines of British Columbia.

Wm. S. Vaux Collection. A number of specimens purchased.

Visitor. Chrysocolla, Arizona.

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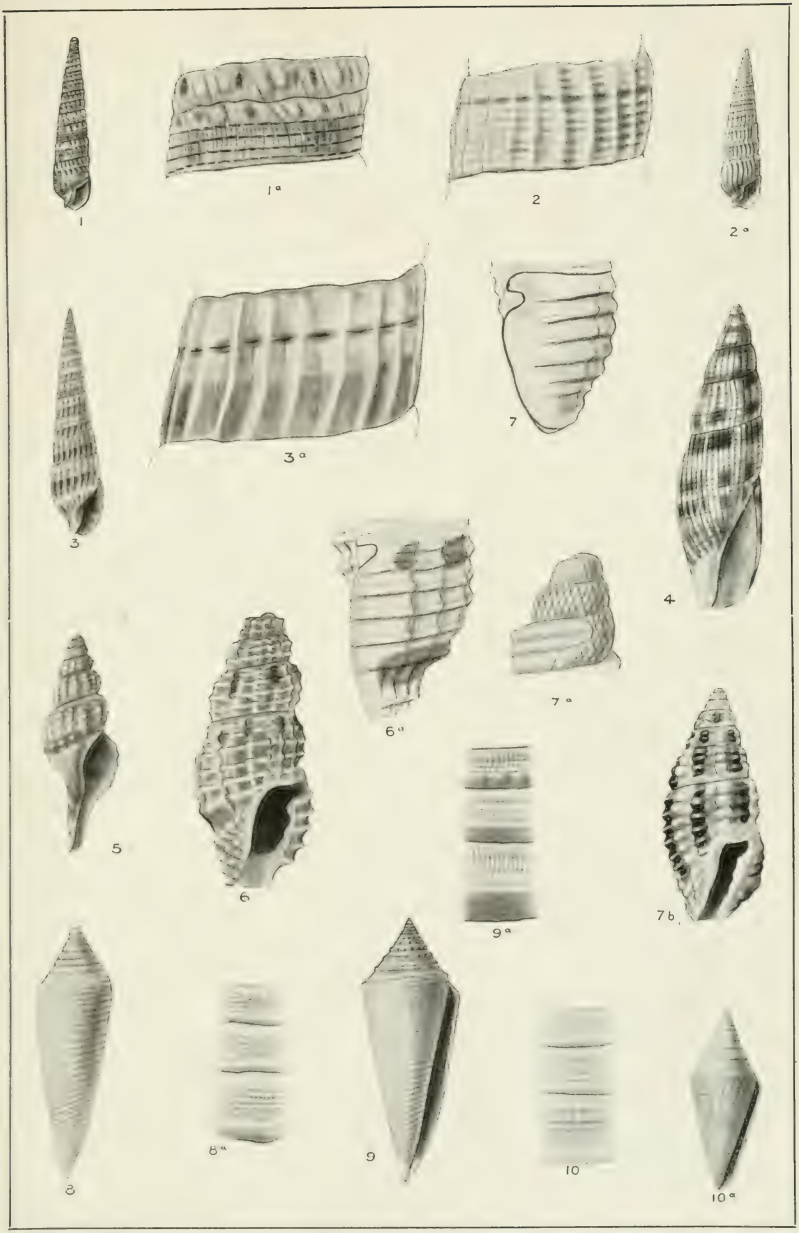

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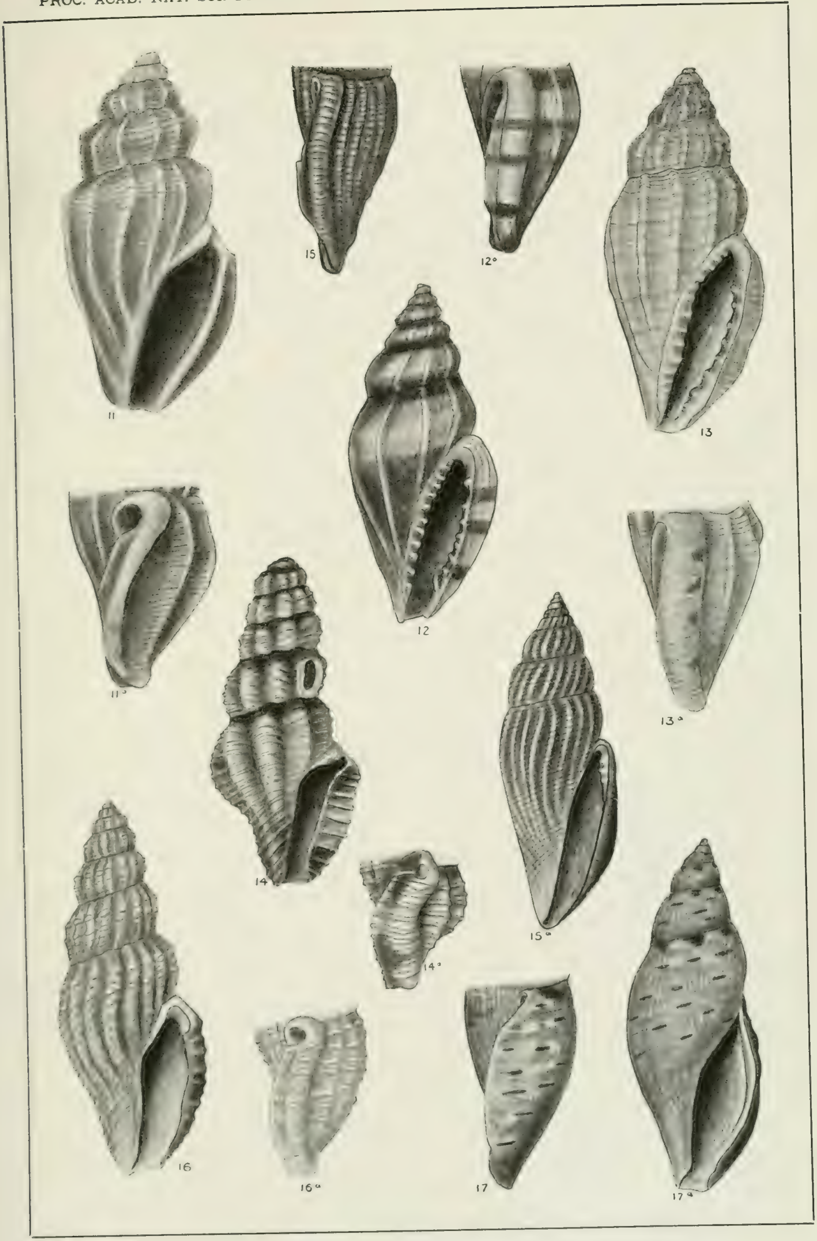

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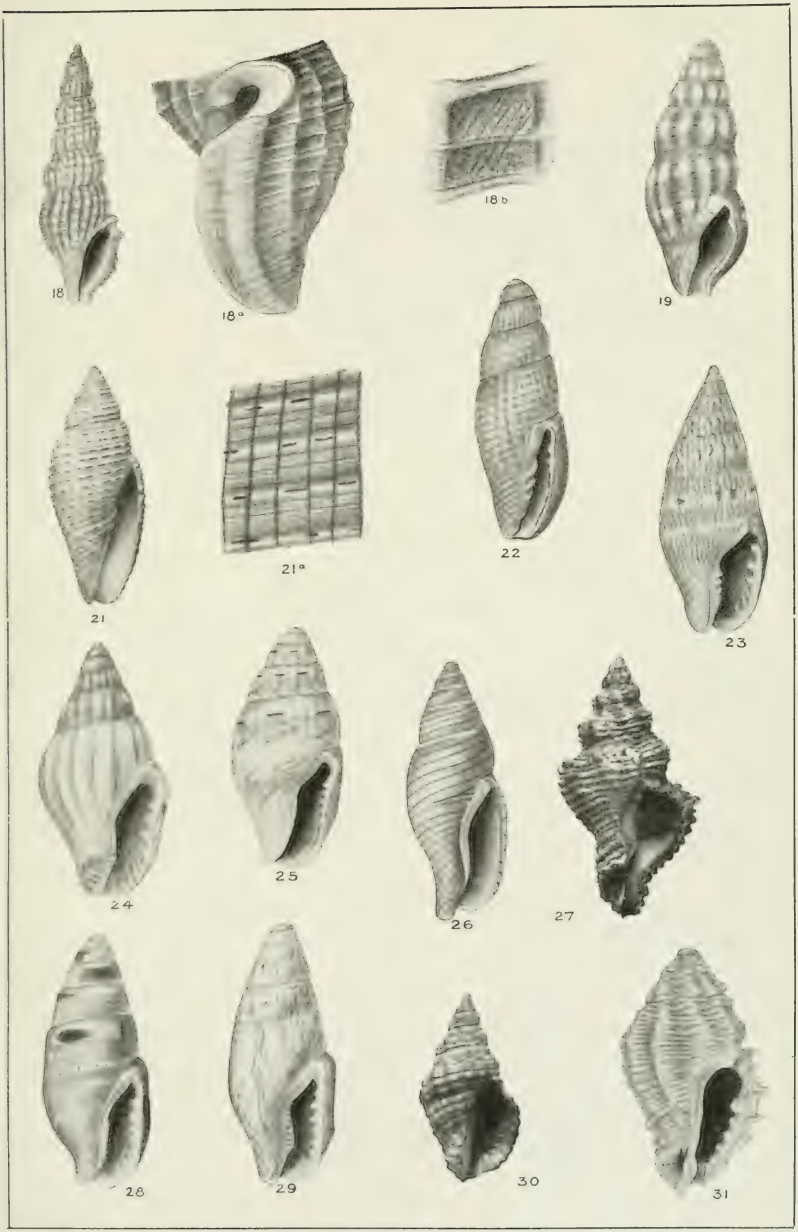

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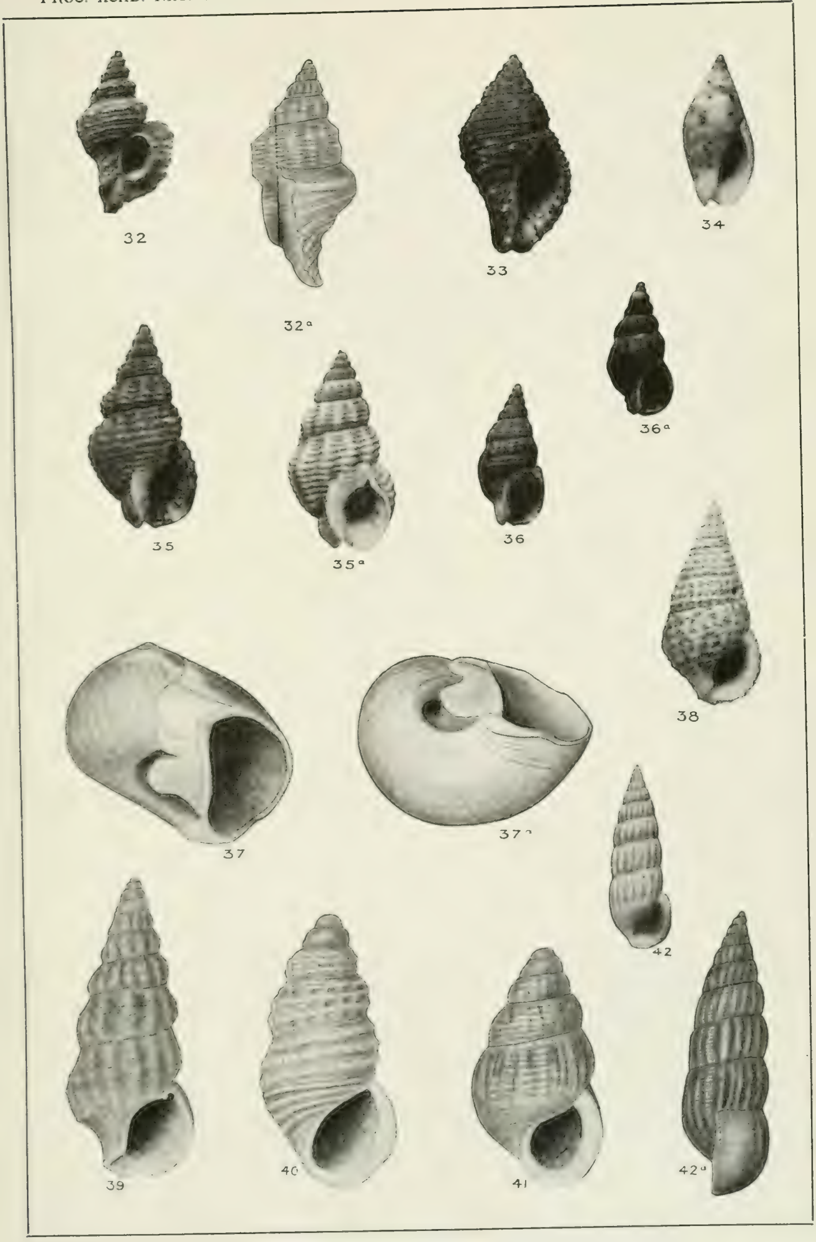

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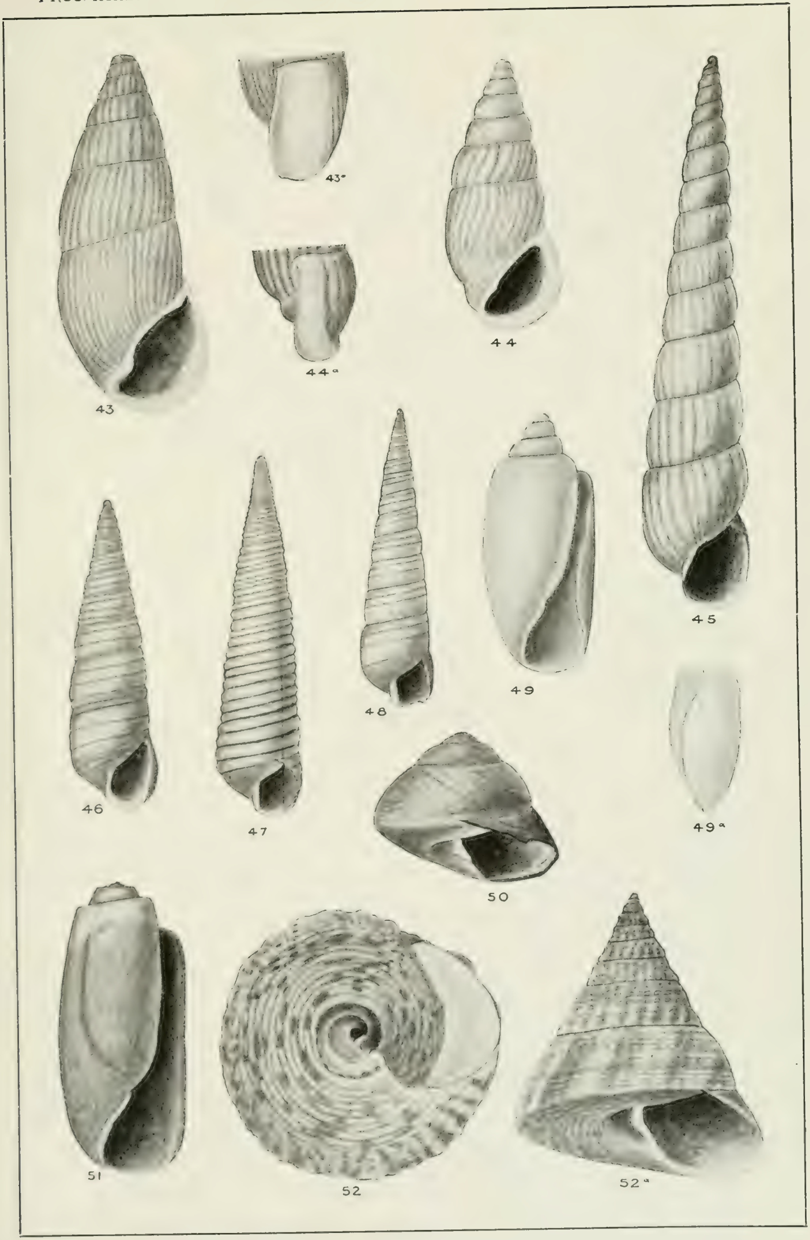

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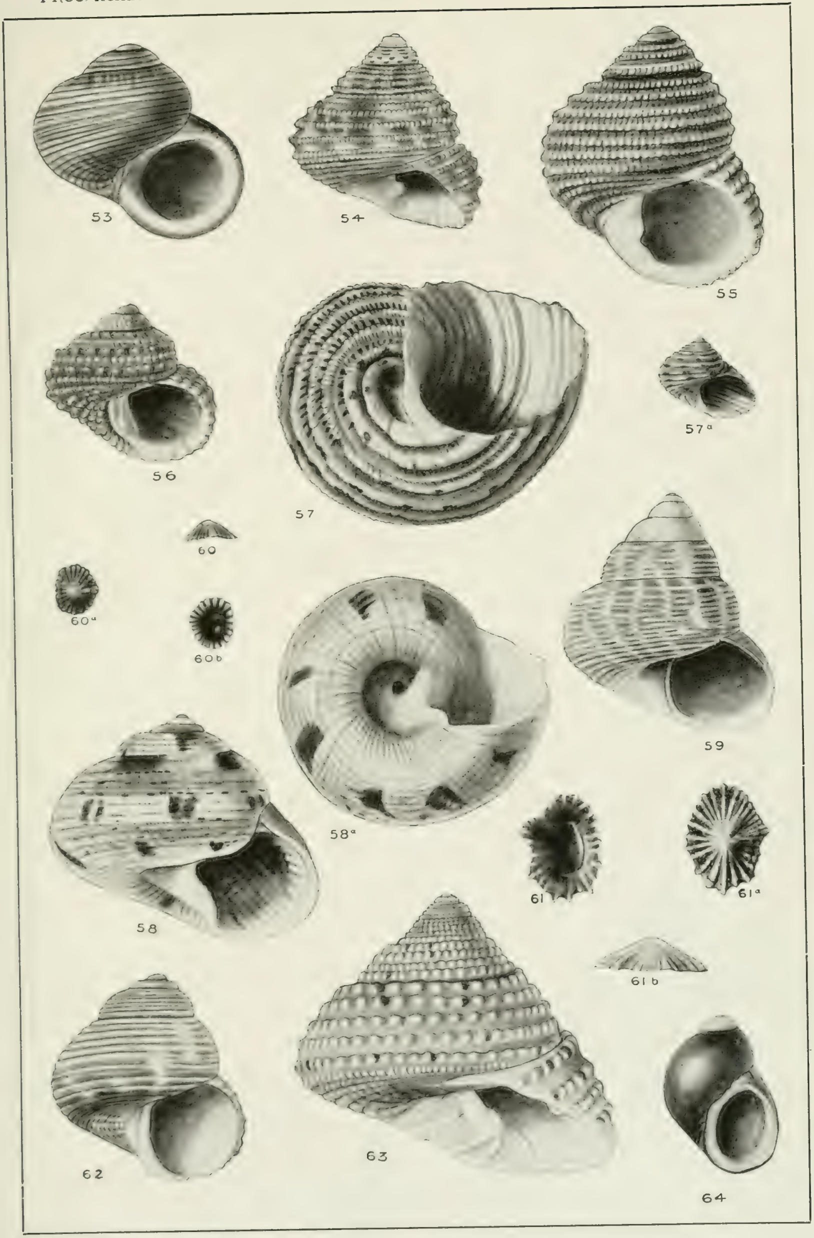

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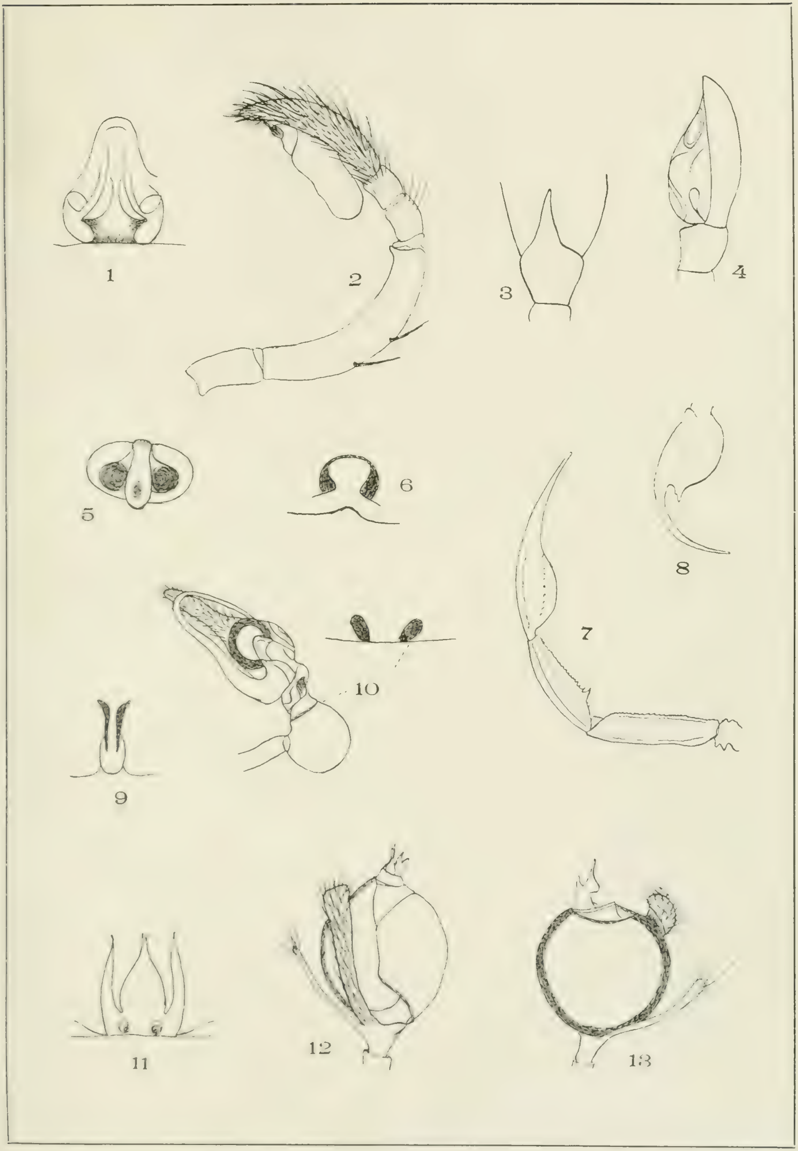

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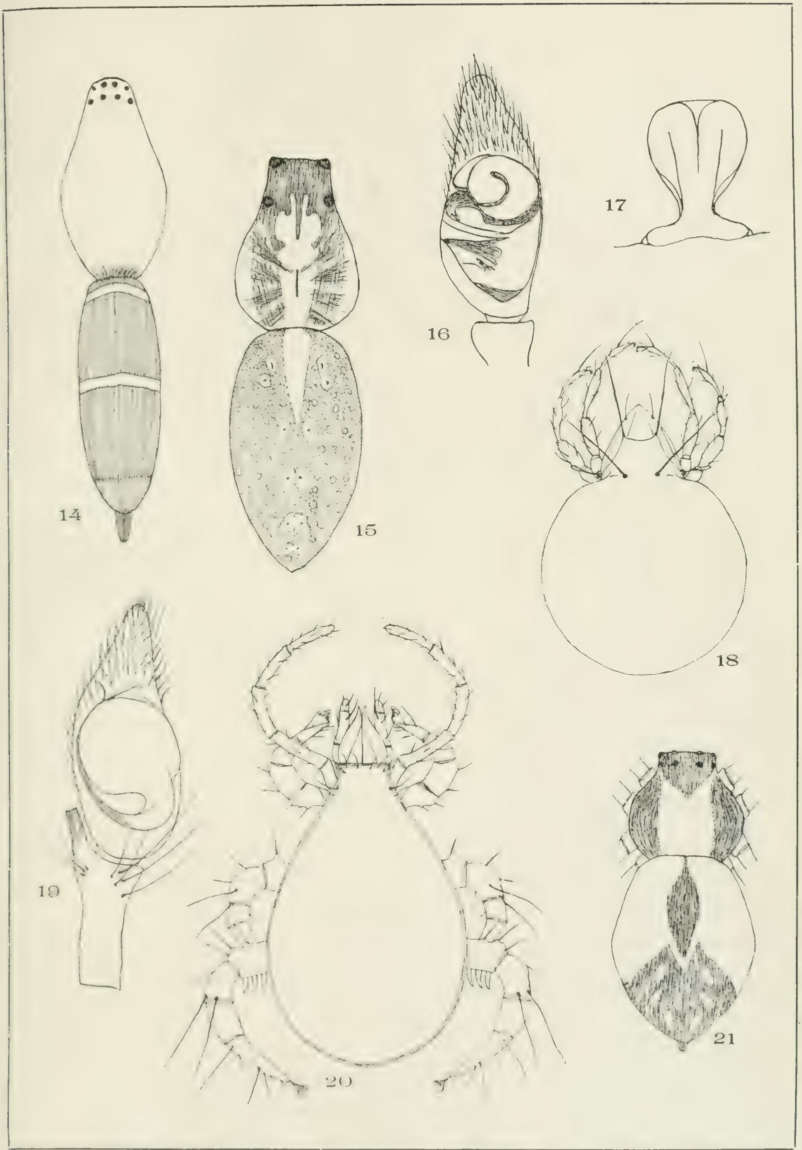

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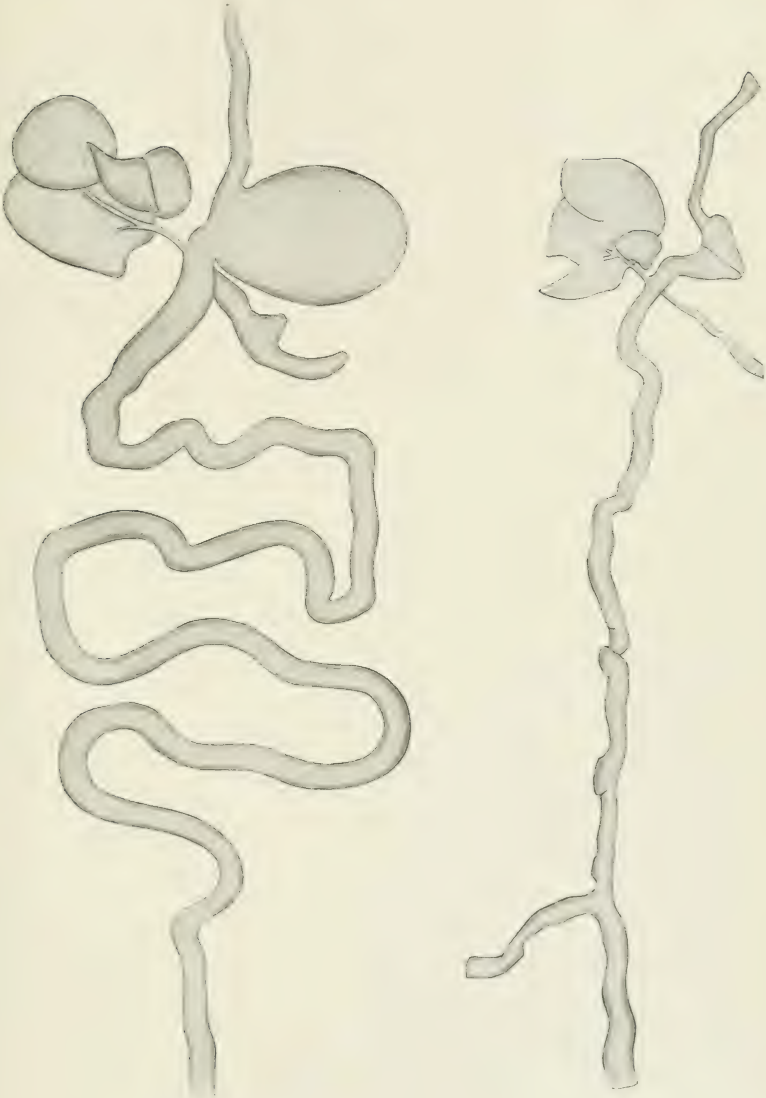

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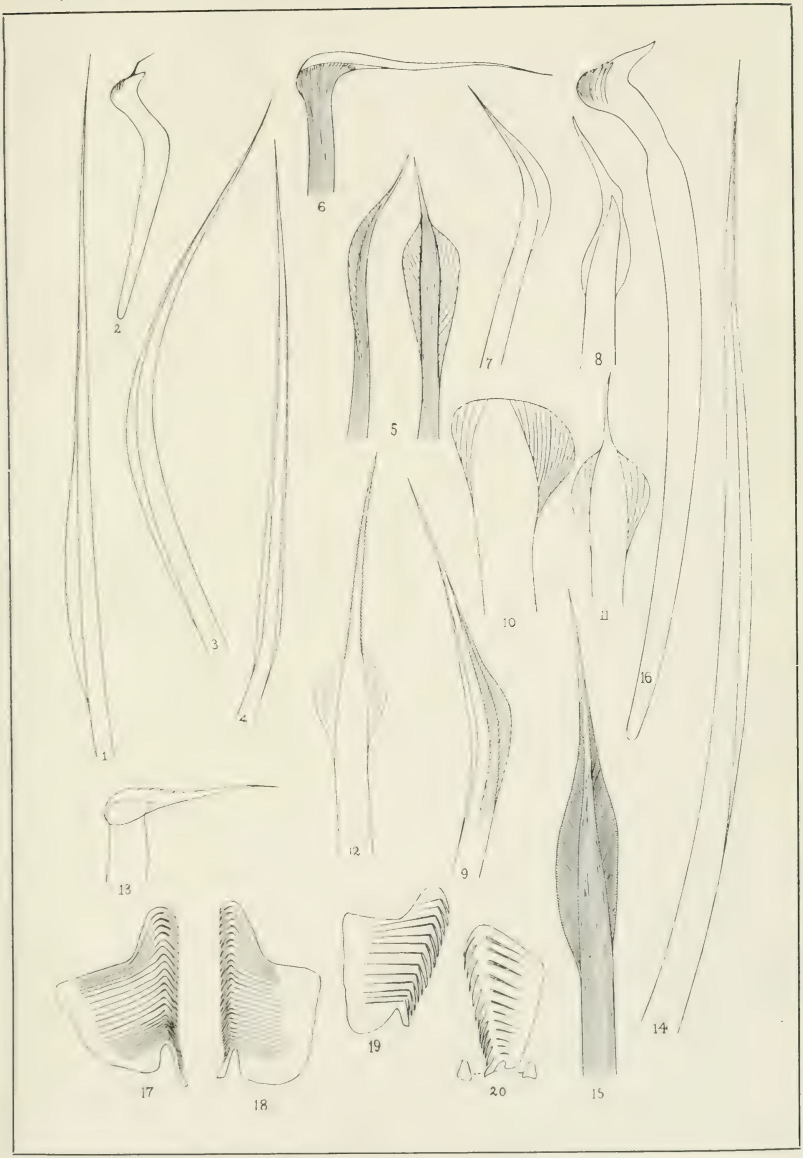
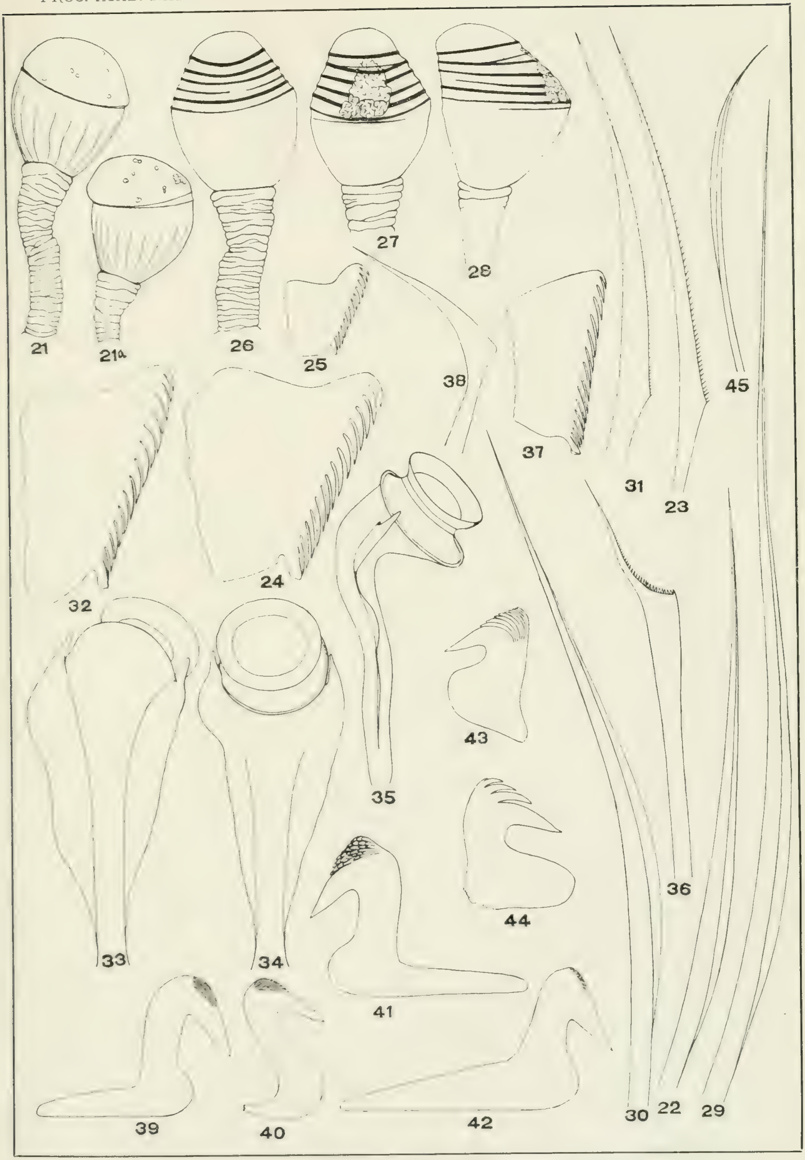
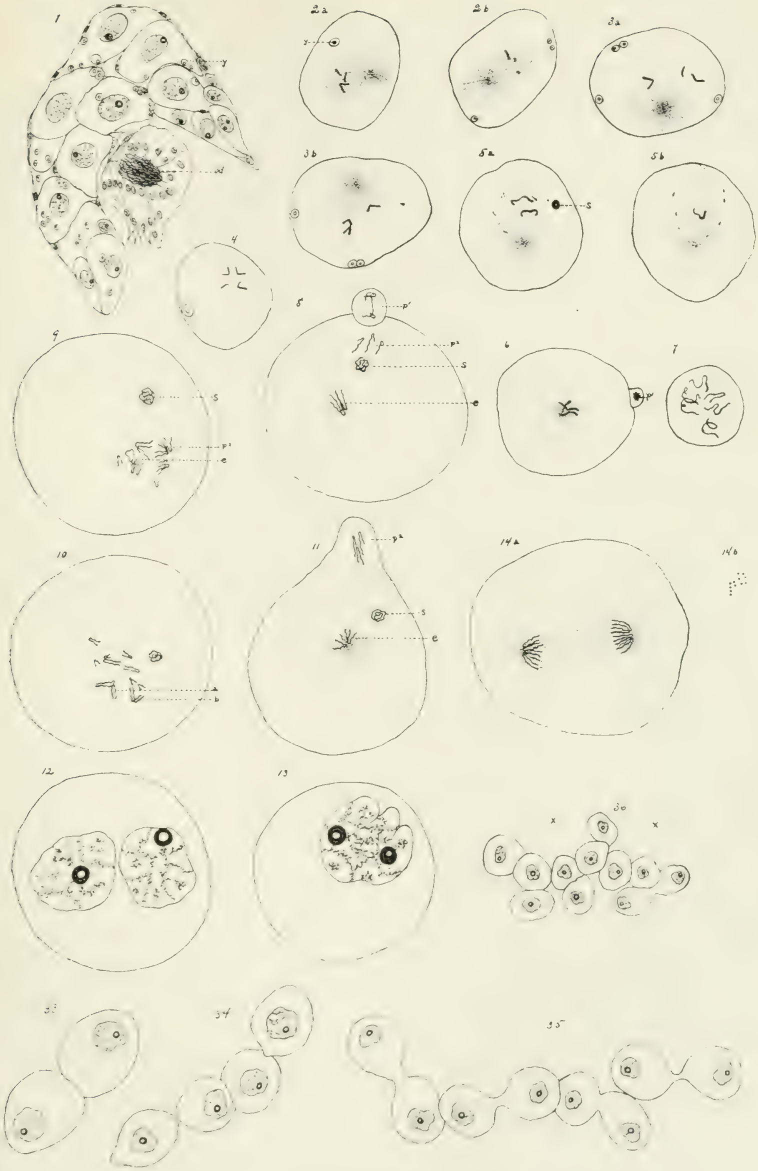


MOORE. SABELLIDÆ AND SERPULIDÆ.



MOORE. SABELLIDÆ AND SERPULIDÆ.



STEVENS. PLANARIA SIMPLISSIMA CURTIS.

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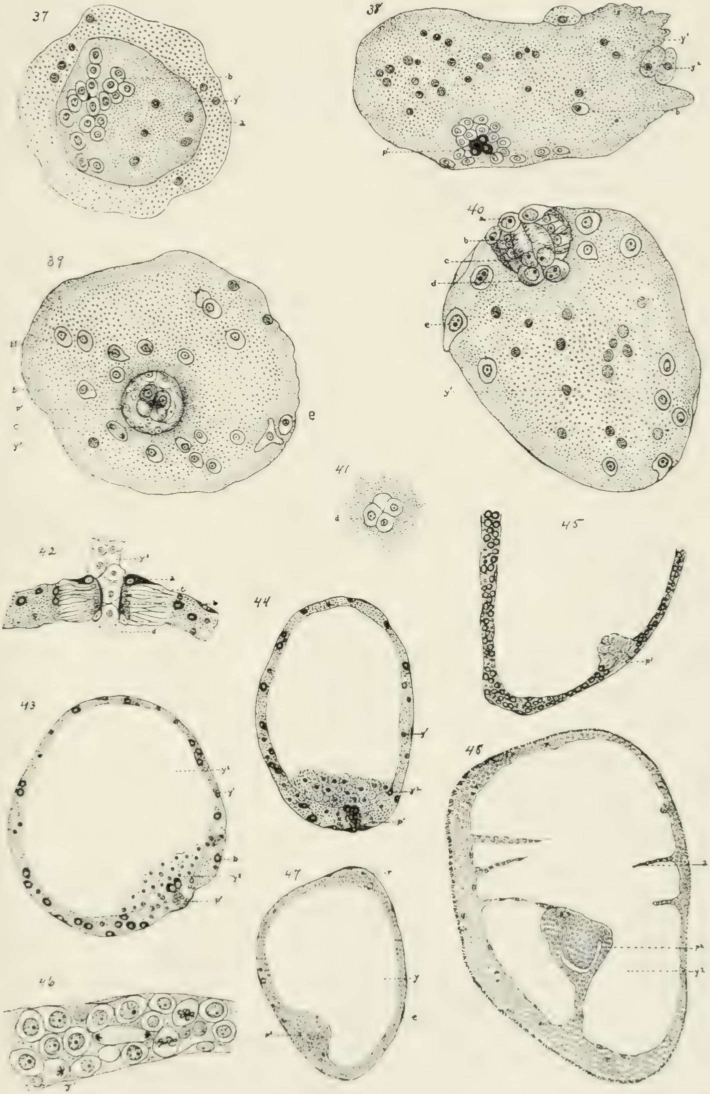

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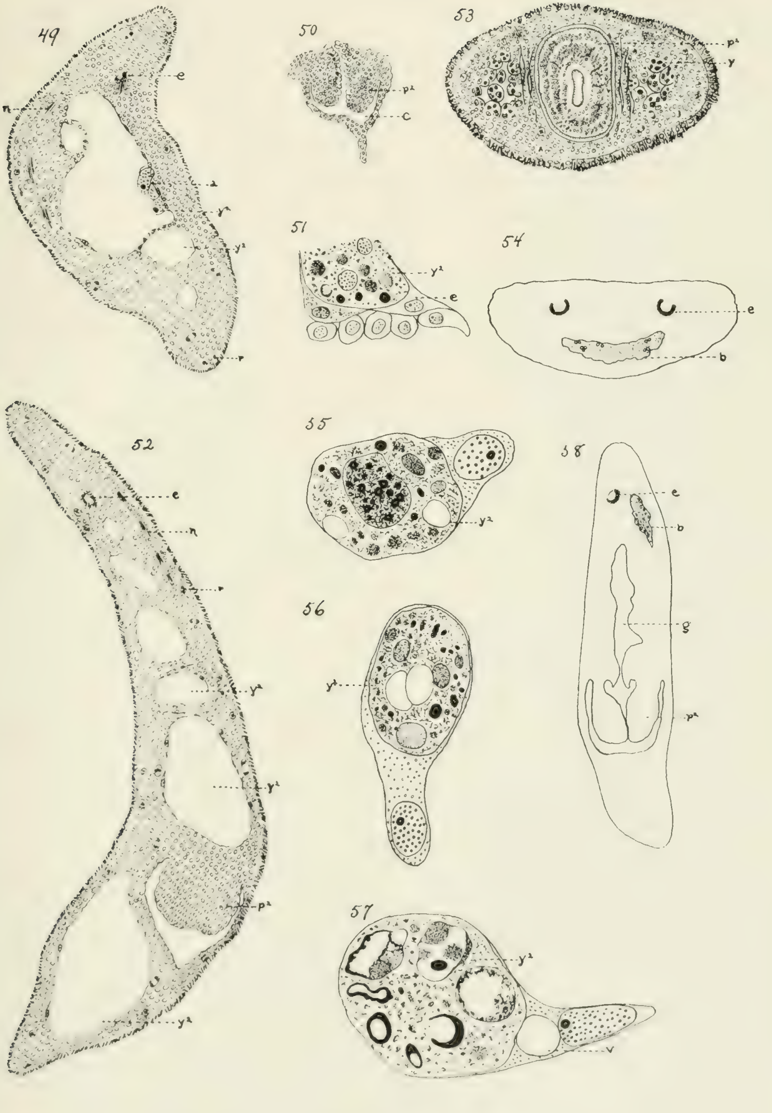
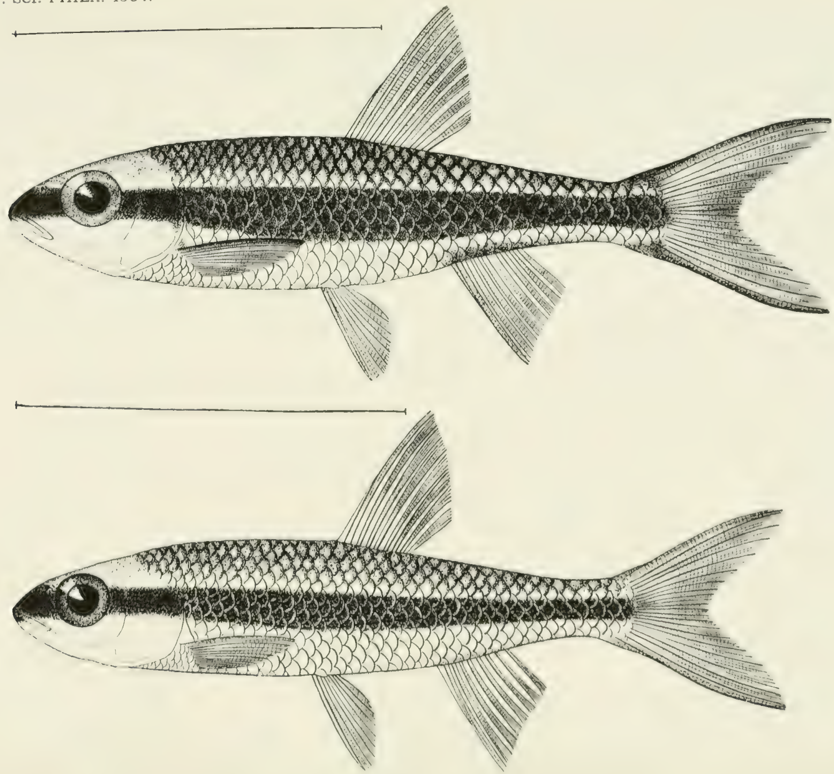


STEVENS. PLANARIA SIMPLISSIMA CURTIS



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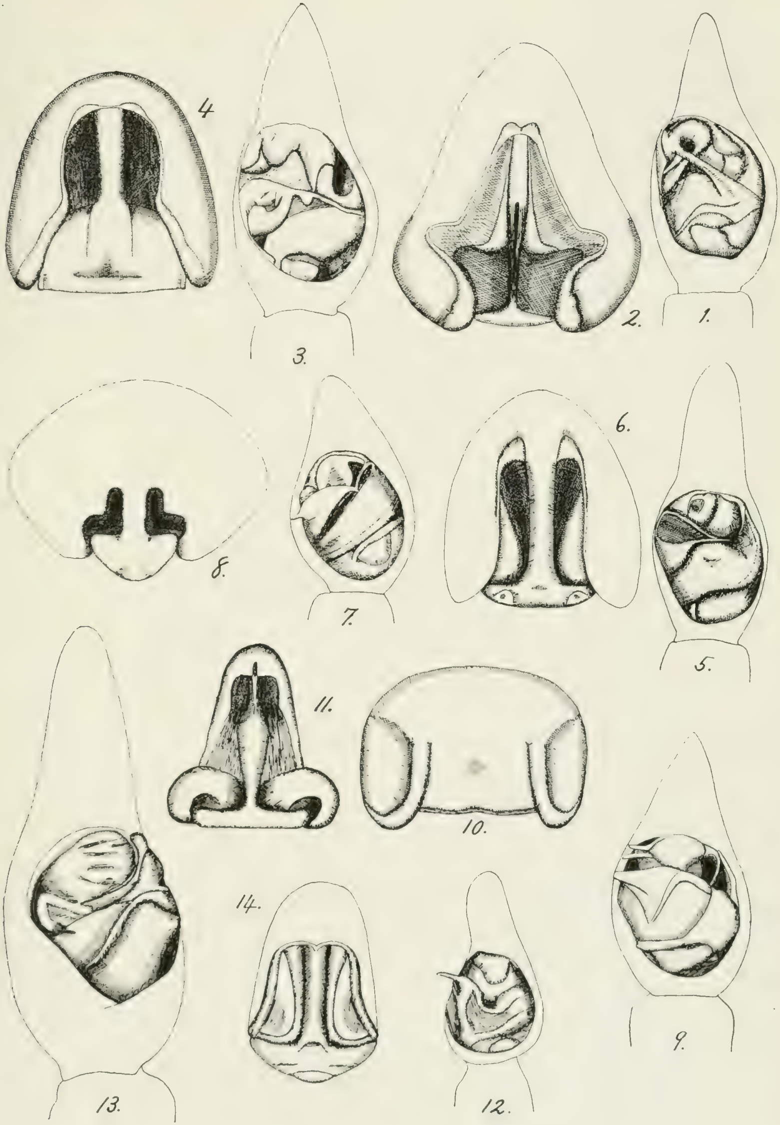
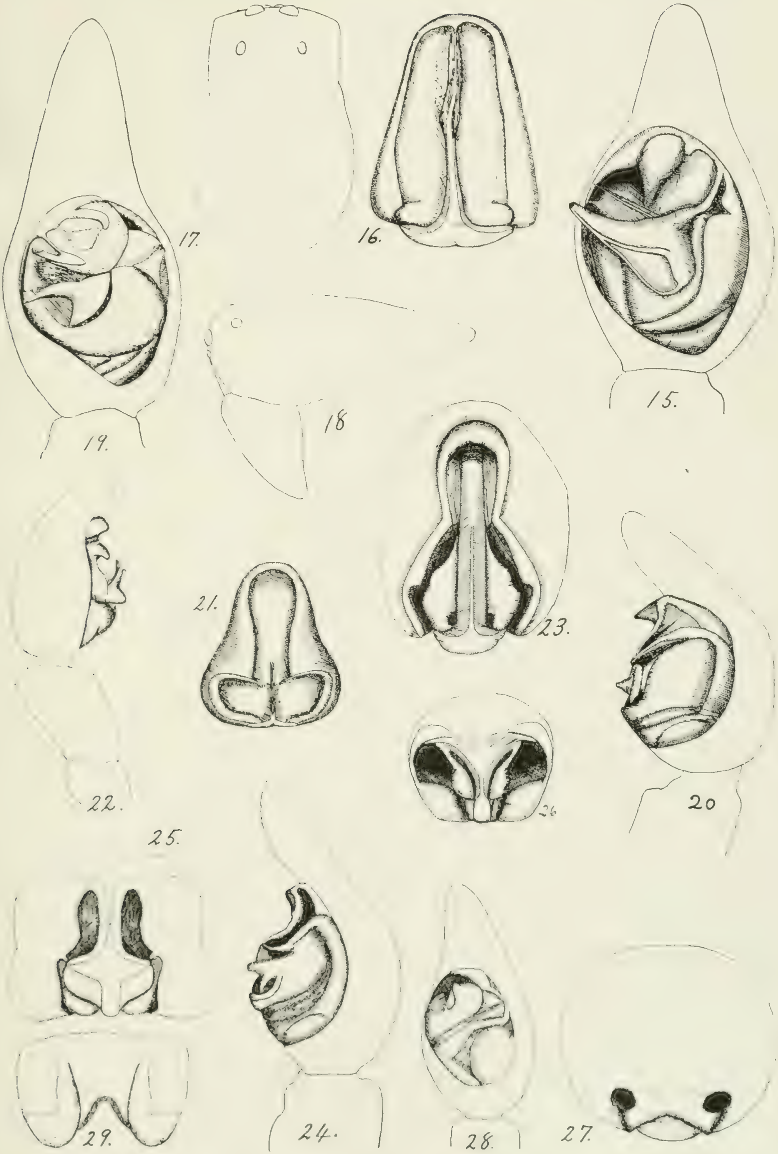
NOTROPIS CHALYBÆUS (COPE).



MONTGOMERY ON LYCOSIDÆ AND PISAURIDÆ.



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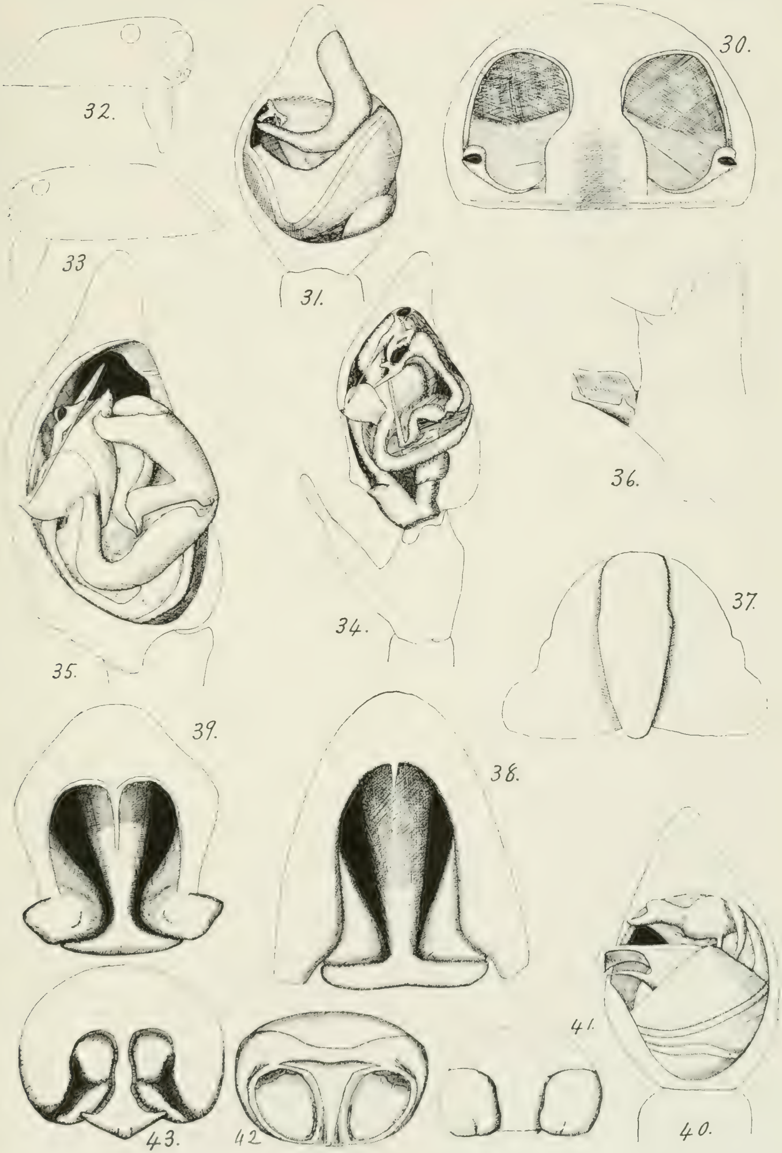

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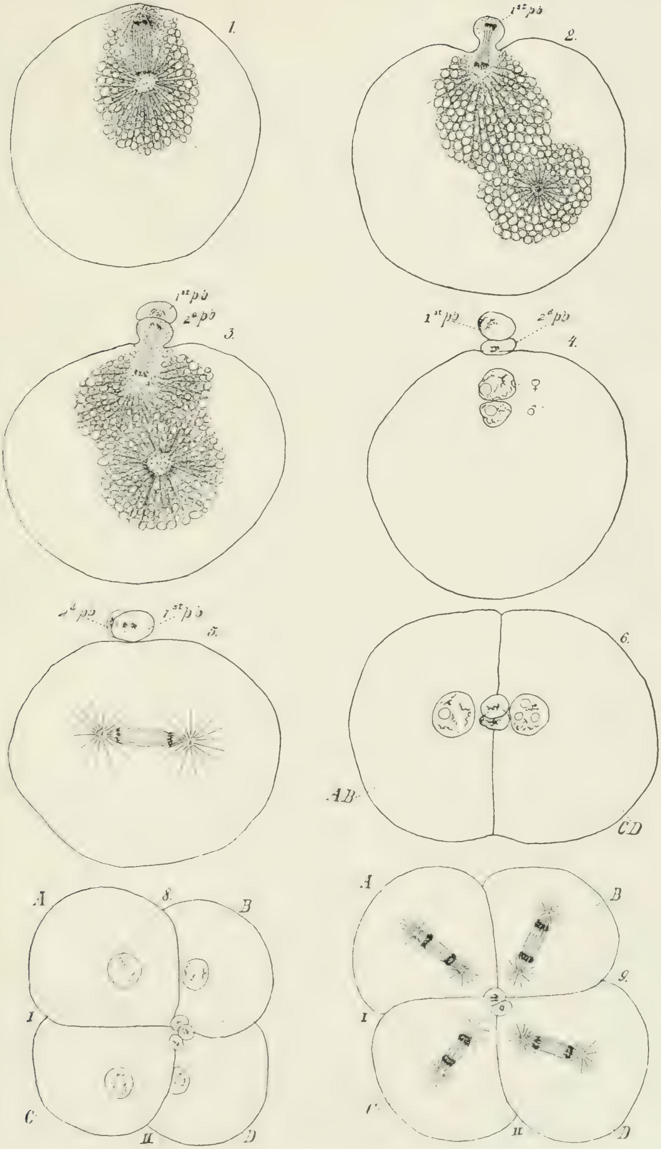

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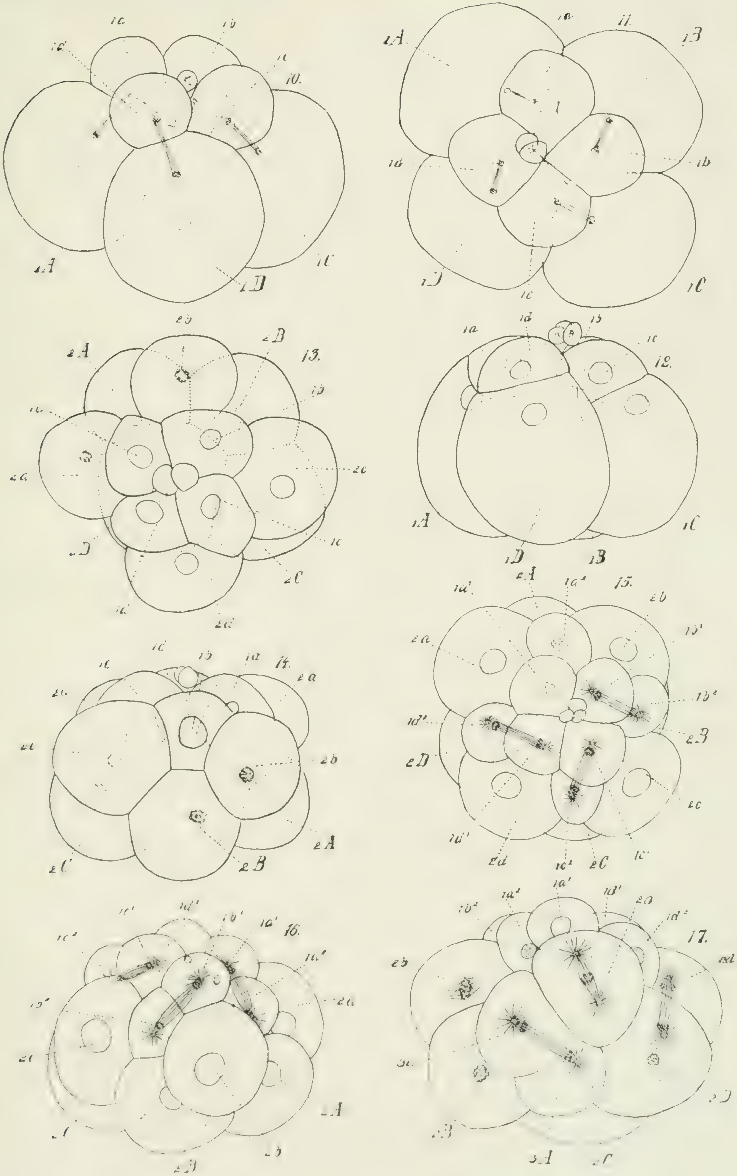

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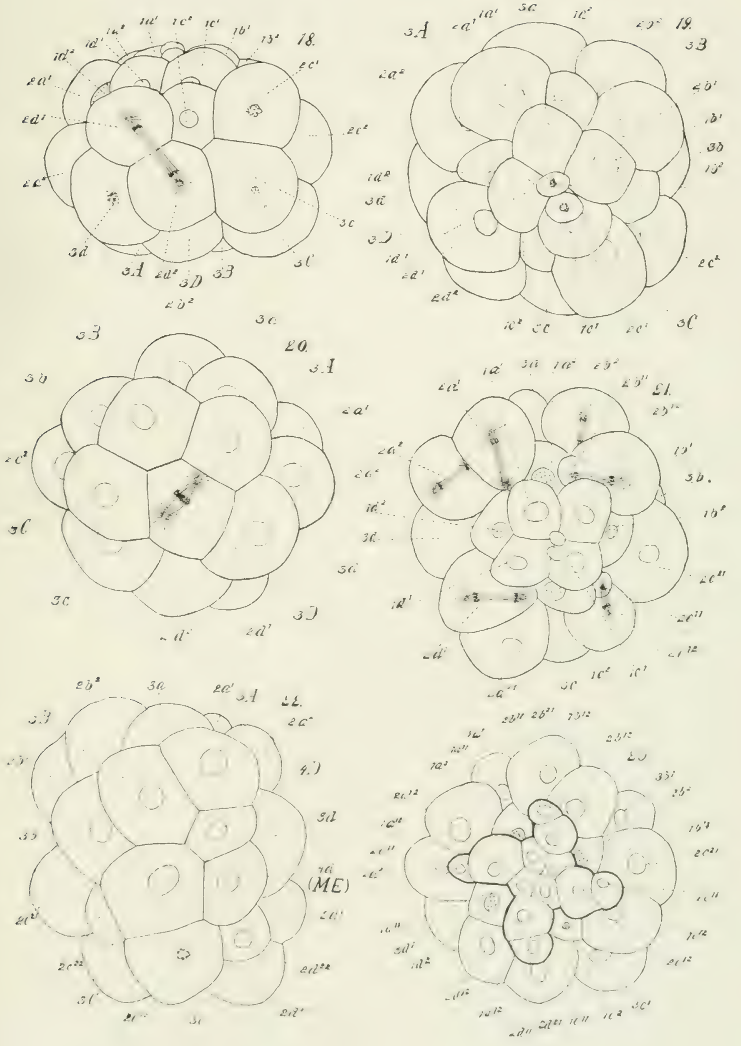

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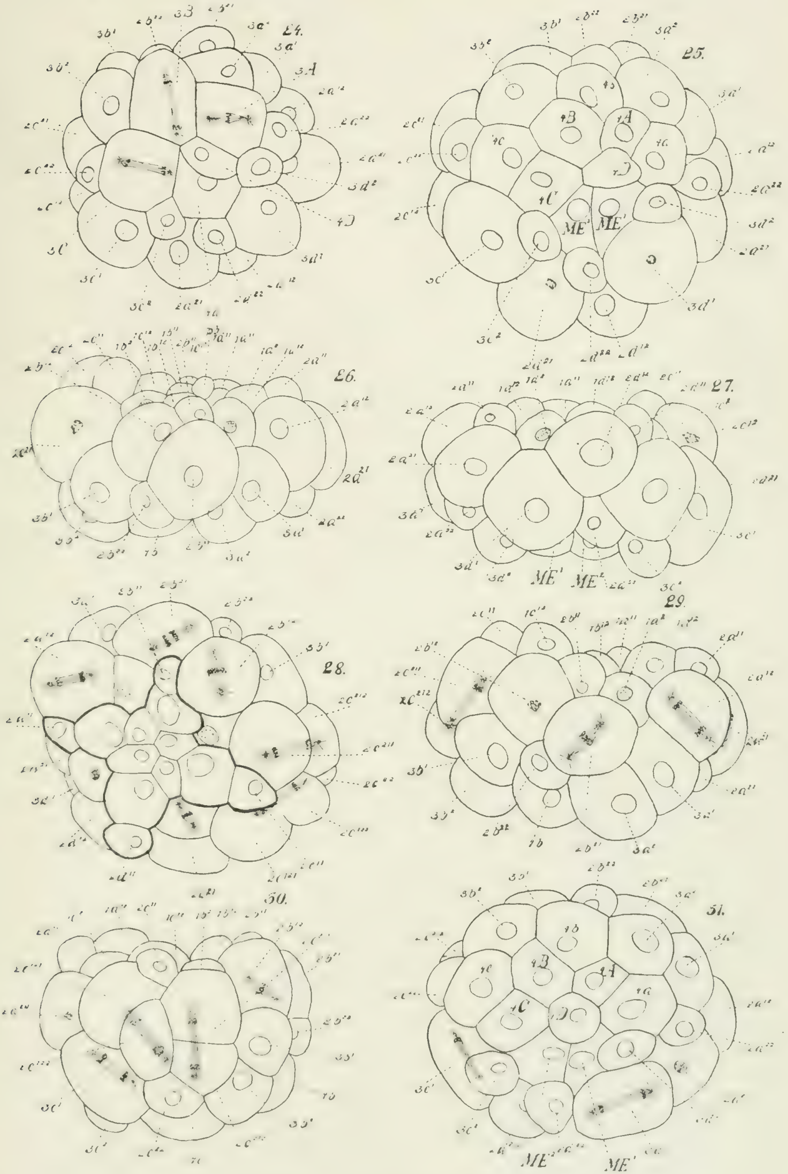

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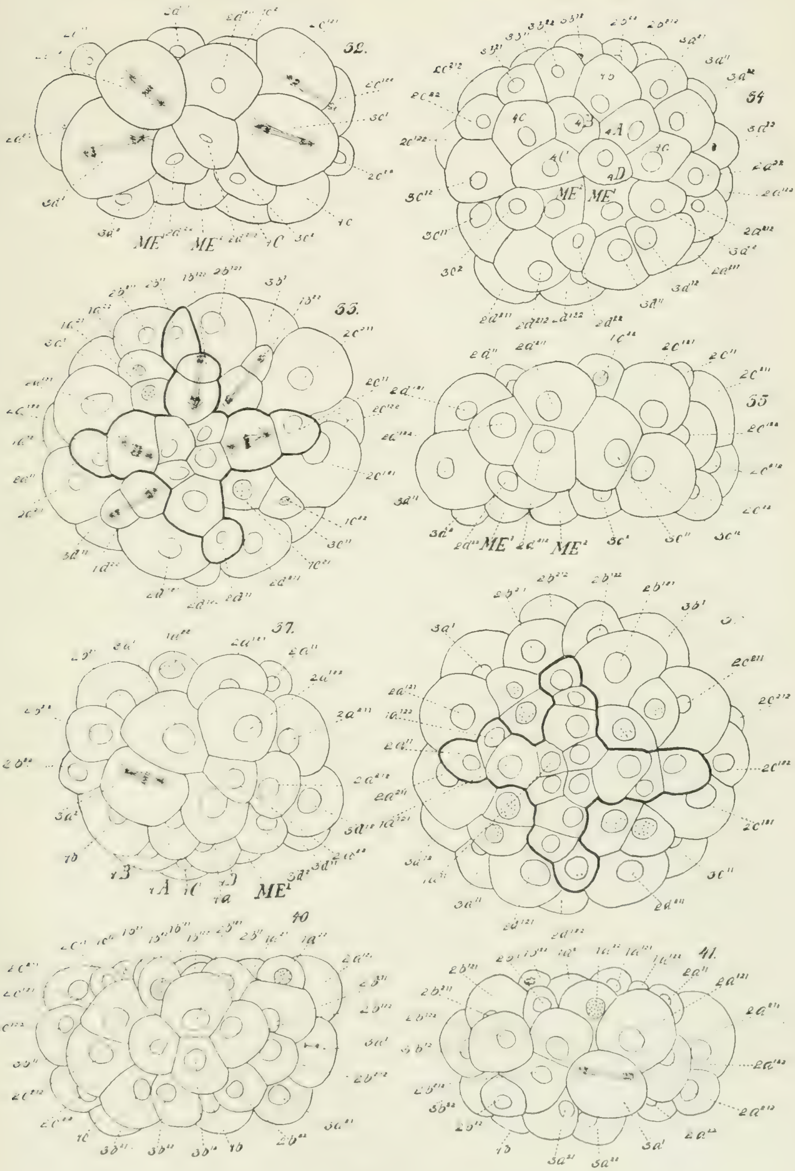

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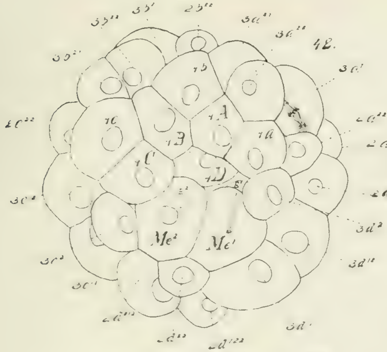

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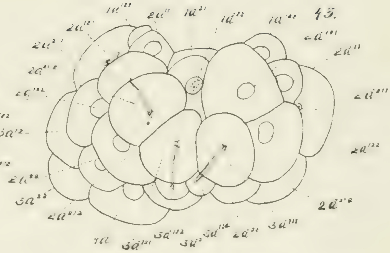

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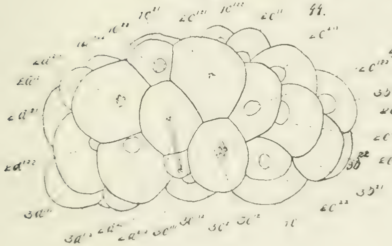

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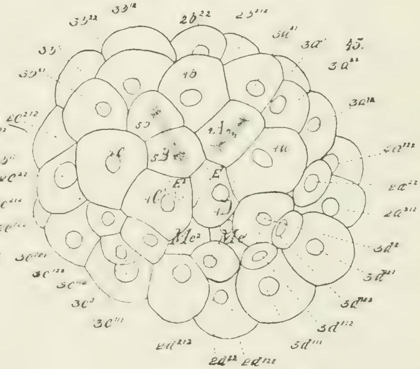

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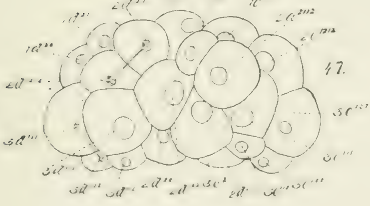

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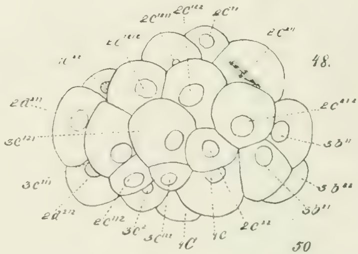

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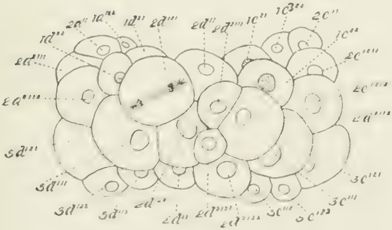

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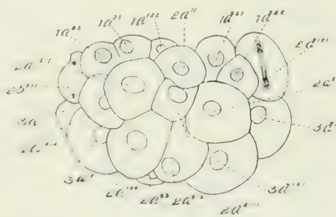

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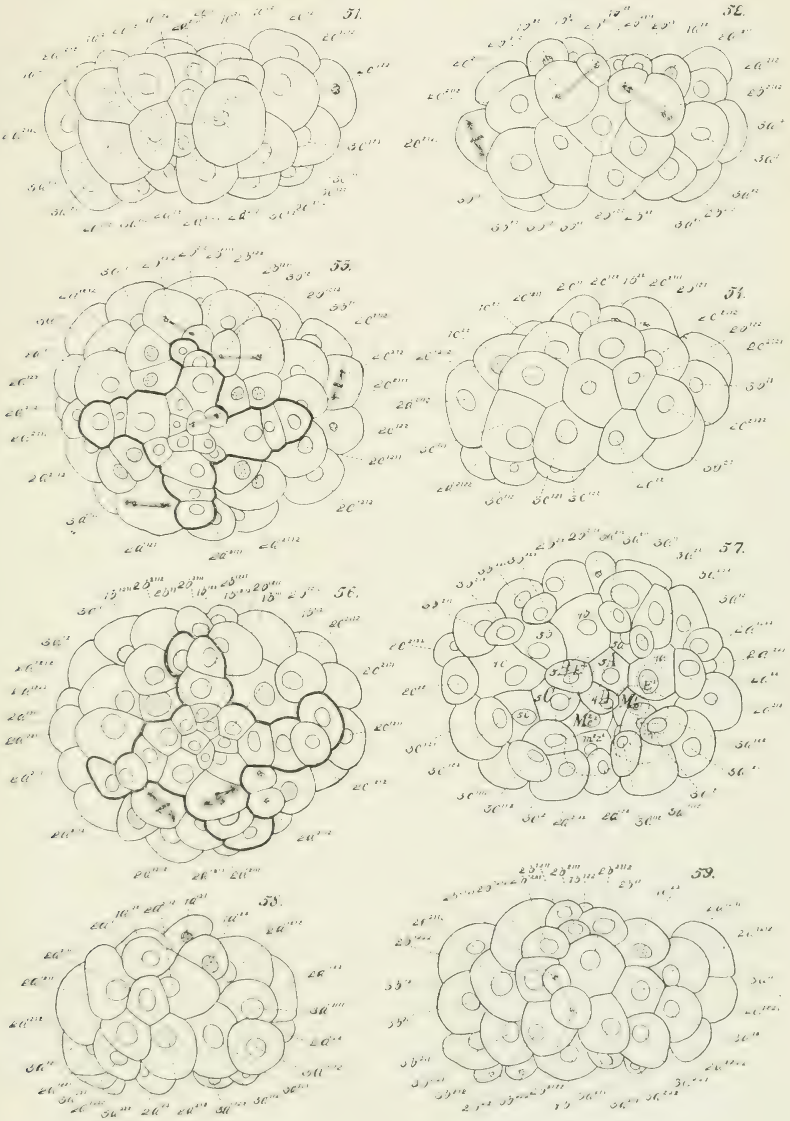

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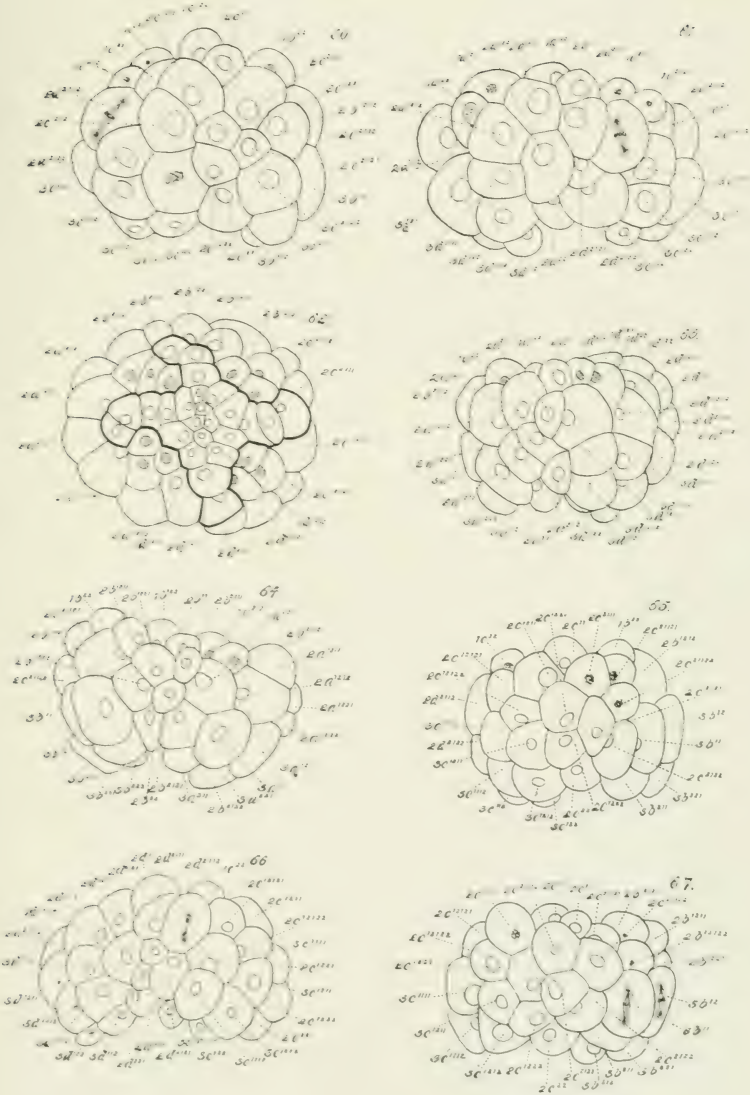

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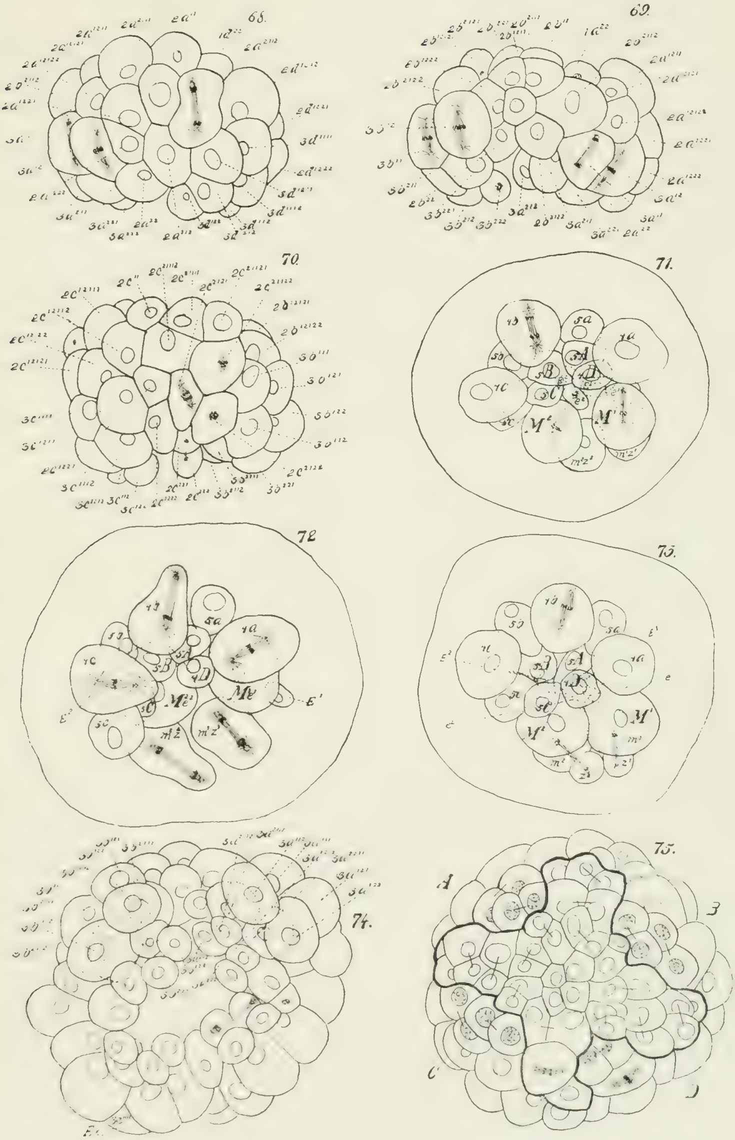

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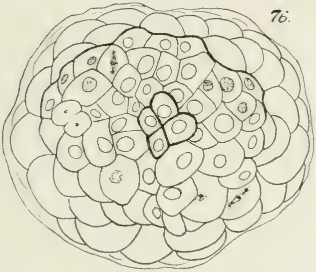

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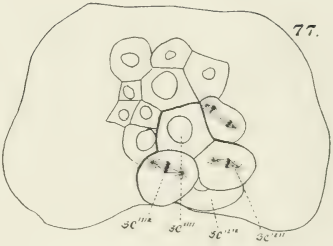

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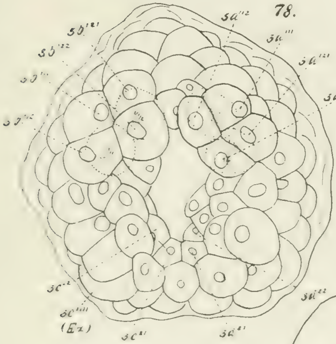

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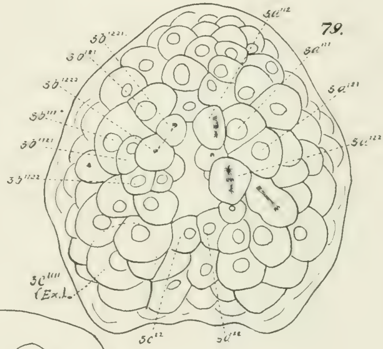

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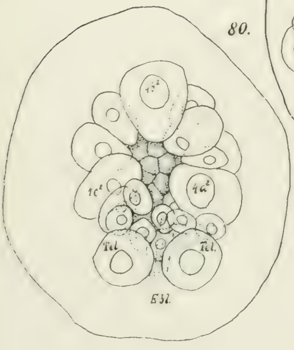

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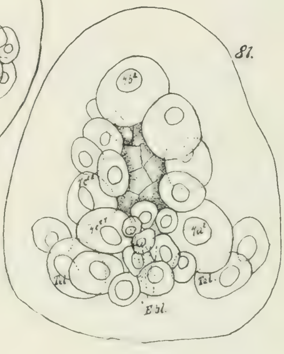

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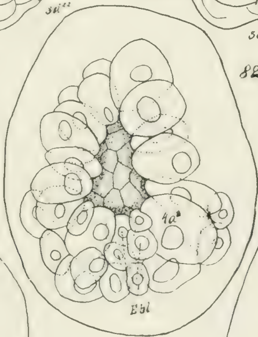

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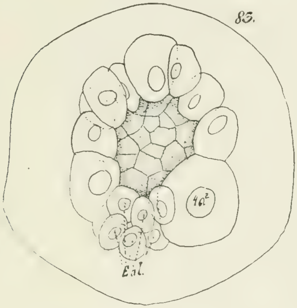

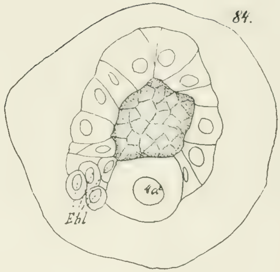

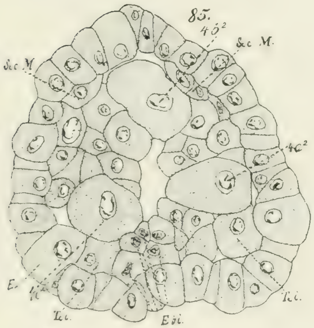

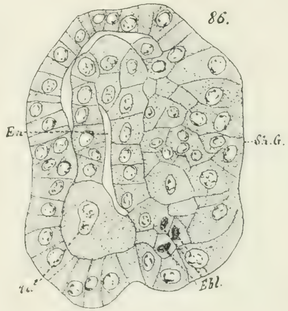

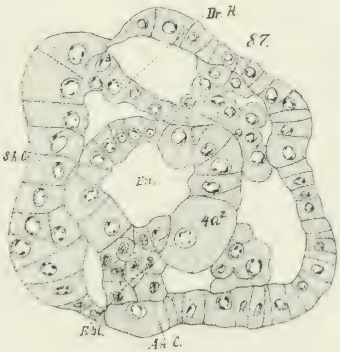

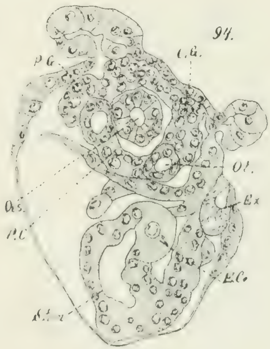

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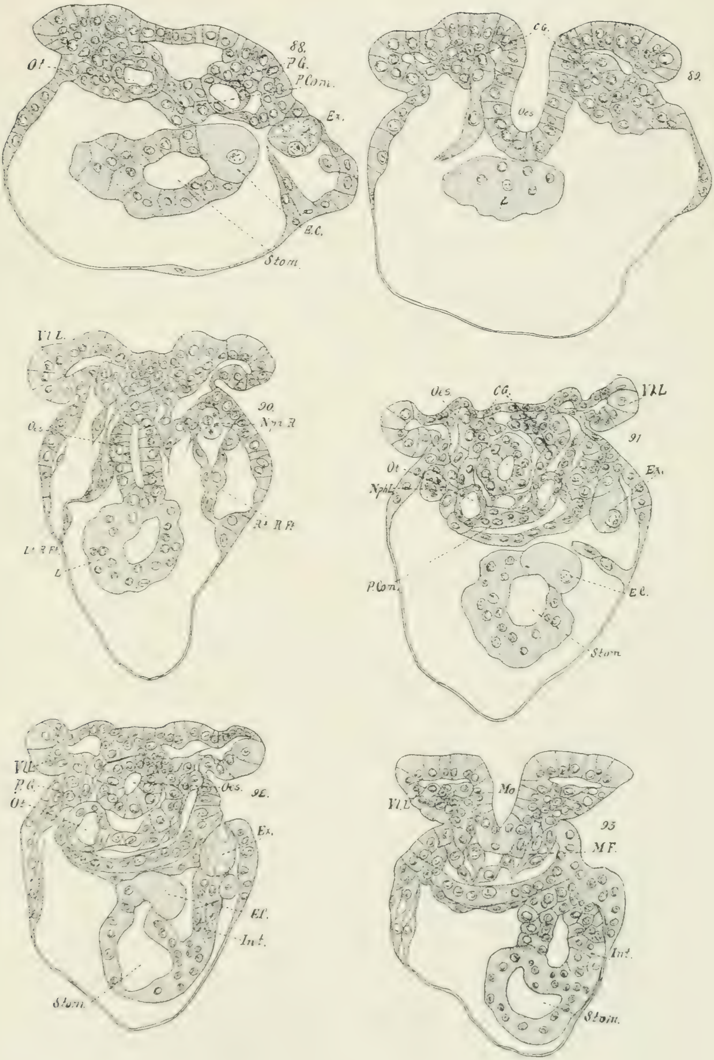

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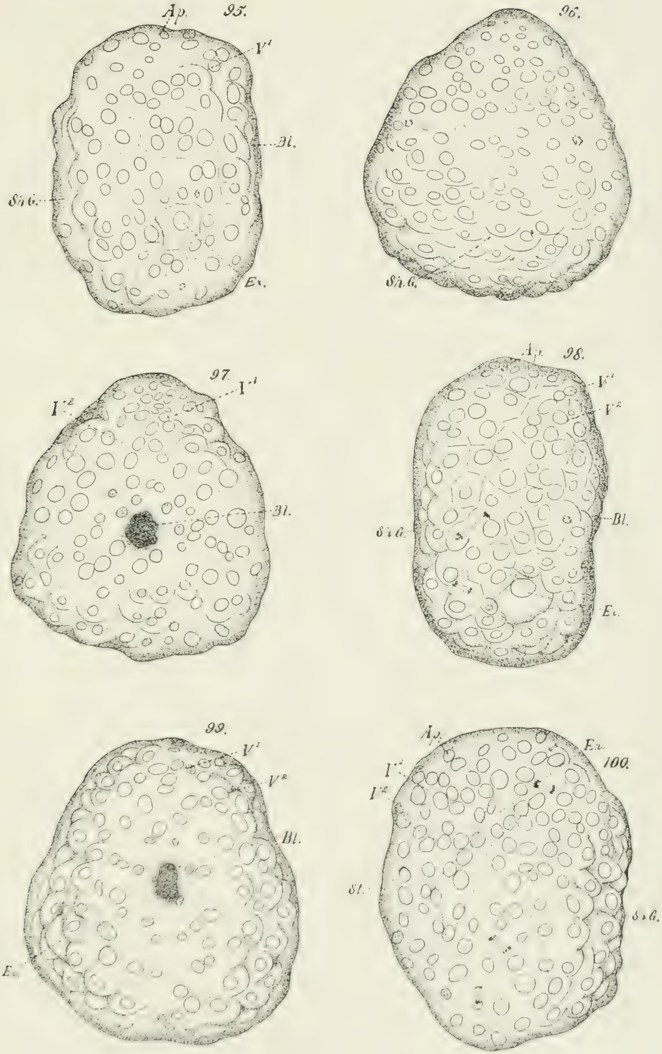

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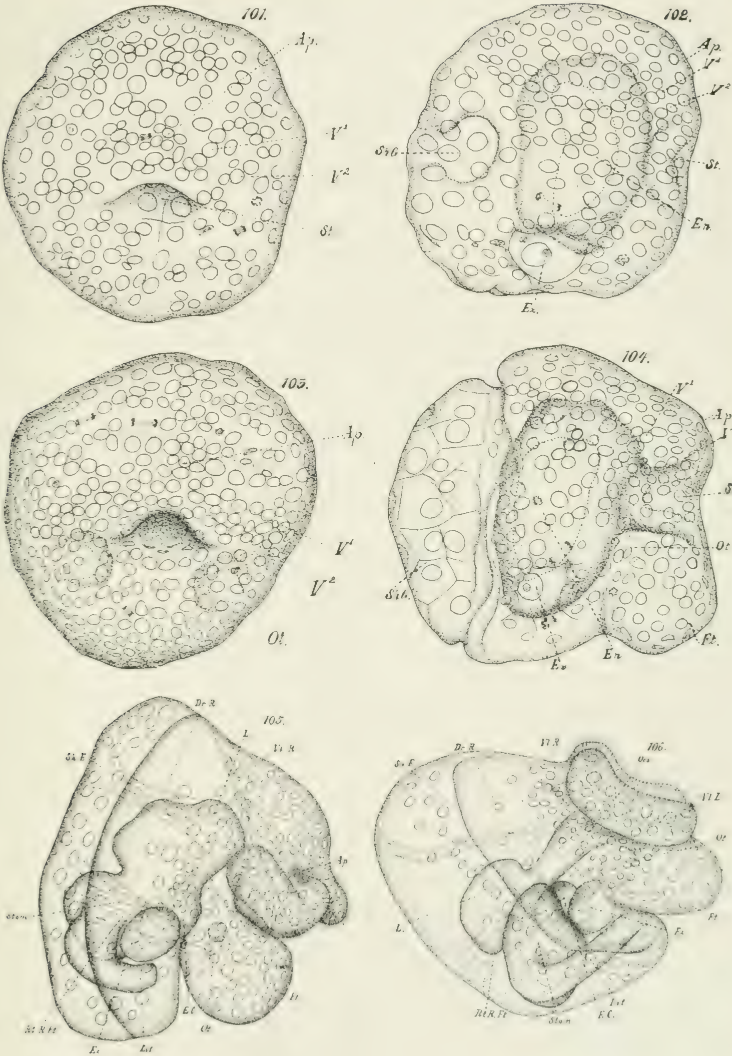

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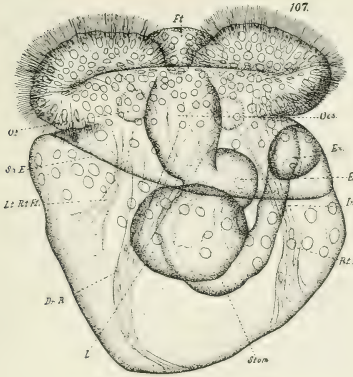

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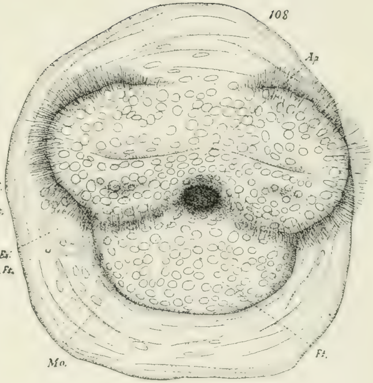

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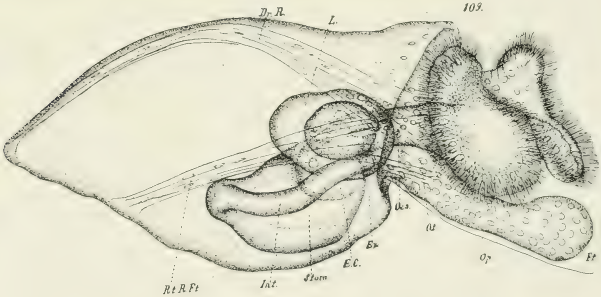

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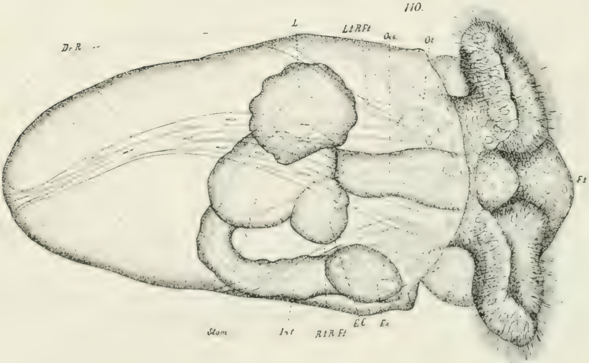
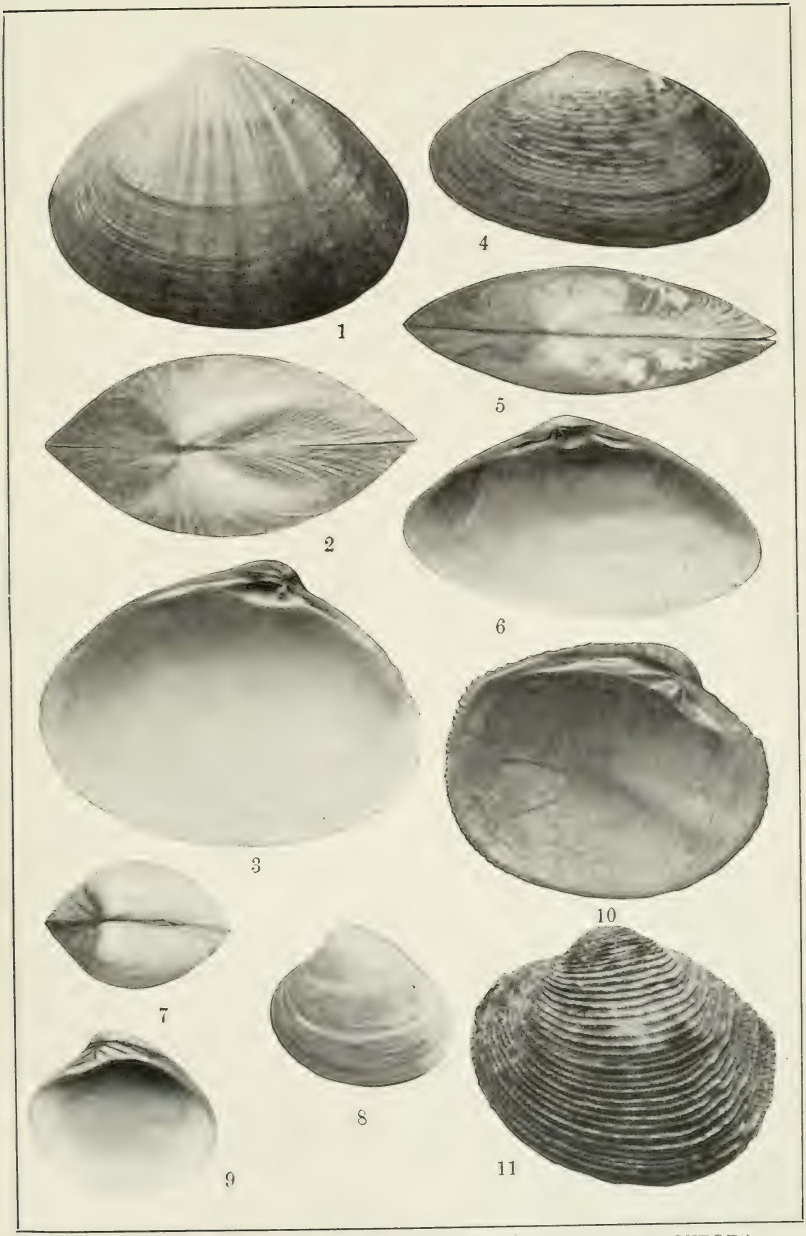


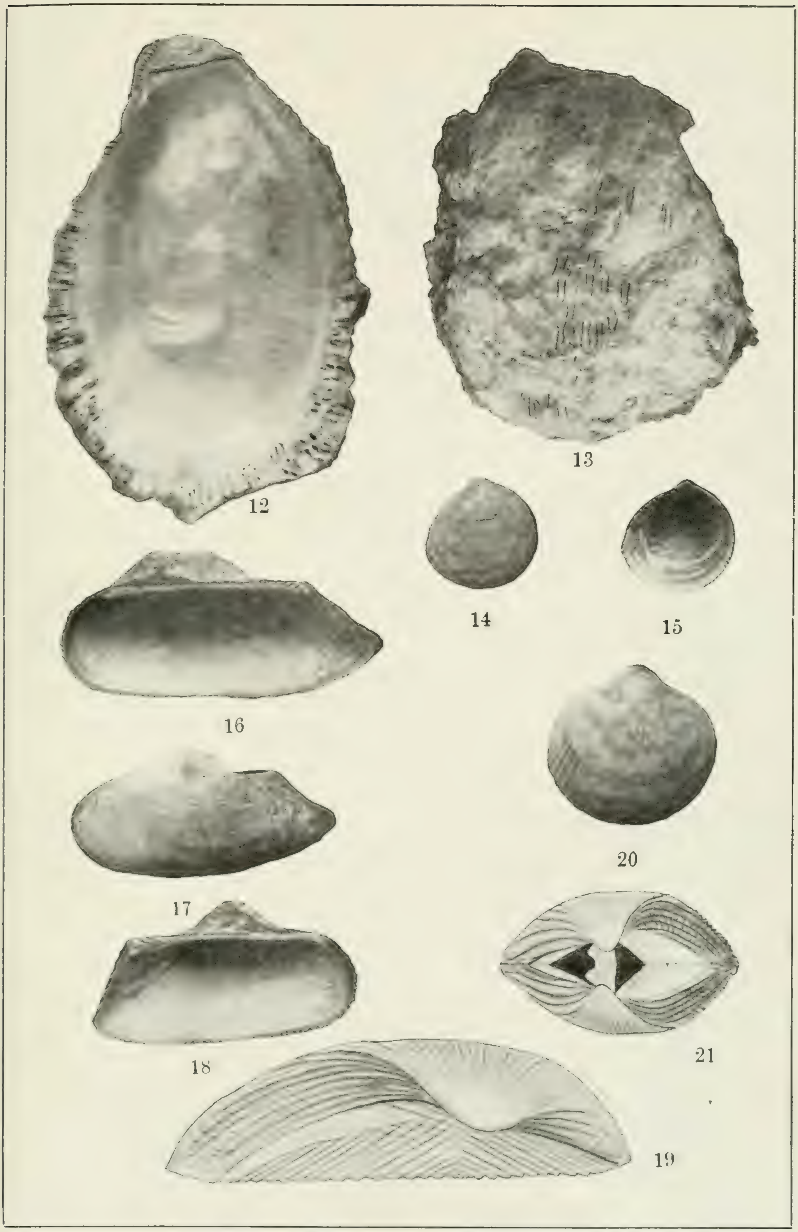
CASTEEL ON FIONA MARINA.

GULICK. FOSSIL LAND SHELLS OF BERMUDA.

MOORE. NEW POLYCHÆTA.



PILSBRY. NEW JAPANESE MARINE MOLLUSCA · PELECYPODA.



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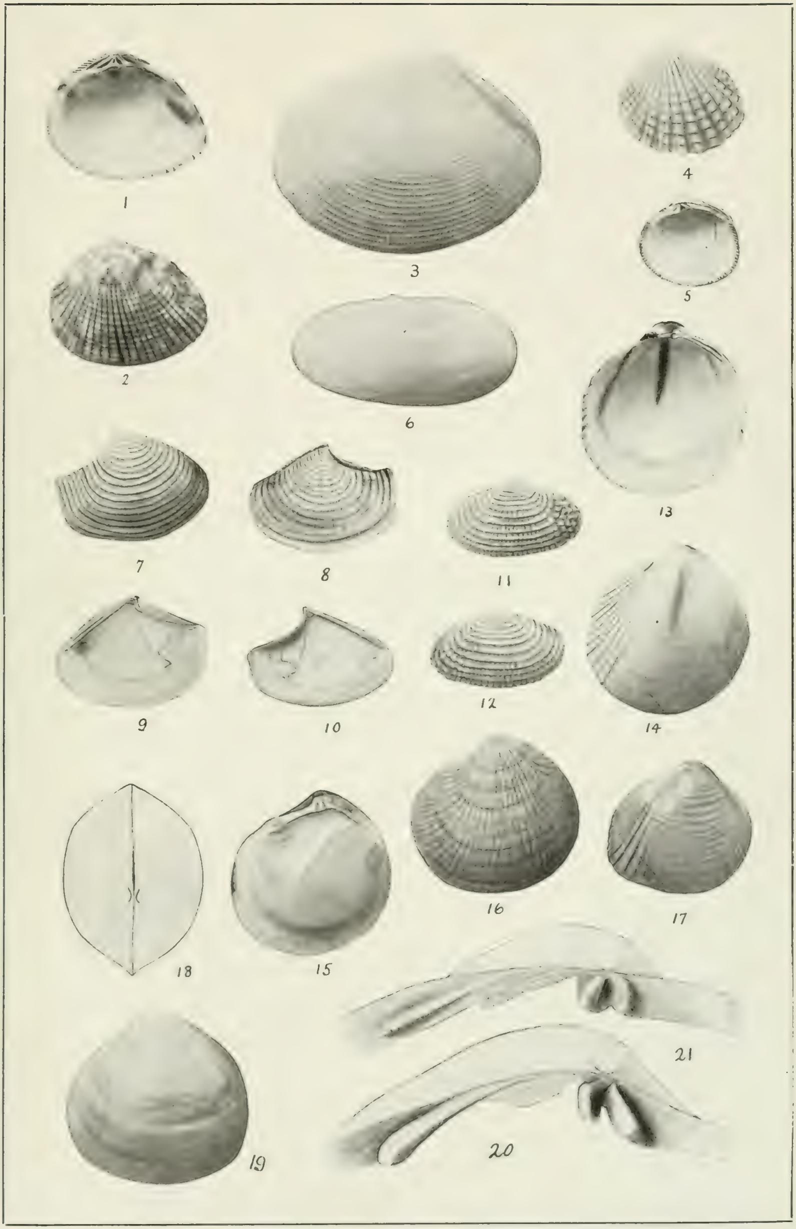

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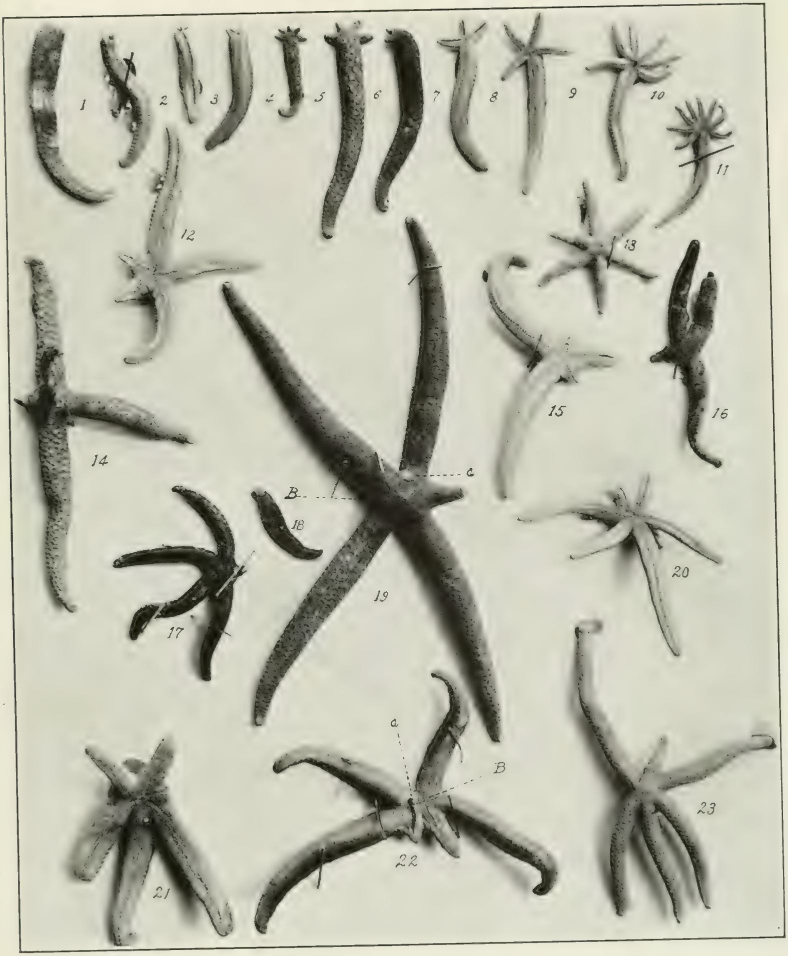
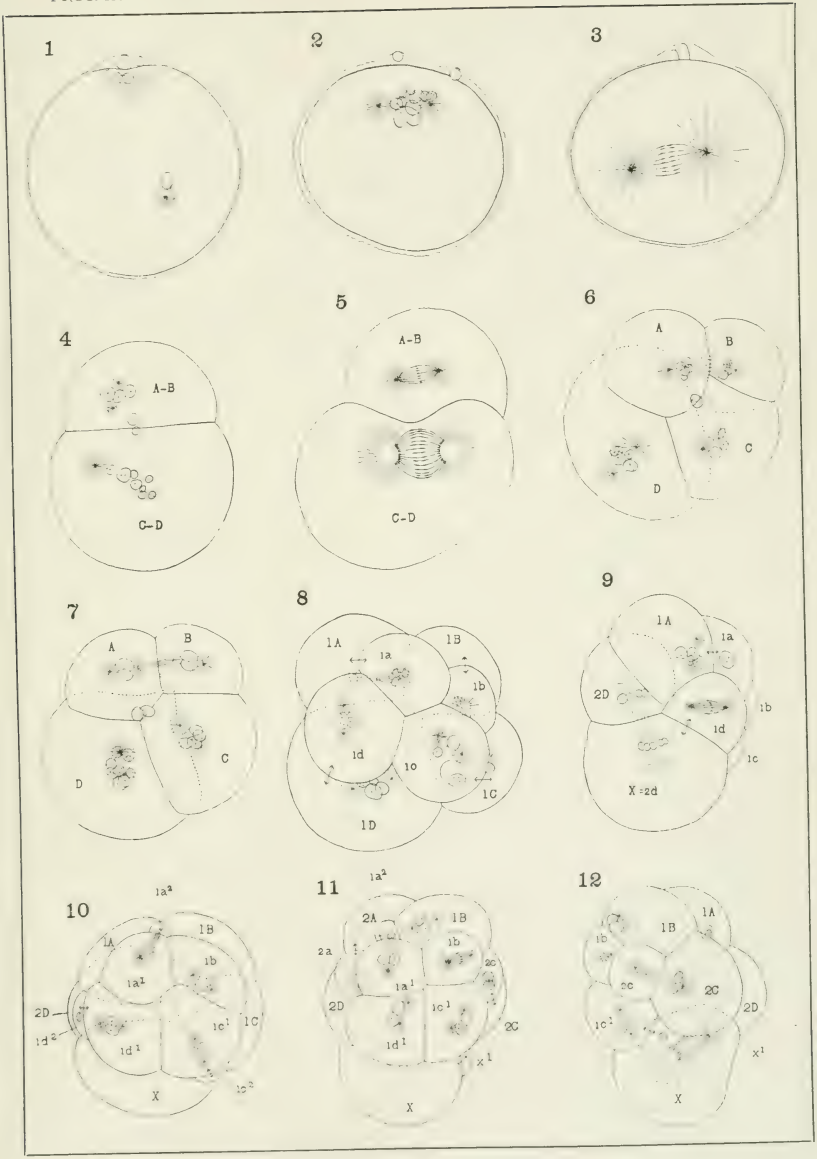


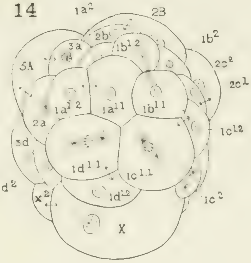
MONKS ON PHATARIA.



NELSON ON DINOPHILUS.

13

14



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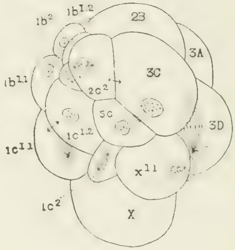

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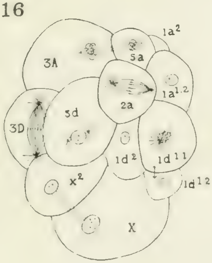

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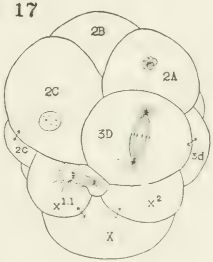

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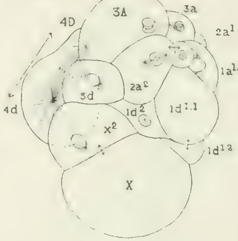

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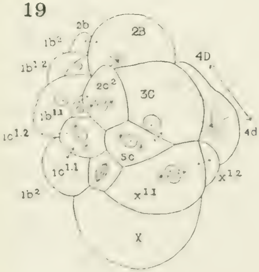

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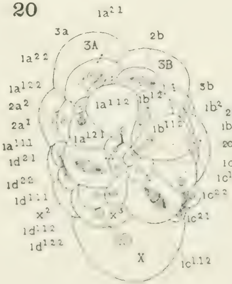

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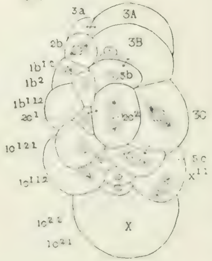

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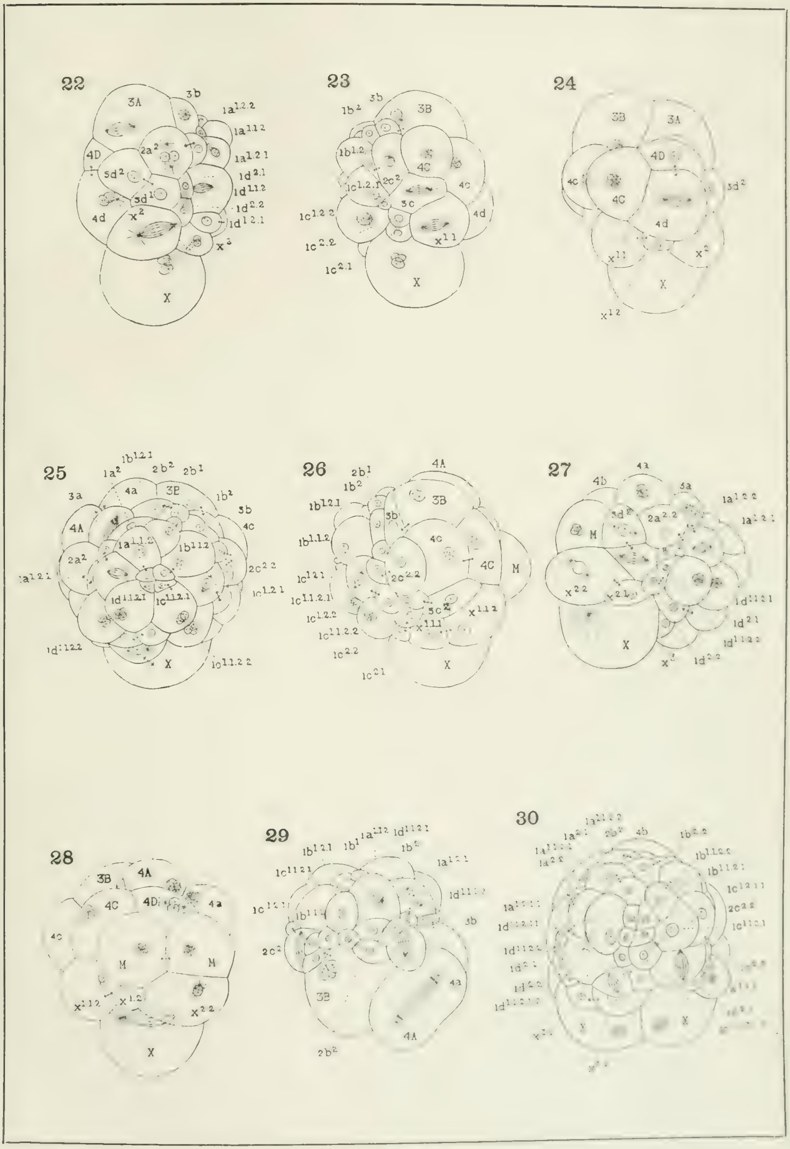

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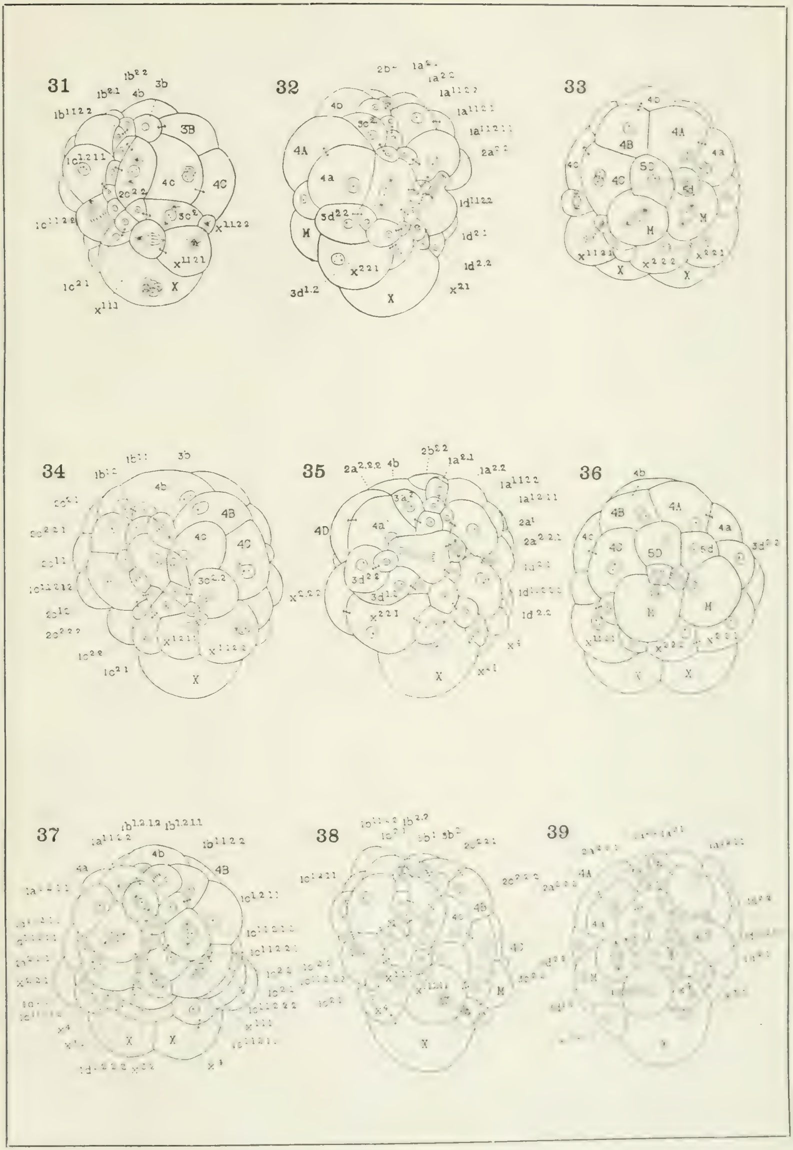

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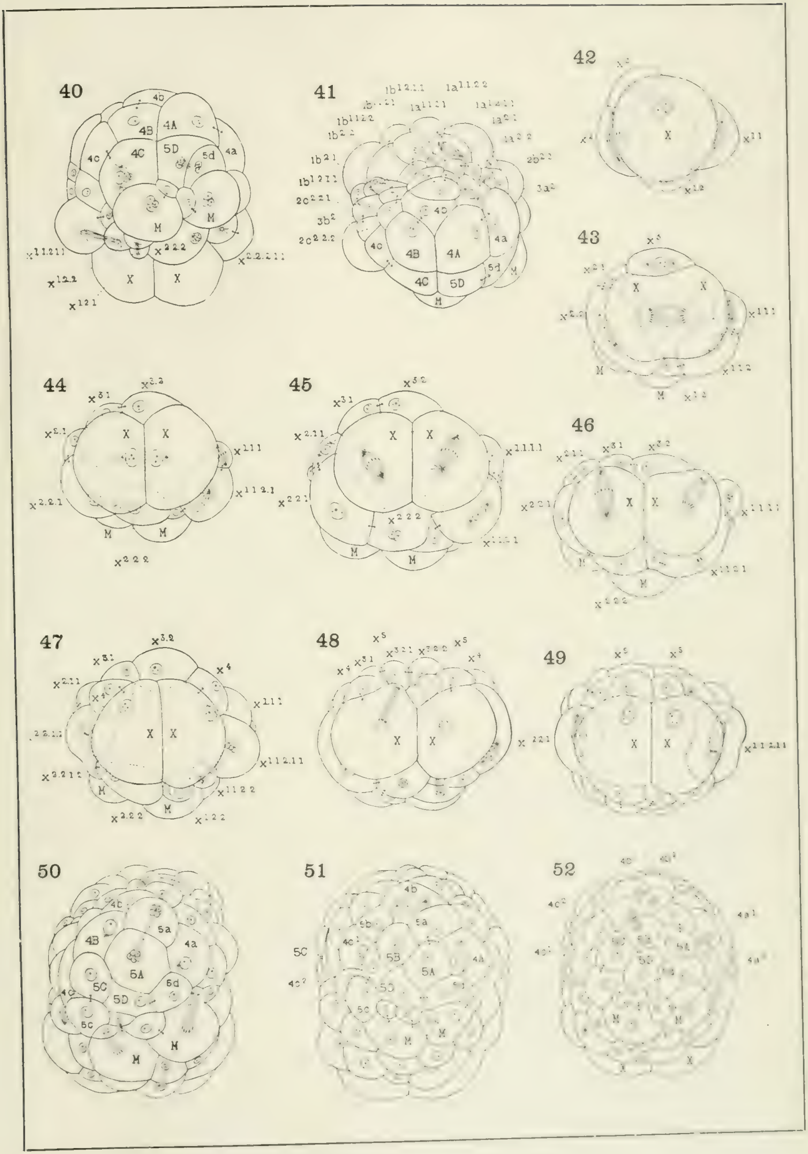

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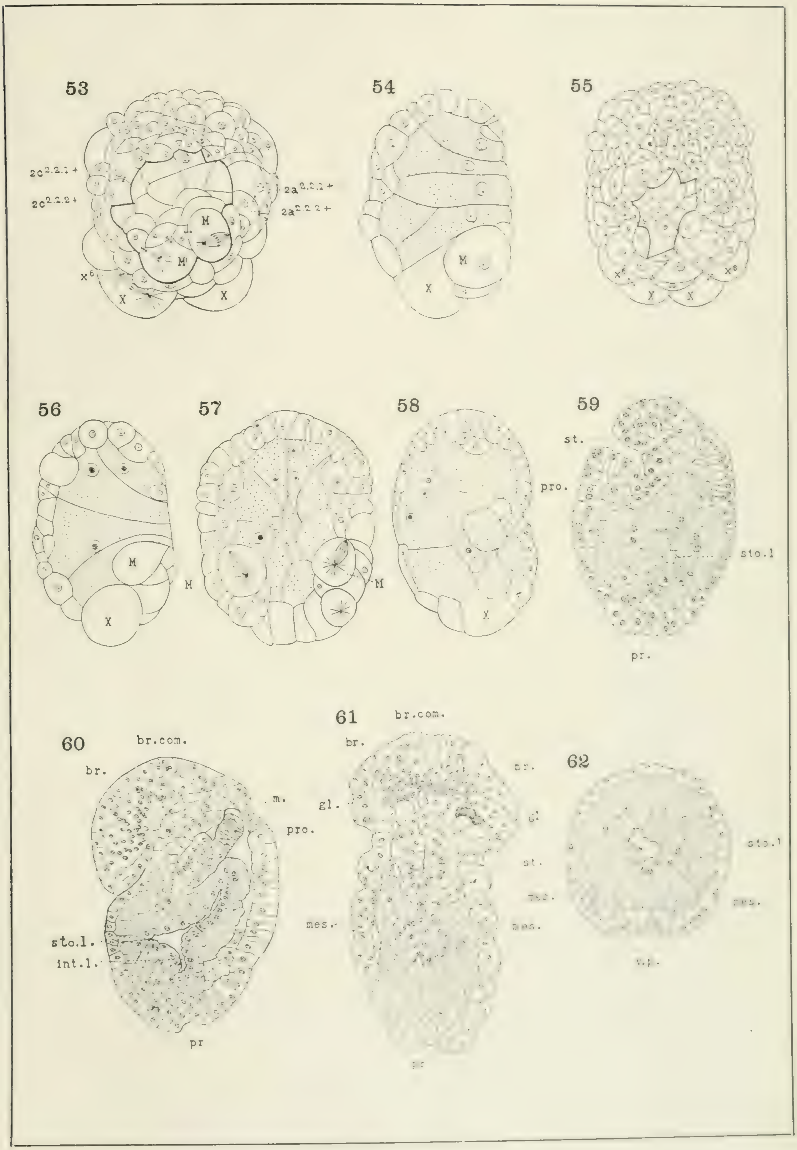

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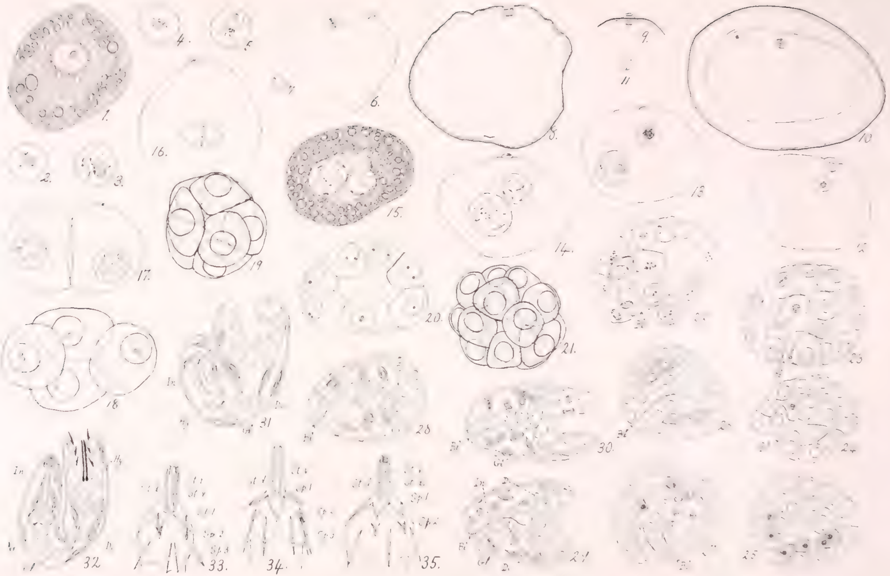
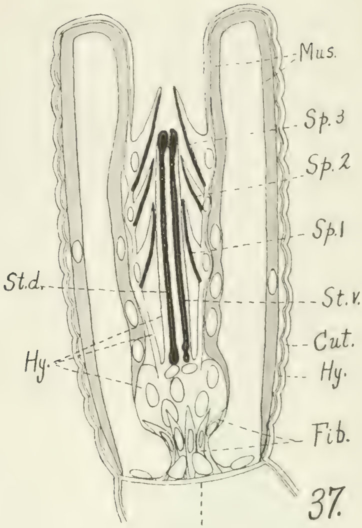


MONTGOMERY. LARVA OF PARAGORDIUS



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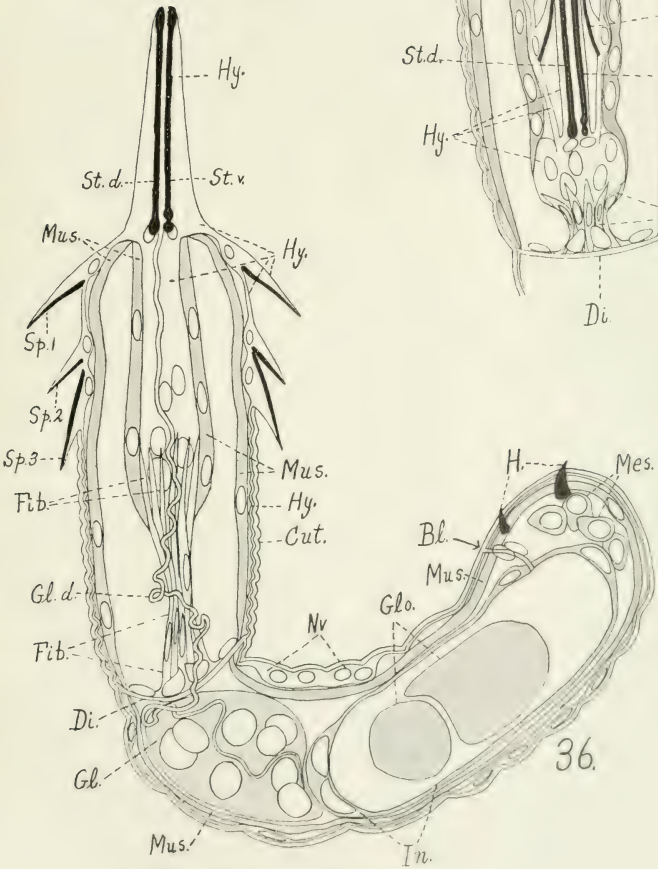

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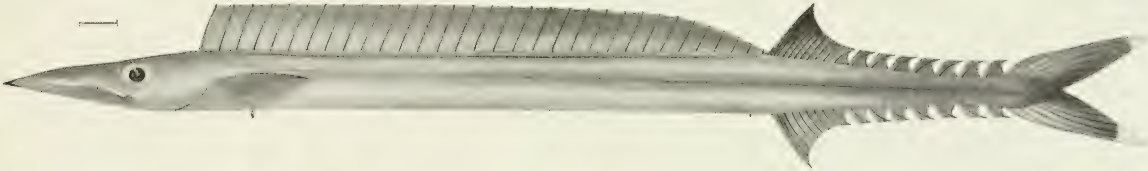
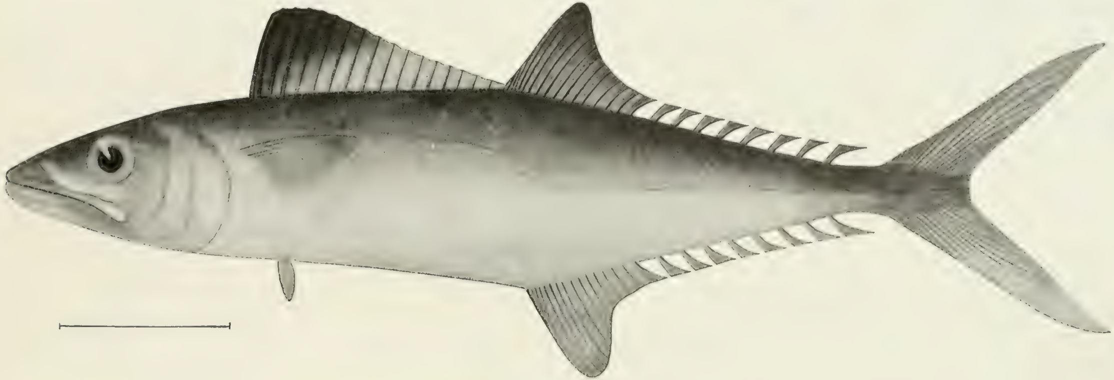
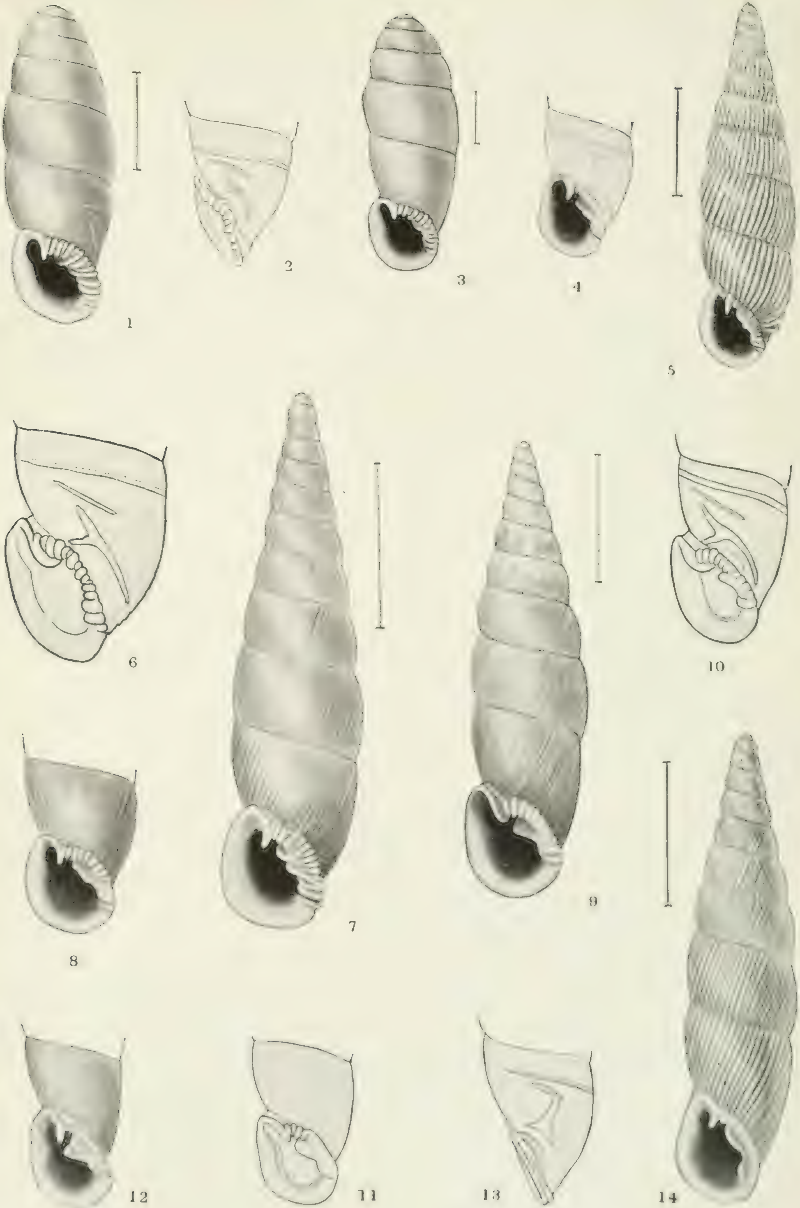
MONTGOMERY. LARVA OF PARAGORDIUS.



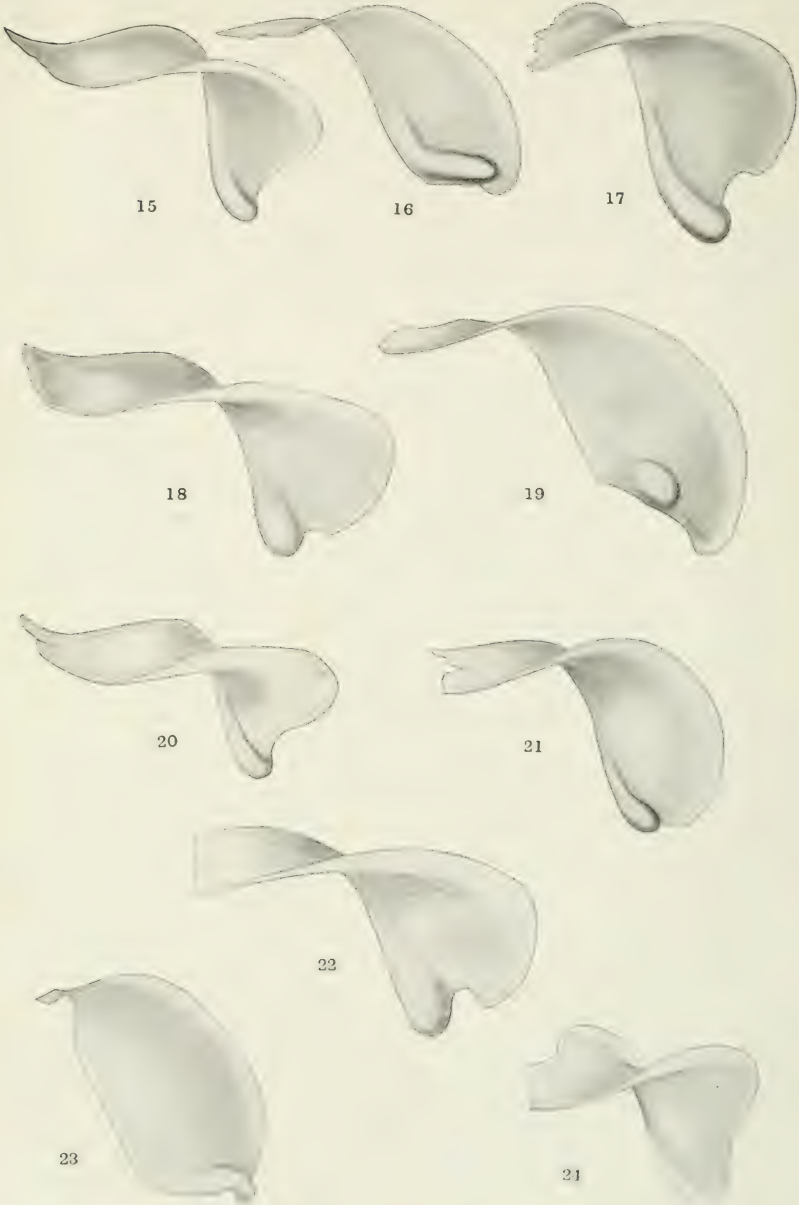


LEMNISOMA SERPENS (CUVIER).
SCOMBEROMORUS ARGYREUS FOWLER.



Pilsbry, del.

PILSBRY. NEW JAPANESE CLAUSILIIDÆ.



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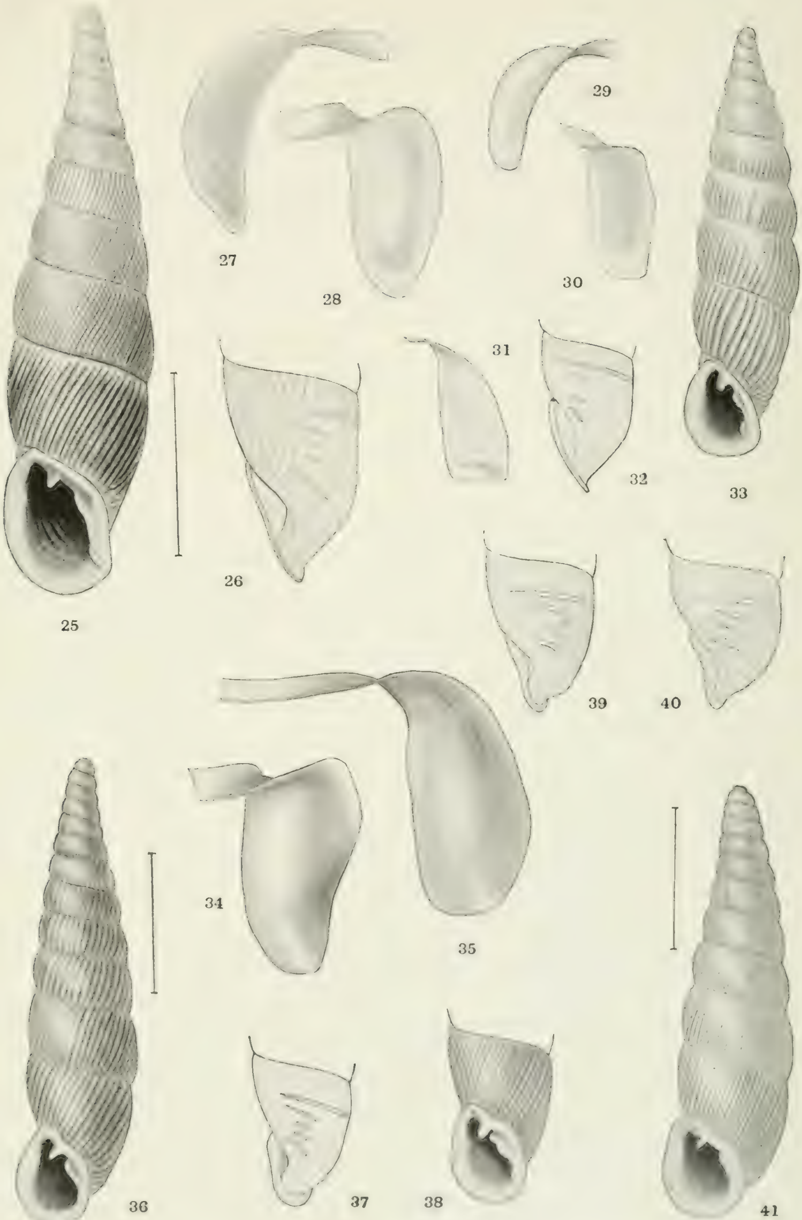
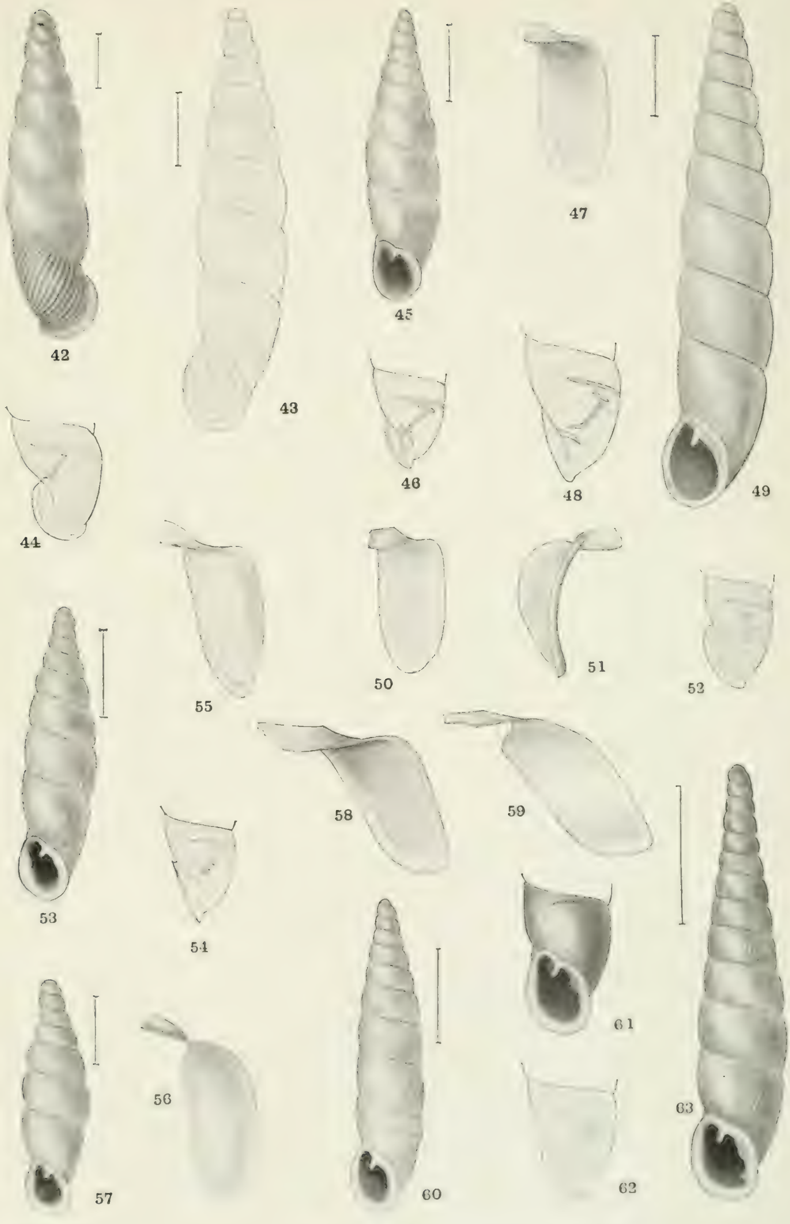


Pilsbry, del.

PILSBRY. NEW JAPANESE CLAUSILIIDÆ.



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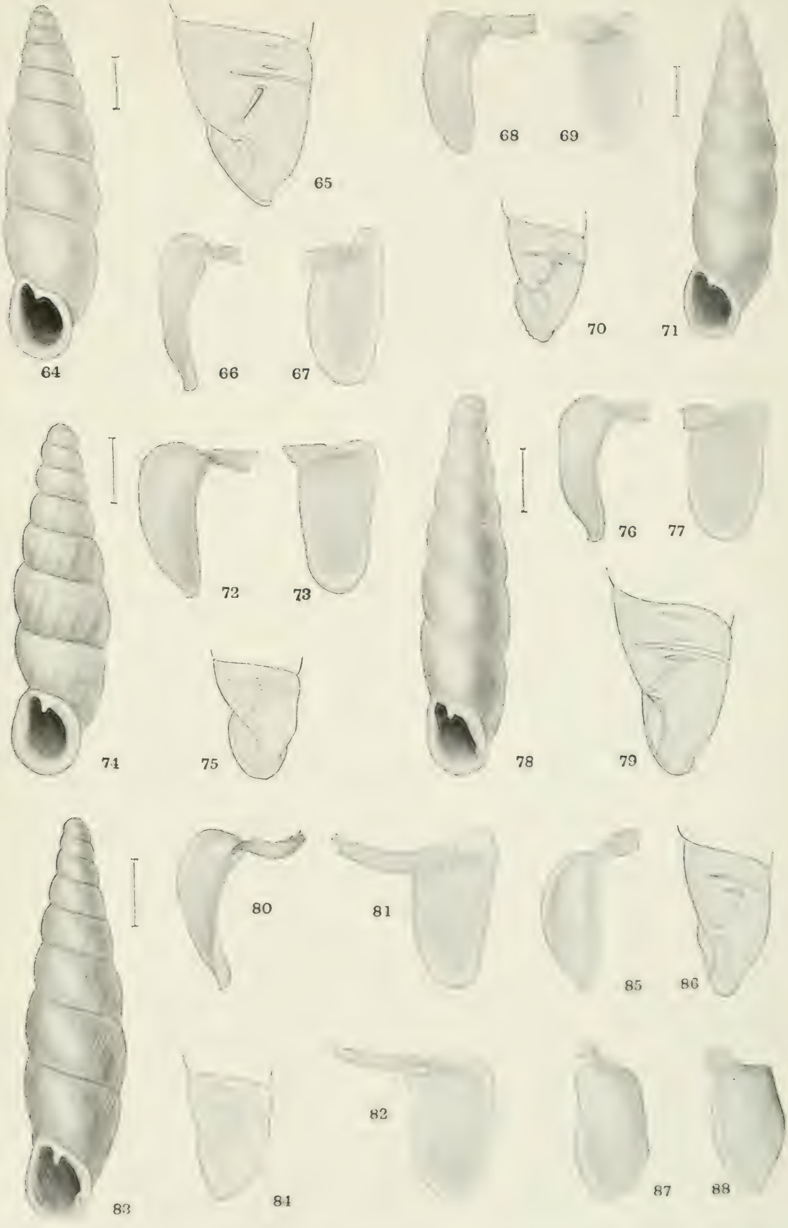

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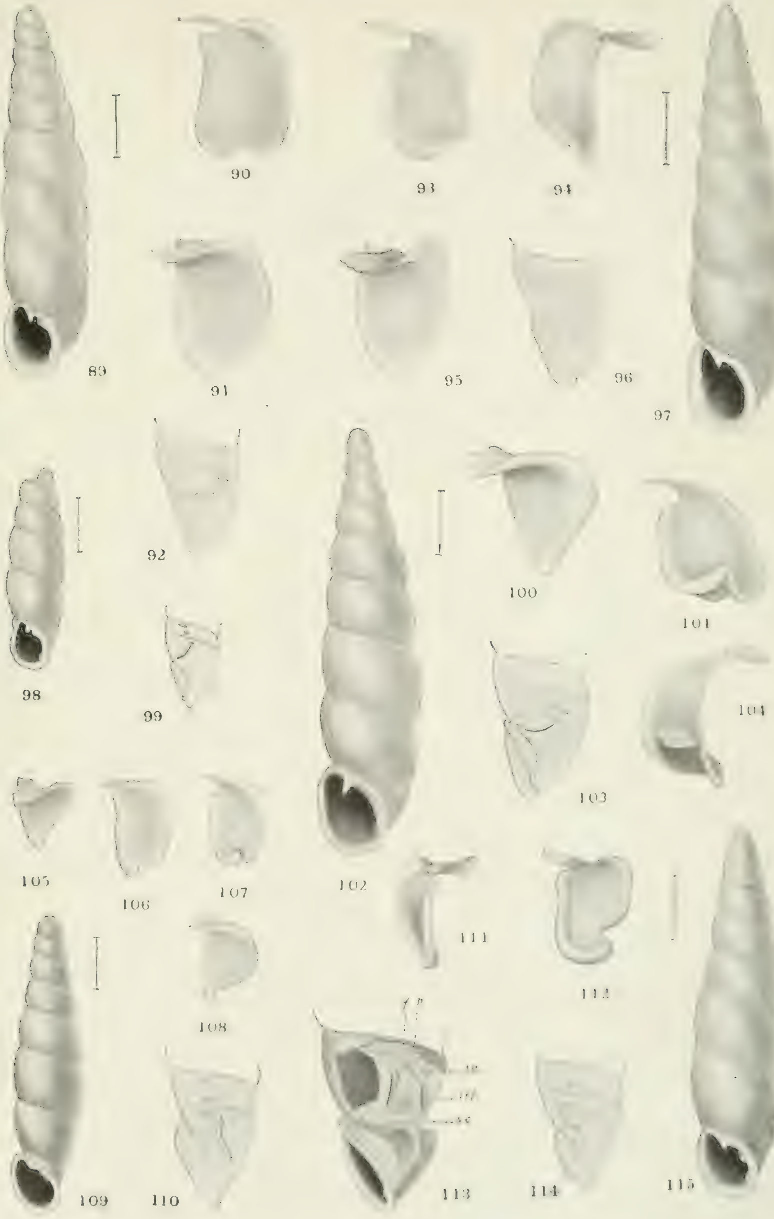

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